ISSN-0115-5369

Aquaculture Extension Manual No. 4

MILKFISH CULTURE IN BRACKISHWATER PONDS

Melchor Lijauco, Jesus V. Juario,
Dan Baliao, Eliseo Grino,
Gerald Quinitio

AQUACULTURE DEPARTMENT
SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER
Tigbauan, Iloilo, Philippines

ISSN-0115-5369

Aquaculture Extension Manual No. 4

MILKFISH CULTURE IN BRACKISHWATER PONDS

Melchor Lijauco, Jesus V. Juario,
Dan Baliao, Eliseo Grino,
Gerald Quinitio

AQUACULTURE DEPARTMENT
SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER
Tigbauan, Iloilo, Philippines

UNDP/FAO
NETWORK OF AQUACULTURE CENTRES IN ASIA

Table of Contents

Page

FOREWORD

In this manual we selected and put together results of research, our own experiences, observations of fishfarmers' production practices, and the documented experiences of a few of the Philippines' more progressive milkfish culturists. It has not been an easy task for a number of reasons:

Firstly, we are aware that the different milkfish producing regions of the country present a wide variety of conditions, a factor that tends to obtuse generalized recommendations; secondly, many of the results of laboratory and field experiments, while scientifically unassailable, have not been adequately refined for application under specific situations and rigorously tested in farmers' ponds; thirdly, a number of fish farming systems, especially those of recent origin, have been showing varying degrees of success, from the modest to the spectacular, which however cannot be adequately traced to well-defined variables; and finally, the business of fish farming is faced with numerous unquantifiable and unpredictable elements for cut and dried recommendations to always ensure its success.

This manual is a guide for operation not a recipe for success in milkfish farming. The information selected for inclusion do not so much prescribe solutions as to lessen risks.

We ask the user to contribute to its refinement, enlargement of scope and content, and, where necessary, make corrections to enhance its usefulness.

I. HANDLING OF FRY

Milkfish fry are fragile and delicate; they should be handled with extra care to lessen mortality.

1. *Counting the fry*

Place the collected fry in a big white plastic basin. Gently scoop several fry with a small white bowl. For a certain number of fry, set aside a corresponding number of stones or pebbles. When a thousand fry have been counted, use its density as the basis of comparison for separating the rest of the catch into lots of thousand. Use the average in ten jars to determine the total number in a consignment. This procedure is inaccurate and could lead to erroneous transaction between dealer and buyer and may eventually result in inaccurate stocking in ponds. However, it is so far the only procedure developed to facilitate fry estimation and transaction.

2. *Storage*

Bangos fry are traditionally kept in unglazed earthen jar (palayok) of 20- to 30-liter capacity. Normally 2,000 to 2,500 fry can be stored in a 20-liter jar half-filled with water. Very few fry dealers are using this container because it easily breaks. Most of them use either big white plastic basins about 15 cm deep and 56 cm in diameter (25 L) or wooden boxes measuring 61 x 61 x 10 cm (36 L). Aside from being unbreakable, these containers have a wider mouth and thus provide a wider water surface area for oxygen exchange and facilitate the removal of dead fry, feces and excess food. Approximately 6,000 to 8,000 fry can be kept in those containers with a water depth of 5 to 10 cm.

Store the fry in seawater or freshwater. If you store them in freshwater, be sure the change from seawater to freshwater is gradual. Most fry dealers generally use 1 part seawater and 2 parts freshwater during summer and a 1:1 ratio during rainy season with a resulting salinity of about 18 parts per thousand. Store the fry in a shaded place (*bodega*) to protect them from direct sunlight and to prevent high temperatures. The fry are stored for two weeks, at the most.

The yolk of a hard-boiled chicken egg is usually fed to the fry during storage. Crush the yolk finely and blend it with a small amount of water. Sieve the resulting mixture through a clean cloth or a fine meshed nylon screen. Dealers usually give three tablespoons of the freshly prepared feed for every 6,000 fry and three hard-boiled egg yolks per 100,000 fry. Feed the fry only once a day.

Change the water daily and remove dead fry, feces and excess food. Smoothly stir the water in circular motion to concentrate the dead fry, feces and excess food at the center. Then scoop them out by using a small plastic bowl. This helps prevent pollution, contamination and development of bacteria and will definitely enhance high survival of fry.

3. *Transport*

Bangos fry are transported in oxygenated plastic bags placed in a native bag made of woven *pandan* leaves (*bayong*) to prevent them from being punctured and to facilitate handling. To transport the fry use 2 polythylene bags, one inside the other, with a dimension of 61 cm in width and 91 cm in length and place them in the *pandan* bag. Fill the polythylene bag 1/2 to 1/3 full of seawater, or ordinary well water if the fry have been acclimated to freshwater. You can put 6,000 to 10,000 fry into one bag. To fill the bag with oxygen, bunch the mouth of the inner bag and press it down to deflate the air inside. Then, introduce oxygen into the bag through a hose to inflate. Close the plastic bags tightly and separately by means of rubber bands. For long distance travel, it is more advantageous to put the oxygenated plastic bags in styrophore boxes or cartons.

II. POND LAYOUT AND CONSTRUCTION

1. *Selection of farm site*

A number of factors affect your choice of a milkfish farm site. These factors have to do with the physical and climatic conditions prevalent in the area, including some socio-economic factors that may affect the construction of ponds and other facilities and farm operations.

a. *Climate*

Milkfish are observed to grow faster in warm water above 23°C, and its growth is retarded when salinity rises beyond 45 parts per thousand. Consequently, regions having a short dry season (3 to 4 months) followed by a relatively wet season are more favorable than those having rainfalls evenly distributed throughout the year. In the latter, difficulty will be encountered in growing lablab. In this situation, the dominant type of food will be the grass green algae or *lumut* which gives lower yields.

b. *Soil*

The best types of soil are clay, clay loam and sandy clay. Hard mud of the above types is preferable to the soft and loose kind. These soils insure good quality materials for diking and make good pond bottom for the growth of algae. Highly acidic soils should be avoided. This type of soils is characterized by yellowish to reddish particles often becoming reddish when exposed.

c. *Topography*

Level marshes and tidal flats are preferred sites. Undulating or rolling areas entail big capital expenses for excavation and levelling. Also, large-scale excavation of uneven surface may expose poor quality soil which may require a long period of conditioning to make the pond bottom productive.

Normally, swampland areas, although level, may slope slightly towards the river or coastline. A good knowledge about the lay of the site helps you minimize earthwork and plan your farm layout to fit the natural topography of the site.

d. *Elevation*

A milkfish farm must have proper elevations in order to insure adequate water supply and to effect drainage when necessary. Therefore, the pond bottom elevation or elevations should enable water to be supplied during ordinary high tides and allow draining during ordinary low tides.

A poorly constructed fishpond is one that has to wait for extremely high tides to admit water, and extremely low tides to drain.

Different regions have different tide ranges; some with wide ranges, some with narrow ranges. Therefore, a prospective farmer needs to know the tidal characteristic of his locality to enable him to determine the ideal pond elevation for his area.

e. *Water Supply*

Good quality water should be adequate all year round. It may come from a tidal river, stream or creek or directly from the sea. Salinity of the water from a tidal river may vary widely from that of seawater to brackishwater depending upon its distance from the open sea and the nature of the surrounding area. Occasional pollution of the river water may occur as there may be industrial establishments located upstream. The likelihood that the water is polluted should be investigated.

The presence of a source of freshwater is beneficial especially during a long dry season, to prevent the rise in pond water salinity. Moreover, lower salinities also favor the growth of prawns especially the sugpo aside from milkfish. In some cases, fishpond sites are situated alongside or near hills or high grounds. Run-off water from these high grounds can be prevented from directly flowing into the fishpond system by constructing diversion canals beyond the peripheral dikes.

f. *Vegetation*

Thickly vegetated areas should be avoided. Aside from entailing extra expenses in uprooting trees and other plants, the presence of excessive tree stumps may indicate poor quality soil.

g. *Other socio-economic factors*

Pond construction and management depends largely on the availability of cheap and skilled labor, accessibility to markets and sources of construction materials and production inputs as well as the peace and order situation in the locality. These factors can off-set the technical considerations discussed earlier.

2. *Layout*

Farm layout or design will depend on various factors such as a) type of operation desired; b) and such factors as size, shore development, the shape of the site.

The type of operation may be a) purely nursery system; b) purely rearing pond system; and c) combination system or one with both the nursery and rearing pond system. In the first, the farm consists mainly of nursery ponds and holding or stunting ponds. Fry are grown into fingerlings which are sold to other fish farmers.

In the second system, the farm is divided into rearing pond compartments. No nursery pond system is provided. Stunting or holding pond may or may not be present. In the combination or complete system, the farm is apportioned into nurseries, stunting, and rearing ponds. Independent operation is normally possible in this type for rearing fry to fingerlings and to marketable size.

In any one of these types, the twin objectives in the planning of a layout or design are functionality and economy. Overall others, a rectangular farm project is ideal as it will cost relatively less in terms of dike construction and earthwork. Project sites which are long and narrow or very irregular in shape will entail higher development cost.

The following may serve as guidelines in planning the layout of a farm.

1. The main gate is generally located at the lowest portion closest to the source of water, but strategically located as to distribute water effectively into the pond system. Normally, a one-door main gate is sufficient for a 10-hectare project.

2. The whole area is enclosed by well-built perimeter dikes. Smaller secondary dikes divide the area into smaller compartments.

3. For effective water management and ease of transfer and harvest of stock a system of canals and catching ponds is provided. A section of the main canal immediately in

front of the main gate may be used as catching or holding compartment for fish.

4. Each pond must be operable independently of one another.

5. The nursery system is situated close to the stunting or transition pond, and is centrally located to minimize distance of transfer of fingerlings within the farm. In large projects more than one nursery system may be necessary.

6. The plan should, as much as possible, divide the farm symmetrically into regular-shaped pond compartments. Crooked or winding partition dikes are more expensive to construct besides being more subject to wave erosion.

7. The nursery pond typically ranges from 1000 to 4000 square meters; stunting or transition pond averages 10,000 square meters; while rearing ponds vary from a few hectares to 15 hectares or even more. An ideal size for rearing pond is about 5 hectares.

8. In a combination system, the nursery ponds occupy 3 to 5% of the farm area; stunting and transition ponds 20 to 30%; the rest for rearing ponds, canals, dikes, etc.

9. Perimeter dikes along rivers, creeks and shorelines should be built 3 to 6 meters within the property boundaries to allow growth of rooted vegetations which will serve as wind or wave breakers.

3. *Construction*

Developing a virgin site into a milkfish farm should follow specific strategies and work program after all other technical factors have been considered. For instance, a fishpond may be developed wholly if the area involved is small or when initial capitalization allows such undertaking. Otherwise, partial construction may be undertaken and the income derived from a limited operation is plowed back for further development or improvement.

Construction may be mechanized by using swampdozers, cranes, etc. In general, fishponds are built using manual labor, especially in areas which are relatively waterlogged or hardly accessible for heavy equipment to move in.

Normally, the first structure to be constructed is the perimeter dike in order to control the level of water inside the site. Without any control, water in the job site will rise and fall with the tide which makes programming or scheduling of work extremely difficult, if not impossible.

Simultaneous with the construction of the perimeter dike, work on the main gate may be started once its exact location has been fixed. At this stage some effort must be made to establish a benchmark (based on the zero datum of the tide) from where elevation of dikes, gates, pond floor, etc. must be reckoned.

It is extremely helpful to have a topographic survey of the site, especially in large projects to help plot a strategy of earthmoving that will entail the least cost. Such topographic survey may be contracted to a licensed surveyor if precision is required, although in most cases experienced pond contractors employ practical surveying methods making use of the water surface as a giant level to estimate relative differences in land elevations.

While the work on perimeter dikes progresses, construction of partition or secondary dikes may start to make up pond compartments and water ways. Some sections of the partition dikes may be kept open to allow passage of flatboats or dozers during clearing, excavation and levelling if excess soils need to be transported outside the compartment.

Clearing and levelling may be undertaken immediately after the compartments are formed or postponed until after the trunks have decayed. When excavating extensively, it is advisable to save the rich top soils by piling them up in a large heap. This is possible with the use of mechanized equipment. The top soil is pushed back into the pond after excavation to form the top layer of the pond bottom. Another way of preventing the loss of top soil is by doing strip excavation. This is done by excavating strips of land alternately after every 3 or 4 meters. The unexcavated areas including top soils are then levelled and made to fill the excavated strips.

4. *Plan and specification*

The major structures in a milkfish farm are 1) Main or perimeter dikes; 2) Secondary and tertiary dikes forming pond compartments and canals; and 3) Water inlets and outlets. Other essential structures are the caretakers house, chilling or killing tank and a storage shed or bodega.

The *path of the main dike* is cleared of trees and grasses including buried roots and stumps up to 2-4 meters wider than the proposed base. A puddle trench *mitsa* of about 50 centimeters wide and 50 centimeters deep is dug in the middle of the clearing. Packed with good soil, the *mitsa* helps anchor the dike to the subsoil and reduces seepage.

The *height of the main dike* should be at least 1 meter higher than the highest flood level at the locality. The slope may vary from 1:1 ratio (1 unit of horizontal for every 1 unit of vertical rise) in relatively protected section to 1.5:1 in exposed sections. Boulders may be used to reinforce sides that may be subjected to extreme current or wave actions. The crown should be at least 1 meter wide; in some it extends over 3 meters or more to allow vehicles to pass through.

During construction by manual labor, the whole length of the dike is divided into a number of sections, each assigned to a team of 10 to 15 workers. The dike is constructed layer by layer of neatly placed mud blocks, allowing each layer to shrink and settle before piling on another. Piled up in at least three horizontal layers, the finished dike should have an allowance of about 15-20% for shrinkage and setting.

Secondary and tertiary dikes are comparatively smaller and steeper than the main perimeter dikes. The secondary dikes form the large ponds and main water canals. The crown ranges from 0.5 to 1.0 meter and with a height of 1.0 to 1.5 meters from the pond bottom. The slope usually has a 1:1 ratio. Tertiary dikes make up the nursery pond system, with about 0.3 meter crown, 0.8 meter width at the base and 0.8 meter height.

These dikes are constructed in much the same way as the main dikes. Berms may be provided if there is a large excess of soil materials inside the compartments.

The *main gate* is one of the most important structures in the farm. If it fails to control water from the source, the whole fishpond faces the danger of being overflooded since secondary and tertiary dikes are much smaller and lower than the perimeter dikes. Repair work on a defective main gate is a major undertaking involving big expense. The construction of this gate, therefore, demands careful planning and utmost supervision. It may be made of wood or reinforced concrete.

Take into account four basic considerations when building a concrete gate:

1. Adequate foundation
2. Adequate reinforcement against sidewise pressure;
3. Prevention of undercutting.

Work on the gate starts by enclosing the site with temporary dikes. To insure a strong foundation, bamboo poles are driven 12 inches apart, center to center, until the hardest soil layer is reached. In addition to this, wooden stakes 2 inches thick, 6 inches wide and about 6 feet long should be driven close to one another forming a single line directly below the center of the wall and aprons. This will reduce the probability of scouring of the bottom. The piles are then covered with medium sized boulders on top of which are positioned the reinforcement bars before pouring in a class A concrete mixture 20 cm thick. One-half inch diameter steel bars are used for vertical and 3/8 inch for horizontal reinforcement. The sides of the gate which are about 1 meter apart rise vertically to the crown and extends all the way across the dike with the outer edges curving outward to form the wings. Curing is done by sprinkling the formed concrete with water or by covering the same with moist sacks.

The walls are provided with three pairs of grooves; the middle for the removable slabs to control water and the other two-one at each end for the screen to prevent entrance or escape of fish.

Secondary/Tertiary gates. These gates lead to the rearing ponds, transition ponds and nursery ponds. Ordinarily, they are made of wood and painted with coal tar, although they may be made of concrete or hollow blocks. Sizes are proportionate to dikes. Designs vary from the ordinary open sluice type to culvert or monk type. It is also useful to provide two pairs of middle grooves 30 centimeters apart (instead of the usual 1 pair) for occasional needs to soil seal the gates. Mud packs are held between two sets of slabs.

The gates may or may not have floorings. To reduce scourings, at least 2 feet wide lumber boards are sunk or nailed directly below the screen grooves at both ends and below the slab grooves in the middle.

Pipes. For small ponds, pipes can be used instead of the ordinary type of secondary and tertiary gates. They may be made of wood, asbestos or concrete. Common size is about 30 centimeters in diameter and the length depends on the span of the base of the dike. They are provided with slabs, screen or plugs to control water and to prevent entry or escape of fish to and from the pond.

Chilling or killing tank. This is designed to facilitate harvest and to pre-chill the fish in iced water before shipment to markets. Made either of wood or concrete, the tank normally measures 1 to 2 meters wide, 3 to 4 meters long and about 1 meter high. This is constructed immediately adjacent to the main catching pond where the harvested fish are temporarily confined. The fish are then seined, scooped or bailed out and put into the ice water contained in the tank. This way the fish die with the least struggle, thus, preventing damage to scales at the same time prolonging its qood quality.

III. POND OPERATION – CULTURE AND MANAGEMENT

1. *Nursery Pond Management*

The nursery pond locally called *semillahan, pabiayan* or *palakihan* is an essential unit in a bangos farm. Representing 3-5% of the farm, it is typically shallow and relatively smaller in area varying in size from 1,000 to 4,000 square meters. Fry are cared for in the nursery pond, stunted in the transition pond and stocked in the rearing pond where they are grown to marketable size. The pond units are arranged so that the nursery ponds are closest to the transition ponds. Together they comprise the nursery pond system. The nursery pond system is separated by secondary or tertiary dikes and provided with gates or pipes and canal systems or catching ponds to insure effective water distribution and ease in transferring and harvesting the stocks.

The goal of the nursery pond system is to provide the fish farmer with healthy and stunted fingerlings. Its attainment depends on the techniques and meticulous care practised by the farmer.

a. *Nursery pond preparation*

The amount and kind of natural food utilized by bangos fry to fingerlings are dependent on the manner they are produced in nursery ponds. Natural food is grown by known techniques using chiefly the combination of organic and inorganic fertilizers. For nursery pond operation there are two methods employed in rearing natural food namely, the lablab and the plankton method. Lablab is a biological complex of small plants and animals occurring initially in the pond bottom as a brownish, greenish and yellowish film. As lablab grow, additional layers develop forming a flabby mat at the bottom. Some patches detach and float. Plankton, on the other hand, is the collective term for all micro-organisms suspended in the water. This consists mainly of phytoplankton (plants) and zooplankton (animals). Maintained properly and abundantly lablab and plankton offer good sources of food for bangos fry and fingerlings.

Preparation of nursery pond starts one or two months before stocking the fry. This is done to obtain the best growth of natural food, eradicate unwanted species and maintain good water quality.

For lablab preparation the following procedures are done:

Level pond bottom to get the most production area and make water management more efficient.

Drain pond completely and allow to dry for about 1 to 2 weeks until soil cracks. Prolonged drying is not advisable; it makes the soil hard and powdery.

Apply chicken manure at 2 tons per hectare. Flood to a depth barely covering the pond bottom and apply 2 to 3 days later 1 bag of 16-20-0 (or 1/2 bag 18-46-0) per hectare. Urea (45-0-0) may be applied to speed up breakdown of chicken manure at the rate of 15 kilograms per hectare. Method of application is by broadcasting.

Increase depth gradually over a period of 1 to 1-1/2 months, 3 to 5 centimeters each time until the stocking depth of 25 to 30 centimeters is reached. An abrupt increase in depth causes lablab to detach and float. Install fine meshed screens at gates to prevent re-entry of wild species.

Subsequent application of 16-20-0 or 18-46-0 may be made at 1 to 2 weeks interval to bolster growth of lablab.

In case the plankton method is used, the following procedures are followed:

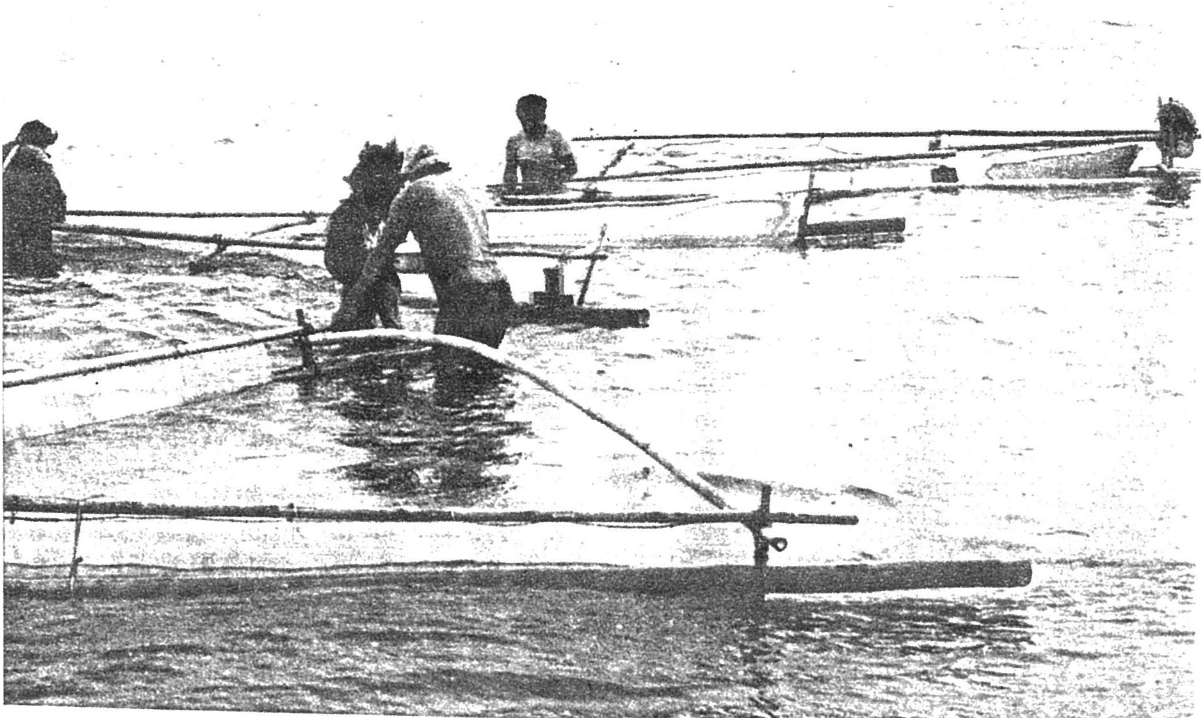
Drain the pond completely long enough to eradicate wild species and pests.

Admit water to a depth of at least 65 centimeters, preferably 75 to 100 centimeters. Take care that gates are provided with fine meshed screens to prevent re-entry of wild species. Apply 1 bag 16-20-0 (or 1/2 bag 18-46-0) on a platform. Plankton should bloom after about a few days characterized by a rich green pond water and a visibility of about 15-40 centimeters. Re-apply fertilizer if plankton does not bloom. If there is plankton bloom and the visibility is less than 15 centimeters (meaning there is excessively abundant plankton) stop fertilization and replace about 1/4 of the pond water. The pond is now ready for stocking.

b. *Nursery pond operation*

Mortality among bangos fry has been observed to occur mostly between the time of collection and stocking. This is due to poor handling techniques, presence of predators, dirty facilities, and salinity or temperature shocks. To minimize loss of fry, adopt proper techniques of sorting out predators and acclimating the fry to temperature and salinity conditions.

Newly arrived fry are normally contained in plastic bags with lower salinity ranging from 15-25 parts per thousand. The fry are usually emptied into plastic basins to facilitate sorting out of predators. If salinity of the water in the transport bag and that of the nursery pond are approximately the same, the fry may be stocked directly into the pond at the rate of 30 to 50 fry per square meter. However, if the salinity difference is over 5 parts per thousand acclimation should be done to prevent salinity shock during transfer,



Collection of milkfish fry using scissors net or *sakag* along Iloilo coast.

especially when the fry is moving from lower to higher salinity.

b1. Indoor acclimation

Acclimation should be done indoors by gradually increasing or decreasing the salinity of the water in the basin containing the fry until pond water and transport water salinity are equal. Length of acclimation period may extend from 3 to 4 hours.

The fry are stocked in the pond in the early morning or late afternoon to prevent temperature shock. Fry are released directly to the nursery pond. To further insure that the fry are not subjected abruptly to the harsh condition in the pond they may be stocked and held for about one week in an acclimation pond prior to release into the nursery pond proper.

b2. The acclimation pond

This pond is constructed about a week before the expected arrival of the fry. It is essentially a small pond within a nursery pond built in a corner near the gate about a foot away from the peripheral dike to prevent run-off water. The quantity of stocked planned for the nursery pond proper determines the size of the acclimation pond. Ordinarily, a density of 4,000 to 5,000 fry per square meter is used in the acclimation pond. The acclimation pond is provided with a temporary shade using palm leaves or fronds placed on a bamboo framework about a meter above the pond. This provision keeps the water temperature cool even during hot weather. Also, the pond may be fenced in by a fine meshed nylon screen to prevent crawler-type predators like snakes and crabs from getting inside.

The fry stay in this temporary pond for about a week feeding on lablab. Hard-boiled egg yolk mashed in little water may be given daily, one egg for 50,000 fry. After about a week, when the fry shall have become darker and have developed some scales, the temporary dikes are broken in some sections allowing the fry to swim out freely into the nursery pond proper.

b3. Care of stock

After stocking, the primary concern is to keep water condition favorable for both the fry and natural food. Dikes, gates and screens should be regularly inspected to prevent excessive loss of water due to leaks and seepages. Whenever possible, water should be changed especially during long summer months to prevent salinity from increasing to unfavorable levels. This is done by draining about 1/3 of the pond water during low tide and reflooding the pond gradually during high tide. When there is an impending rain or typhoon, flushboards should be kept at water level to allow rainwater to flow out to prevent sudden drop of salinity.

After about one month and a half the fry shall have grown to fingerlings ranging from 1 to 3 grams. These may now be transferred to a transition or stunting pond. Part of it may also be directly stocked into some rearing ponds.

b4. Transfer/harvest

Collecting fingerlings is done late at night or early afternoon when the temperature is low. The fingerlings are led into the catching pond by inducing them to swim against the current. From there, they are seined and held temporarily by a fingerling seine *bitinan* set in the canal near the mouth of a gate where there is inflowing water. The seine containing the fingerlings is then carried along the canal close to the transition or stunting pond. The fingerlings may now be scooped out and transferred back to the pond.

b5. Transition pond or stunting pond

In a transition or stunting pond, with a stocking density of 10 to 15 fingerlings per square meter, the fish subsist on the natural food (lablab or plankton) for about 1 to 2 months. After this the amount of food left may not be enough to keep the fish healthy. Occasional fertilization may be done to replenish the natural food; but for a prolonged stunting period of six months or more, supplemental feeding may be necessary. Fine rice bran maybe given at 5% of the body weight daily. For example, 50,000 fingerlings weighing 3 grams each will have a total weight of 150 g. Therefore, the amount of daily feed is 15 kg. An indication that the fish needs supplemental feeding is when they become thin; otherwise, feeding is not necessary. Water should be replenished as often as possible to keep the pond condition at its optimum.

2. *Rearing Pond Operation*

Marketable-sized fish are produced in the large rearing or grow-out ponds. This operation is the last in the actual production process prior to harvest and marketing. The success of this depends very much on the age of the fishpond itself, how developed the ponds are, how much are the production inputs, and how good the care and supervision given to the stock.

Newly constructed fishponds generally require a period of 1 to 2 years before the ponds shall have become fully conditioned to give its normal yield capacity. In pond bottoms it takes time to develop the soft colloidal texture necessary for good growth of fishfood. The extend of development may affect the production operation. Well-levelled ponds are likely to produce more than those which still have mounds and tree stumps left. The amount of supervision, production inputs and work experience vary from operator to operator.

a. *Methods of culture*

a1. The prevalent culture practices maybe classified into three general categories. These, according to type of natural food base grown for the milkfish, are:

The lumut method — This was very common before the 1960's and especially those frequented by freshwater. The principal food grown for the milkfish is the filamentous green algae, sometimes locally known as *lumut jusi.* The ponds are relatively deep with about 40 to 60 centimeters of water and stocked with about 1,000 to 1,500 fingerlings per hectare. The algae are initially grown by planting, broadcasting or spreading. They are fertilized mainly by commercial pelletized fertilizers. Potential yields are generally low ranging from 500 to 600 kg/ha/year at two crops a year.

Lablab method — This is often referred to as the improved method of culturing milkfish. Lablab is local term for the benthic algal community consisting of very small plants and animal forming like a mat on the soil but sometimes floating on the surface in clumps or patches. This was the type of food grown in the nurseries for the fry even during the early years when *lumut jusi* was the principal food in the rearing pond. Lablab is more nutritious than *lumut.* Stocking density normally ranges from 2,000 to 3,000 fingerlings per hectare. However, growing lablab abundantly considerably requires more material inputs and supervision. Yield potential is estimated at 1.5 to 2.5 tons per hectare per year.

Plankton method – Planktons are minute plant and animal communities that are freefloating in the water column. These organisms are essentially the same as those making up the lablab but are not concentrated in the manner the lablab is formed. This method requires deep water, ranging from 0.75 to 1 meter and a considerably shorter period of pond preparation. However, abundance of plankton and, thus yield, has remained unpredictable. For still unexplained reasons production varies from very low to very high. The adoption of this method may be constrained by: 1) the inability of most areas to maintain deep water; and 2) the uncertain yields.

a2. According to stock composition and length of the culture:

Mono-sized, straight culture – In this method a pond is stocked with a more or less uniform size of fingerlings and grown from 2 to 4 months, sometimes longer, depending on the initial size and density of the fingerlings, the desired size at harvest and the type and abundance of food present in the pond. The culture period may also depend on the age of the fingerlings. Older or stunted fingerlings are believed to grow faster than newly grown one.

With abundant lablab, a pond may be stocked with 2,000 to 3,000 fingerlings per hectare and grown into marketable size – 3 to 4 pieces per kilo – in 3 to 4 months culture period. Exceptionally productive may receive more stock or may require shorter culture period to grow the same size of harvestable fish. Mortality is generally placed at 10 percent.

Mono-sized, progression system – This method is practised in some areas especially when ponds are not very productive. A stock of uniform size fingerlings is reared in a pond for about two months and transferred to another newly prepared pond of approximately the same size before it is finally harvested after another two months. The previously vacated pond is immediately prepared to receive another batch of fingerlings. Transfer of stock is done by simply breaking a section or two of the dike separating the two ponds and allowing the fish to swim against the flow of water.

Stock manipulation – Two alternative methods may be recommended to further increase total yields from lablab ponds. These, however, should be done in relatively well developed fishponds to insure that schedules of stocking and harvest are followed.

Modular system – This is an improvement of the mono-sized progression system. The main differences is that one starts with a high density of stock which diminishes after every transfer from one pond to another. Inversely, the pond area increases. Three ponds contiguous to one another are selected to form a module with areas increasing in a 1:2:4 ratio, say, 1 hectare, 2 hectares and 4 hectares, respectively. The first pond is stocked with 10,000 fingerlings ranging from 3 to 5 grams each and cultured for about 30 days. These are then transferred to the second and on to the third pond, staying for about the same culture period of 30 days in each. Assuming a 10 percent mortality in each pond, the density or stocking rate in the second and last pond is about 4,500 and

2,000 per hectare, respectively. A pond once emptied, is immediately prepared to receive another stock, thus, permitting a continuous program of pond preparation, stocking and transfer of harvest. In this manner, 6 to 8 crops a year may be realized. The short culture period of 30 days in each pond will prevent complete or total grazing of the food making the pond preparation period shorter. A strict adherence to schedules and availability of fingerlings are important factors when practising this method.

Multi-sized stock — The pond is stocked with three sized-groups of fingerlings, averaging about 5 g, 20 g and 80 g, respectively at 1,500/ha each group. Harvesting commences as soon as the largest size-group reaches marketable size of from 180 to 250 grams a piece, which should be about 45-60 days after stocking. The second and third harvests should come after about the same length of time. A fourth batch of fingerlings may be introduced prior to the third harvest if sufficient food is maintained. This method is estimated to yield after 2 tons/ha/year. Limitations, however, are the availability of fingerlings of the required size at the time they are needed for stocking and difficulties involved in selective harvesting. The use of gill net leaves marks on or seriously damages the fish which lowers market price to certain extent. Besides, gill netting involves extra operation time and additional labor.

a3. Polyculture in milkfish pond

This means raising other fishes or crustaceans with milkfish in the same pond. The most commonly used is the tiger prawn or sugpo. Fry of sugpo are collected in the same grounds where milkfish fry are caught. Sugpo fry are sometimes stocked directly in milkfish rearing ponds at rates varying from a few hundred to about 1,000 pieces per hectare. No extra management or care is given the prawn except occasional feeding with skinned and chopped meat of water snakes. Prawns are harvested together with milkfish after 3 or 4 months. Prawns are likely to survive during the wet season when salinity does not go beyond 40 parts per thousand. In some areas, juveniles of mud crab or *alimango* are stocked in milkfish ponds especially those which still have earth mounds and decaying tree trunks. Like prawns, crabs favor lower salinities. After about 3 months, adult crabs may be harvested, a few dozen at a time. Crabs are harvested with the use of a pole and line baited with small chunks of fish or watersnake flesh. Although an additional source of income, raising crabs runs the risk of dikes being destroyed.

b. *Pre-stocking management*

A crop period ends with the pond having been drained completely to remove whatever is left of the stock and other saleable fishes. Preparation starts immediately for the next crop.

b1. Lablab production — This is often referred to as the improved method of culturing milkfish. Lablab is a local term for the benthic algal community consisting of very small floating on the surface in clumps or patches. This was the type of food grown in the nurseries for the fry even during the early years when *lumut jusi* was the principal food in the rearing pond. Lablab is more nutritious than *lumut*. Stocking density normally ranges from 2,000 to 3,000 fingerlings per hectare. However, growing lablab abundantly considerably requires more material inputs and supervision. Yield potential is estimated at 1.5 to 2.5 tons per hectare per year.

b2. Plankton production – Planktons are minute plant and animal communities that are free-floating in the water column. These organisms are essentially the same as those making up the lablab but are not concentrated in the manner the lablab is formed. This method requires deep water, ranging from 0.75 to 1 meter and a considerably shorter period of pond preparation. However, abundance of plankton and, thus yield, has remained unpredictable. For still unexplained reasons production varies from very low to very high. The adoption of this method maybe considered by: 1) the inability of most areas to maintain deep water; and 2) the uncertain yields.

b3. Pest and predator control

Among the more common fishes that prey on milkfish are ten-pounder (bidbid), tarpon (buan-buan), sea bass (apahap), and gobies (biya). *Tilapia* and *Poecilla* are food competitors as they reproduce in the pond. The nest building habit of tilapia destroys lablab forming at the bottom. Snails when existing in great numbers will prevent lablab from getting established. These pests and predators are eliminated during the drying period after the harvest.

If this is not possible, pesticides (organic or inorganic) may be resorted to. These should be used only when all other physical or mechanical means have been done.

The harmful effects of continued use of inorganic pesticides in ponds are not fully understood. The danger may lie on the residues accumulated over a long period which may lead to possible contamination of the pond itself, to fish, and fish consumers. In fact, most advanced countries have long prohibited the use of many pesticides.

Whenever possible, the use of organic pesticides such as tobacco dust, derris roots and others are preferable. These are transformed into fertilizers upon decay and do not persist in the soil. When using tobacco dust, spread over moist bottom 300 to 400 kilograms per hectare and allow to stand for about a week.

b4. Liming

Lime is used primarily as a soil conditioner. It corrects acidity, promotes the release of nutrients, combines with suspended materials to form solids that can easily be flushed, and, to some extent, reduces the occurrence of diseases.

In general, new ponds require more lime than old established ponds. Sandy soil and sandy loam need less lime while loam and clay loam demand more. Lime is normally applied once every five years, even longer if soil reacts favorably.

For correct and precise determination of doses, the assistance of a soil laboratory should be sought. Soil samples may be brought for analysis and lime requirement determined. One simple method of determining whether liming is required is the use of litmus or hydrion paper. When moistened, these papers change colors indicating acidity (pink color) or alkalinity (blue color).

c. *Stocking procedure*

As soon as the rearing ponds are ready for stocking, fingerlings are caught from the nursery or stunting ponds and held in a fingerling seine. This seine may be set in a canal where it is carried slowly close to the pond where the fish are to be stocked. If this is not possible, a few hundreds at a time may be put in plastic bags and carried to the pond. It is best to count the fingerlings to prevent under or over stocking. The fingerling seine should be positioned near the mouth of the gate where flowing water can sustain the fish that are crowded in the seine. Time of stocking should be done during the cooler part of the day, say late evening or early morning. The fingerlings are released near the mouth of the gate where water is normally deep. Slowly release them to prevent environmental shock.

d. *Post-stocking management*

The main concern after stocking is to maintain the optimum water condition for both the fish and the natural food. When using lablab as the food base, it is necessary to apply fertilizer (16-20-0) at the rate of 1 bag/ha/month divided into small doses applied at 10 to 12 days intervals to maintain good growth of food. If the tide allows, replenish about 1/3 of the pond water before every fertilizer application. During hot months more frequent flooding is needed to compensate for evaporation. Depth is kept at about 30-40 centimeters, at most 50 centimeters. During rainy months, it is necessary to replenish water to prevent sudden drop in salinity.

Towards the end of the culture period, lablab may be prematurely depleted because of poor water conditions and persistent inclement weather. In such a situation, the stock may be thinned out or partially harvested to ease up the grazing rate. Sometimes the whole stock is transfered to a freshly prepared pond. Supplemental feed may be given at a daily rate of about 5 percent of the estimated total weight of the fish, using rice bran or bread crumbs.

Abnormal occurrences may at times be experienced such as the fish appearing to be gasping at the surface or swimming in circles. These are believed to be indications of stress associated especially with insufficient dissolved oxygen. Water should be replenished at the first opportunity. Extreme cases are mass kills occuring especially in the morning of a very calm and windless day. If the tide is favorable, water should be admitted immediately. If this is not possible, water from an adjoining pond may be made to flow so that water is agitated. Pumps may also be used in such an emergency.

Sudden rain or thunderstorm during a hot day may also present dangers. Sudden change in water temperature may result to some death.

Adverse weather conditions should be anticipated. Extra precautions should be observed to minimize possibility of dike washout, flooding, and the like.

IV. HARVEST AND POSTHARVEST

1. *Harvest*

When the milkfish attain marketable size, they are harvested by either of the following methods:

a. *Total drainage.* At present total drainage of pond as a means of harvesting marketable-sized bangos is seldom used. It lowers the quality of the harvested fish because the mud which adheres to the fish is difficult to remove completely, thereby giving the fish a muddy smell or taste.

b. *Current method (pasubang).* This method takes advantage of the against-the-current swimming behavior of milkfish. The water in the rearing pond is partially drained during low tide. Then water is allowed to enter at high tide so that the fishes would swim through the gate and into the catching pond. The gate is closed when the fishes have been impounded. Depending on the size of the catching pond, the fishes are either seined, scooped or both. The remaining fishes in the pond are collected by total drainage. This method is used for total or partial harvesting of the stock. The *pasubang* method is very convenient; almost 95% of the fishes are concentrated. The fish are cleaner than those obtained by total drainage.

c. *Electric shock method.* Some fishfarmers use electric shock to harvest milkfish. As in the *current method*, the fishes are let into a concrete catching pond. Once they are in, the water level is decreased and electrical shocks from an induction coil are used to kill the fish. The fish die quickly and are picked up from the catching pond with a net. The fishes are cleaner since very little mud accumulates at the concrete bottom of the catching pond.

d. *Gill netting.* The principle involved is similar to that used in open waters. This method is employed when only a limited number of fish is harvested for household consumption or small-scale selling. This method is laborious and the gill net leaves a mark around the nape of the bangos, thereby lowering the price of the harvested fish.

e. *Seining.* Some fishfarmers use the seine to partially harvest the stock.

2. *Postharvest*

After harvest, the fishes are washed with pond water and sorted according to size. To prevent the fishes from losing more scales due to subsequent handling, they are usually dipped in iced water before packing.

Some fishfarmers use a chilling tank or box in killing the harvested fish. The tank or box, usually made of wood, is prepared by placing at least two blocks of ice for every ton of fish. The blocks of ice are broken into small pieces and a small amount of water is added. To prevent the fish from losing scales or from mechanical damage due to the flipping movements before they die, a bamboo screen is placed over the fish until the movement ceases. Sort them according to size before packing them in wooden or metal boxes, metal tubs (baneras) or baskets baskets (kaings). Crushed ice is scattered among the fish in the container with a ratio of one kg of ice to one kg of fish. The amount of ice depend on the length of time that the fish would be stored in the container.

3. *Processing*

At present, a certain quantity of harvested milkfish are either canned, smoked or deboned. These command a higher price in the market.

V. ECONOMICS AND COSTING

Conditions that affect or influence the construction and actual operation of a milkfish farm vary widely from place to place and from region to region. The technical viability of a project does not necessarily mean that acceptable economic returns are assured. More than technical factors, economic variables are often more difficult to contend with since these are dictated by forces beyond the control of the fish farmer. For instance, costs of construction and production inputs such as lumber, hardware, fertilizers, etc., transportation costs, and market price levels of the produce are all influenced by the nationwide economic conditions of the industries. However, general estimates may be made to provide guidelines for prospective farm operators.

1. *Cost of construction*

The major expenses involve earthwork for diking, levelling and clearing. Recent estimates place the initial cost of development from ₱25,000 to ₱35,000 per hectare if manual labor is used. Mechanization will cost higher although the construction period may be shortened by more than one-half the time it takes manual labor to finish.

2. *Cost of operation*

Excluding capital and taxes, the three major items of expense are fish seeds, hired labor and production inputs equivalent to about 30%, 18% 15%, respectively. Recent studies reveal that cost of production varies from 60 to 75% of the gross income derived from the sale of milkfish. For example, at a selling price of ₱6.00 per kilo, a net income (excluding taxes and marketing expenses) should amount to ₱1.50 to ₱2.40 per kilo produced. This range may increase or decrease depending on how well the management can maximize the benefits from the investment on the three major expense items.

3. *Production/yields*

Milkfish farms in the Philippines yield an average of about 650 kilograms per hectare per year ranging from about 300 to 400 kilograms in less productive areas to about 800 to 1,000 kilograms in productive ones. Exceptionally well-developed and effectively managed ponds are believed to be capable of producing as high as 2,000 to 3,000 kilograms per hectare per year.

APPENDIX 1

A. FRY COLLECTION

The catching season for bangos fry lasts from March to June and also from September to December in some areas of the country. Collection is generally done in the morning during high tides along the coast, near or at the mouth of rivers. Fry are more abundant during the new and full moon periods.

Fry collecting gears

These are the more commonly used collecting gears:

a. *Sagap* or *sayod* (fry seine). This is a seine made of *sinamay,* nylon or fine-meshed cotton netting with each end tied to a bamboo pole. The netting is about 1.5 m wide and up to 5 m long. The seine is dragged along the shores by 2 persons, one on each end.

b. *Sweeper.* This has a fan-like structure consisting of whole bamboos to make it float and wrapped all around with fine-meshed nylon. The end, also made of whole bamboo, is rectangular in shape and is also wrapped with fine-mesh netting where the fry are accumulated and collected. The sweeper is usually pushed by a single gatherer from the catching end; it can also be pulled by means of a rope tied to the mouth of the gear.

c. *Sakag* (scissors net). This consists of a collapsible triangular frame with either *sinamay,* cotton or nylon fine-mesh netting fastened to it. Generally, a gatherer operates it a wading depths; it may be used in deeper waters by mounting it on a banca.

d. *Fry dozer.* This is a combination of a scissors net and a sweeper. Its V-shaped wings and box-like end are made of whole bamboos to enable the gear to float. The bottom is made of *sinamay* cloth or fine-meshed netting that extends from the end to the tip of the wings. It is operated like a scissors net.

e. *Bulldozer.* This is similar to the sweeper but its wings are extended to have a wider mouth and it has a raft-like structure at the bulldozer proper which is at the end section. The gear is usually operated at night and in deeper waters. Some are provided with a kerosene lamp attached to a bamboo pole positioned at the center of the fishing gear. This is operated by two men; one paddles while the other scoops the fry accumulated at the rectangular end.

f. *Saplad* (set fry trap). This is a stationary bamboo and net trap set at the shallow (about 1 meter deep) portions of the mouth of rivers, estuaries, and tidal creeks. It is made up of a V-shaped barricade of pounded bamboo set firmly into the bottom facing downstream. At the point of intersection of the pounded bamboo walls is an opening through which the fry are guided into the saplad proper, a half-hoop fine-meshed sinamay net about 1.5 m long and 60 cm wide held in place by two parallel bamboo poles.

g. *Fry trawl.* This is a longer version of the sagay or sayod (fry seine). There is a bag end at the center of the gear. Two men at opposite ends drag the trawl along the coast. Floats are attached to the upper edge of the net while lead weights are attached to the lower edge.