NURSERY AND GROW-OUT OPERATION AND MANAGEMENT OF MILKFISH

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ABSTRACT

This paper reviews the results of studies on the pond culture of milkfish *Chanos chanos* Forsskal at the SEAFDEC Leganes Brackishwater Station, Leganes, Iloilo since its establishment in 1973. Substantial contribution on the nursery system includes increased stocking density and survival through the use of nylon substrates, supplemental feeding with rice bran, the use of hatchery-reared and stunted fingerlings as alternative sources of stocks, and improvements in the acclimation process. Studies on monoculture and polyculture in grow-out ponds investigated the use of stunted fingerlings, kitchen or algal nursery ponds, stock manipulation techniques, increased stocking density using the plankton method, method frequency and quantity of fertilization, modular pond culture system, and initial findings on fish diseases. Constraints setting back increased production in the Philippines are discussed.

INTRODUCTION

Milkfish farming is one of the major aquaculture ventures in the Philippines. Milkfish culture originated centuries ago starting with the enclosure of nipa swamps or inlets indenting the shores with dikes at their narrowest entrance. Stocking was by chance entry of fry carried by the incoming tide. With the conversion of swamp-lands into productive culture areas, it became necessary to dispense with this inadequate and uncertain method of stocking the ponds.

Traditional milkfish farming employed an enclosed portion within the nursery pond which served as acclimation area. The delicate fry were allowed to grow for a few weeks before they were released into the rest of the nursery pond (Pillai 1962). Those in the Visayas and Mindanao, however, were generally without nursery ponds. As a result, only one harvest could be made in one year with an average production of 70 kg/ha/yr (Villaluz 1953). Milkfish fry were stocked at 25-50/m^2 and rice bran was fed at 5-10 kg/ha/day once the natural food was depleted (Pillai 1962). The fry were kept for 1-2 months and could be overstocked to keep them stunted until ready for stocking into rearing ponds.

There was no definite stocking density in rearing ponds as stocking was primarily dependent upon the availability of *lumut* to support the stock (Adams et al 1932). Villaluz (1952) reported that this practice was a real hit-and-miss method as oftentimes *lumut* was depleted long before milkfish were ready for harvest. In some fish farms, a transition pond was used before fish were stocked in rearing ponds. The fingerlings were stocked at 1 500-2 500/ha and reared for 3 months until they have grown to three inches length. They were then transferred to rearing ponds and raised for 4-7 months depending upon the quantity of *lumut* available (Pillai 1962). Some progressive farmers, such as those in Dagupan City, use bigger post-fingerlings, so that culture usually took only 6-8 weeks.

Fertilization was carried out primarily by using organic fertilizers such as chicken, cow and pig manure, human night soil, rice bran, and leaves of leguminous plants (Pillai 1962). Pests and predators were eradicated by thorough drying of pond bottom for 1-2 weeks until it cracked. Screens made of abaca or sinamay cloth were installed at the sluice gates to prevent entry of unwanted species.

Various strides have since then been made and, noteworthy of which was the introduction of the shallow-water method commonly called *lablab* method by a Taiwanese consultant in the 1960's. In 1974, one year after the establishment of SEAFDEC in Iloilo, the first cooperators' program was launched to collect benchmark information on the traditional pond management practices under varied pond conditions (Agbayani et al 1975). Out of 16 cooperators, six applied chemicals such as Aquatin, DDT, and Bayluscide to eliminate pests and predators such as snails, tilapia, ten-pounders, and gobies during pond preparation. Fertilization seemed accepted among cooperators. Nine cooperators applied inorganic fertilizers in different quality and quantity. This suggested that in spite of its long existence, some milkfish farms were extensively managed.

A socio-economic survey of the milkfish industry reported that the average inorganic fertilizer rates varied from two applications of 37 kg/ha/yr of nitrogen to seven applications of 40 kg/ha/yr of phosphorus to somewhere between these two extremes (Librero et al 1977).

Some traditional farms yielded, 50-300 kg/ha/yr (Hopkins and Hopkins 1983). In 1975, the national average production was 605 kg/ha/yr (PCARR 1978). A decade later, it increased to 870 kg/ha/yr (Samson 1985). Milkfish production from brackishwater ponds alone yielded 135 951 mt in 1980 which rose to 198 729 mt in 1984 (BFAR 1984). By 1990, milkfish brackishwater production is projected to be 395 000 mt, a demand at 145 690 mt and exports at 1 129 mt (Samson 1985).

This paper highlights the results of experiments on milkfish nursery and grow-out culture at the SEAFDEC Leganes Brackishwater Station. Other results need refinement before their application while other techniques have already been disseminated to the industry through in-situ training programs, publications, cooperators' programs, and consultative meetings with fish farmers. At these meetings, SEAFDEC researchers come to know the problems of the industry, so that research thrusts of the Department can be geared towards their solutions.

MILKFISH POND OPERATION AND MANAGEMENT

Rearing Facilities

The experimental ponds used for milkfish nursery and growing studies at the SEAFDEC Leganes Brackishwater Station are of 24-144 m^2, 12-350 m^2, and 6-2 000 m^2. Four units of 1 ha each serve as production ponds. The nursery system consists of 4-1 000 m^2 and 2-1 500 m^2 ponds which supply milkfish fingerlings for both research and production. The milkfish modular system consists of 4 sets of modules at sizes 1:2:4. On the other side of Gui-gui Creek, a 1-2 000 m^2 pond serves as transition area for one set of module at sizes 1:3:5. The transfer gates between the modules facilitate the movement of stocks. Generally, the ponds are rectangular and oriented according to the prevailing wind direction to minimize dike erosion by wave action.

Nursery System

An effective method of eradicating predators consists of applying lime at 1 t/ha and ammonium sulfate (21-0-0) at 10 g/m^2 to undrained canals, holes, and gate areas when the water pH is still high. Gobies, tilapia, and shrimps are killed in less than an hour when eradication is carried out under strong sunlight when the air is still, as wind increases ammonia loss considerably (Norfolk et al 1981). Since liming is routine during pond preparation, the only additional cost incurred is that of 21-0-0. This is an improvement over the use of chemical pesticides which leaves residual effects and destroys the pond ecology.

With the breakthrough in the spawning of milkfish in captivity, it was imperative to compare the performance of the hatchery-produced fry with those of the wild-caught ones. Results showed that there was no significant difference in survival and growth in both sources of fry (Baliao et al 1980). This suggests that the hatchery-produced fry can be an alternative fry source to alleviate shortage.

Nursery studies were directed towards improving the survival of 50-60% and stocking density of 25-50 fry/m^2. The highest mean survival of 71.5% was obtained for fry stocked at 75/m^2 and fed with rice bran and the lowest mean survival of 51.7% at 50 fry/m^2 without supplemental feeding (Villegas and Bombeo 1981). High survival rate of 81% at 100 fry/m^2 was attained by installing nylon screen substrates to increase the surface area for attachment of food organisms (Anon. 1982). Rice bran was given at 5% biomass one month after stocking fry. The possibility of mass fry production was investigated in a 1-ha pond using the *lablab* method stocked with 500 000 fry. A high survival rate of 88.7% was largely due to an effective predator control (Anon. 1979).

Stunting of milkfish fingerlings has long been practised in the, industry. However, the effects of stunting duration and stocking density on the survival of stunted fish were poorly understood. Hence, a study was conducted with stocking densities of 15, 20, 25, and 30 fingerlings/m^2 subjected to 6-month stunting. Results showed that highest survival of 86.9% was attained at 20 fingerlings/m^2 although this was not significantly different from those in 15 and 25 fingerlings/m^2. Based on these results, a follow-up study was undertaken with 20 fingerlings/m^2 subjected to various stunting durations. Those stunted for 6 and 9 months were not significantly different in mean body weight and survival. Only the 12-month stunted fingerlings yielded significantly lowest results (Baliao et al 1987). From the economic point of view stunting for 6-9 months at 20 fingerlings/m^2 is most cost effective. This permits the production of milkfish fingerlings at lower cost than they can be purchased (Baliao et al 1987).

It should be noted that acclimation ponds and hapa nets which are tedious and time-consuming methods are no longer used in the stocking of fry in the nursery ponds. Researchers at SEAFDEC Leganes Station realize that acclimation is still a vital process before stocking. However, acclimation is now made simple and easy by the gradual adjustment of salinity and temperature of the fry right inside the plastic bags to that of the pond water. Stocking is done during the cooler time of the day.

Grow-out System

Monoculture. The argument against the use of stunted fingerlings in grow-out ponds rests mainly on whether stunting per se could adversely affect growth of stunted fish. Hence, a preliminary study was carried out to compare growth and survival of stunted and non-stunted fingerlings. Non-stunted fingerlings clipped at the right pectoral fin and stunted ones clipped at the left pectoral were stocked in the same pond. Results indicated that there was no significant difference in the growth and survival between two treatments (Lijauco et al 1978). In a related study, a comparison was made using 2-month old non-stunted fingerlings initially weighing 3.3 g, 3-month old and 6-month old stunted ones initially weighing 7.8 g and 43.1 g, respectively. Results showed that survival, weight gain, and total harvest did not differ significantly among three treatments. This suggested that stunting does not adversely affect growth and production of milkfish and can therefore be practised by fish farmers to provide a year-round supply of fingerlings (Tuburan unpublished).

The use of kitchen algal nursery pond at varying sizes of 3%, 6%, and 12% of the grow-out area was verified. The rationale behind its use was to produce maximum biomass *lablab* for fish in grow-out ponds. Results revealed that the control (without algal nurseries) yielded the highest body weight and survival (Anon. 1982). There is, therefore, no need to employ kitchen pond as this reduces the area for fish production.

The possibility of adopting here the stock-manipulation technique popular in Taiwan was tested with two-size groups of fingerlings comprising 50% each of the total population. The total stock in each treatment was 6 000/ha. The study was on the time intervals in stocking which were programmed at 0 (control), 15, 30, and 45 days. The 45-day stocking interval yielded the highest weight gain of 216.6 g, those in the control the lowest value of 165.7 g (Anon. 1983). A subsequent pilot study was undertaken to refine this technique in a modular pond system. Two production runs at a stocking density of 3 000/ha based on the area of the last module yielded 2.2 mt, 200.8 g, and 93.3% for the first run while the second run yielded 2.4 mt, 198.4 g, and 99.4% for gross production, body weight, and survival, respectively (Anon. 1983).

An attempt was made to increase the usual stocking density of 3 000/ha using the deep water or plankton method. This bears an assumption that as the plankton method requires bigger water volume, more food organisms are produced to support higher stocks. The highest mean weight increment of 1.64 g/day was attained at 4 000/ha while the lowest value of 0.76 g/day was attained at 8 000/ha (Anon. 1983). Based on these results, a subsequent study was made with lower densities of 4 000/ha, 5 000/ha, and 6 000/ha which attained weight increments of 1.4 g/day, 1.2 g/day and 1.0 g/day, respectively (Anon. 1984). In the next run, the stocking density was placed at 4 000/ha and different supplemental feeds such as rice bran, trash fish, a mixture of rice bran and trash fish, and no supplemental feeding were evaluated. Fish fed with a mixture of trash fish and rice bran grew best with a weight increment of 1.4 g/day (Anon. 1985). From the results, it appears that further tests on the plankton method are needed before it is recommended to the farmers. It requires deeper water and pond renovation which is expensive.

Lumut was primarily the natural food base in the traditional milkfish culture. However, it was found out that milkfish trypsin was inhibited by a tryptic inhibitor from *Chaetomorpha brachygona,* a major algal component of *lumut.* This may explain the slow growth rate of milkfish fed with *lumut* (Benitez 1985).

Water exchange in milkfish farming is usually done once every two weeks during high tide. An optimum combination of water exchange and fertilization, however, needs to be determined to maximize production. The biweekly water exchange and biweekly fertilization scheme yielded the highest production of 530.2 kg/ha/crop while the biweekly water exchange and weekly fertilization gave the lowest yield of 414.1 kg/ha/crop. No significant difference existed between the weekly and biweekly water exchange when considered as a single factor. The biweekly fertilization, however, resulted in significantly higher production than that of the weekly application (Tuburan unpublished). It is therefore suggested that farmers combine water exchange and fertilization biweekly as this is less laborious and not time-consuming.

Fertilizer application in brackishwater ponds has not been standardized. The use of 16-20-0 at 50 kg/ha and of 45-0-0 at 15 kg/ha, their half-dosages, chicken manure at 0.5/ha, and MASA organic fertilizer (processed from agricultural and industrial wastes) at 0.5/ha applied biweekly were evaluated in milkfish ponds. Mean body weight, survival, and gross fish production were not significantly different among treatments. The net profit, however, was highest with 16-20-0 at 50 kg/ha and 45-0-0 at 15 kg/ha (Tuburan et al unpublished). During the succeeding dry season these fertilizer dosages, their half-dosages and two levels of 18-46-0, were tested. The best fertilizer treatment was that of half-dosages (Tuburan unpublished). It appears that 16-20-0 at 50 kg/ha and 45-0-0 at 15 kg/ha are more efficient in providing nutrients for primary productivity during the wet season while the half-dosages are effective during the dry season. Results, however, need further tests although it appears that inorganic fertilizer enhances good *lablab* growth enough to support milkfish to marketable size.

The broadcast method of fertilization has been popular among fish farmers. Another method used is the silo wherein baskets containing fertilizers are submerged in pond water, allowing continuous supply of nutrients instead of the single biweekly dose. Results showed no significant difference in growth and survival between the broadcast and the silo methods (Gerochi et al unpublished).

The most widely practised milkfish culture system is the straight culture. Recent innovations, however, lead to the modular system which consists of monthly stock transfers in three modules of increasing sizes. This modular pond system was verified in sizes of 1:2:4 at two schemes: (a) 3 000/ha based on the area of the last module, and (B) based on the total area of all modules. Mean body weight and survival were 251 g and 87% for scheme A and 242.8 g and 89% for scheme B. Net production of 608.5 kg/ha/crop in scheme A was higher than 357.4 kg/ha/crop in scheme B (Anon. 1983). A similar study was made with two sets of modules: one set with 1.47 ha, 2.08 ha, and 3.21 ha and another set with 0.68 ha, 0.76 ha, and 1.27 ha. Three consecutive monthly harvests yielded a total of 10.11 mt for A and 2.57 mt for scheme B. Six croppings per year are likely.

Polyculture. Systematic polyculture was not popular before the establishment of the Department. Milkfish was the main culture species while prawns and shrimps were only incidental products. The first polyculture study was with *Penaeus monodon* at 1 500/ha and milkfish at 3 000/ha which gave the highest combined yield of 432 kg/ha (Santiago and Santiago unpublished). In a related study, highest combined production was obtained at 2 000 milkfish/ha and 8 000 prawns/ha which gave 521.3 kg/ha compared with milkfish only which yielded 286.7 kg/ha. Mean net production of both milkfish and prawns considered singly were highest in a combination of 2 000 milkfish/ha and 8 000 prawns/ha although no significant difference existed among treatments (Eldani and Primavera 1981). In another study, highest combined production of 463.6 kg/ha was attained with 2 000 milkfish/ha and 6 000 prawns/ha. At stocking rates of 2 000/ha and 4 000/ha, monoculture of milkfish yielded slightly higher production than polyculture. The competition of prawn against milkfish was almost negligible while milkfish exerted a greater competition against prawn (Pudadera and Lim 1982).

Use of formulated feeds in milkfish monoculture and its polyculture with prawns was tested. Results indicated that highest total production of 335.7 kg/ha was attained in milkfish alone without supplemental feeding. However, this was not significantly different from those stocked with 2 500 milkfish/ha and 3 000 prawns/ha with and without supplemental feeding (Villegas and Baliao 1980).

A comparative study of milkfish and prawn cultured singly and in combination yielded a production of 923.5 kg/ha/crop in polyculture with return on investment (ROI) of 45%. Chopped trash fish was given daily to prawns at 10%, 8%, and 6% of the biomass adjusted monthly (Kuntiyo and Baliao unpublished).

Polyculture of milkfish with crabs yielded the highest combined production of 661.7 kg/ha with 2 500 milkfish/ha and 5 000 crabs/ha (Table 1). As early as day 60, size and weight of crabs varied widely and some crabs had already attained fairly good marketable sizes. The net production of crab was higher in polyculture than in monoculture but the opposite was the case for milkfish (Lijauco et al 1980). Another study confirmed earlier results that 2 500 milkfish/ha and 5 000 crabs/ha had 500 kg/ha crab production and 600 kg/ha milkfish (Baliao 1983).

Polyculture of 3 000/ha milkfish and 6 000/ha prawns was tested in a modular pond. Milkfish attained a mean body weight of 220.2 g while prawns attained 38.75 g (Anon. 1984).

Table 1. Average Production and Survival in Monoculture and Polyculture of the Mud Crab, *Scylla serrata,* and Milkfish

Treatments	Gross Production (Kg/Ha) Milkfish	Crab	Survival (%) Milkfish	Crab	Feed Conversion
Milkfish only: 2500/ha	533.4		97.3		
Crab only: 5000/ha	–	336.2		37.0	18.4
Crab only: 10 000/ha	–	445.3	–	26.5	68.1
Polyculture: Milkfish: 2500/ha	372.9		91.3		
Crab: 5000/ha		449.7		56.0	9.0
Polyculture: Milkfish: 2500/ha	395.0		100.0		
Crab: 10 000/ha	–	529.0	–	26.5	37.3

(Lijauco, Prospero, and Rodriguez 1980)

An attempt was made to polyculture sea bass with various stocking densities of milkfish and tilapia. Results indicated that the best combination of sea bass, milkfish, and tilapia was 5 000/ha, 1 500/ha, and 4 000/ha with survival rates of 75.6%, 89.7% and 70.6% and net production of 1 459.4 kg, 229.9 kg and 168.21 kg/ha/crop, respectively (Anon. 1984).

HARVEST AND POST-HARVEST HANDLING

The harvest method is locally known as *pasulang* or *pasubang* which takes advantage of the behavior of milkfish to swim against the current. This involves draining 85-90% of the pond water during low tide and allowing in water at the incoming high tide so that the fish swim against the current through the tertiary gate and into the catching pond. The gates are then closed after a greater percentage of fish has been impounded while the rest swim back to the rearing area. From the catching pond the fish are seined while the remaining ones are handpicked during the total drain.

PRODUCTION CONSTRAINTS

The various problems that beset milkfish production in the Philippines are technical, social, economic, institutional, environmental, and political (Schmittou et al 1985). Typhoons, acid sulphate soils, and other physical factors are also constraints in some areas. Filipino fish farmers are equipped with skills to practice intensive fertilization and extensive feeding in ponds. The prohibitive costs of imported inorganic fertilizers and commercial feeds, however, restrict them from improving their technology. Generally, the farmers are responsive to technological change and may even take risks in ventures that promise quick returns. The major economic constraints, however, are the high capital required and the high cost of credit. Infrastructure, in relation to availability of ice and transportation, are difficult problems especially outside the Manila-Central Luzon area. Research facilities are believed adequate for effective research but well-trained scientists are still insufficient. Generally, budgets barely meet salary requirements, leaving a small portion for research. The well-trained technicians and researchers often join private companies which offer attractive salary, incentives, and the opportunity to learn the intensive prawn culture techniques which is now the trend. Future expansion is also limited by some regulations on mangrove swamp alterations to protect an important ecological resource. The peace and order situation in the country also poses a threat to the further development of aquaculture.

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