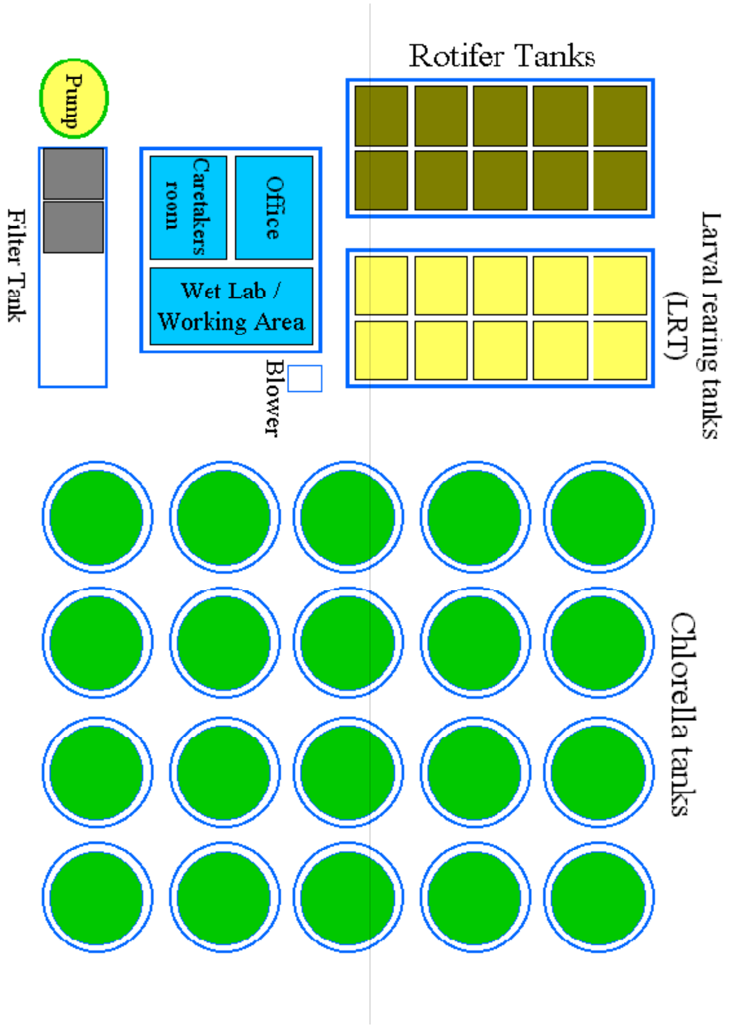
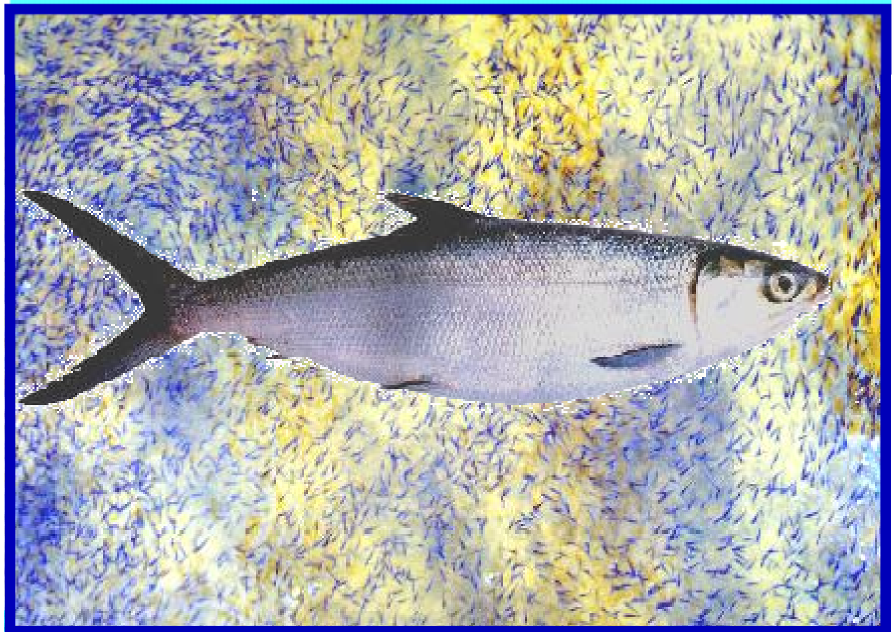
MODEL OF A MODEST SATELLITE HATCHERY



COMMERCIAL PRODUCTION OF MILKFISH FRY

(Hatchery Operations)

Westly R. Rosario, Cordelia B. Nipales and Editha C. Roxas



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FOREWORD

Milkfish, popularly known as *bangus*, is the oldest and most important foodfish being cultured in the Philippines. *Bangus* production has been growing from an aggregate 158.5 thousand tons in 232.3 thousand tons in year 2002. The demand for *bangus* continue to increase as new markets (local and foreign) are being established.

The development of a simplified protocol for producing milkfish fry in commercial scale by BFAR-NIFTDC in Bonuan, Dagupan City is a significant milestone in strengthening the country's supply of bangus fry. The Philippine *Bangus* Development Program was established to ensure the sustainable supply of fry nationwide. It also aims to generate savings from fry importation and open livelihood/job opportunities in the coastal areas.

The production of this booklet the "Commercial Production of Milkfish Fry" is a big forward step in the success of the Phil-*Bangus* Development Progam. Practical guidelines in hatchery engineering, natural food production and broodstock management are fully discussed in this booklet. This will certanily serve as an important tool for hatchery technicians and farm workers engaged in milkfish fry production.

This manual would contribute in building the roadmap for aquaculture development in the country in support to the food security program of the government.

MALCOLM I. SARMIENTO, JR
Director, BFAR

ECONOMICS OF A SATELLITE HATCHERY
(Previously Prawn Hatchery)

Fixed Cost

Construction Materials	P11,472	
Equipment	4,503	
		P 15,975

(Depreciation period in 3 years)

Ten runs/year = P532/run

Production Cost

Feeds and Fertilizers	2,366	
Electrical Bill	17,341	
Salary and Allowance (9 persons)	37,800	
3,000,000 eggs	30,000	
		P 87,507
Depreciation Cost		532
		P 88,039

Calculation of Benefits

Sales (612,000 eggs)	183,600
Less : Operational Expenses	88,039
Net Profit	**P95,561** (1 run of 22 days)

The fry are harvested after 18 to 21 days. At 20 eggs per ml stocking density, the fry are expected to grow faster and maybe harvested in 18 days. They are also bigger and of uniform size.

The harvesting, counting and transporting of fry must be done with optimum care so as not to inflict too much stress to the fry. It is preferred to schedule the harvest in the morning when temperature is colder. A shaded area must be available for the counting of fry.

To harvest the fry, the water level is reduced to about 15 cm. A fine meshed seine net is used to collect the fry in one of the corners. The fry are scooped using plastic bowl and transferred to plastic basin with moderate aeration. To remove the debris, aeration is removed and the water is swirled gently to concentrate the dirt at the middle of the basin. The debris is then siphoned out.

The fry are counted individually or by visual comparison. In individual counting, a white or light colored cup or bowl is used. This technique, although more accurate, is laborious and may entail higher loss to the fry due to stress. In visual comparison technique, identical plastic basins are used. The same amount of water is poured in the basins. Five thousand fry is counted and stocked in one basin to serve as the standard. Other basins are filled with fry with the standard basin as reference to proximate the number of fry visually. The process is repeated until the desired quantity of fry has been met.

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Commercial Production of Milkfish Fry
(Hatchery Operations)

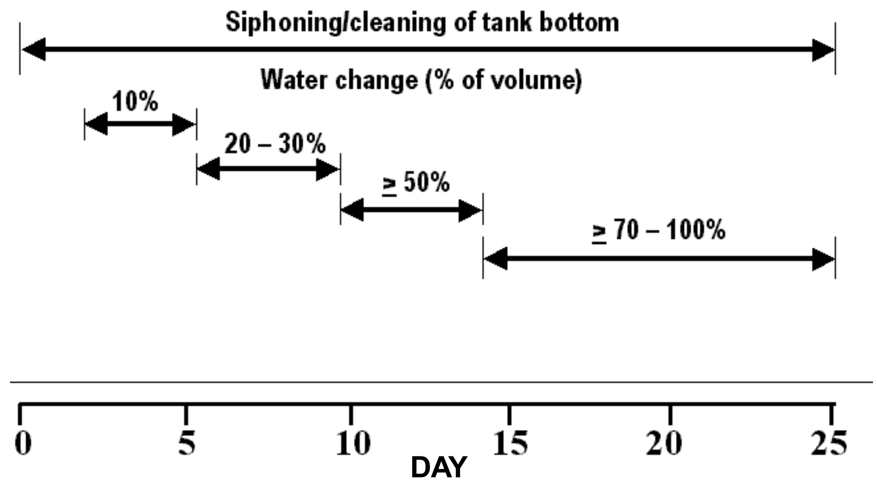
INTRODUCTION

Intensive production of hatchery-bred milkfish fry is a necessary technology in order to augment the current shortage milkfish seeds in the Philippines. In 2002, 358 M fry were imported from Taiwan and Indonesia to support the growing milkfish production industry of the country. I addition, the production of wild fry is recognized to be decreasing. Unless the government will intervene in terms of technology development and transfer, the importation of expensive fry will continue unabated. Fish diseases that maybe introduced accidentally together with the imported fry may also pose as a threat in the future.

BFAR NIFTDC developed a simple protocol to produce milkfish fry which can be duplicated anywhere in the country. The protocol is adopted in the project Phil Bangus Development Program currently being implemented nationwide. The concept includes the use of government, academic and private hatcheries as satellites of the project. Central hatcheries are tasked to produce good quality eggs that will be sold to the satellites for hatching and larval rearing. Some of the satellites will be encouraged to function as complete hatchery depending on their resources and market advantage. Upon the implementation of the project, in two to three years, the increasing demand for milkfish fry in the Philippines will be sustained by local production. Likewise, export of fry may also be realized in the near future.

Water management

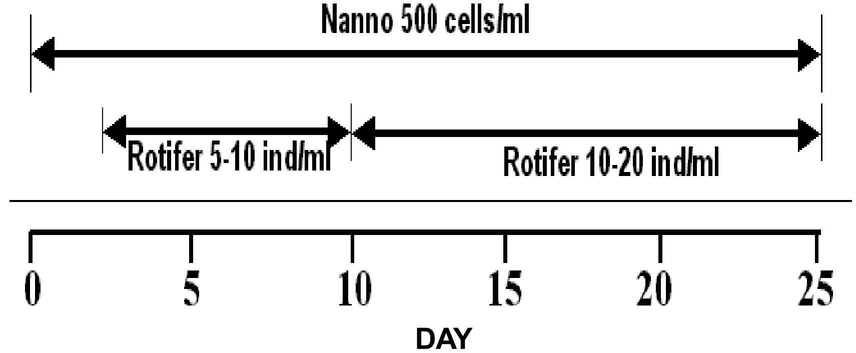
The daily siphoning of dead eggs, larvae, dirt and other debris starts at day 3 until harvest. The volume of tank-water changed daily increases as the larvae gets older. From day 3 to 5, 10 % of the water is changed. From day 5 to 10, water change increases to 20 to 30 %. More than 50 % of the water is changed from day 10 to 15. From day 15 until harvest, more than 70 % of the water is changed daily.



Harvesting and counting

until the larvae are disposed from the hatchery after 18-21 days. Hatching will occur 24 to 26 hours after spawning. The critical aspect of larval rearing is food and water management.

Food management



Natural food is introduced to the larval rearing tank at day 2 when yolk sac of the larvae is about to be consumed. *Nannochloropsis* is given at 500 individuals per ml on the second day. It will serve as food of the rotifers, help stabilize the water quality and control microbial growth. Rotifers are given daily at 5 to 10 individuals per ml from day 3 to 10. This is increased to 10 to 20 individuals per ml from day 10 to 21. Both *Nannochloropsis* and rotifers are given at about 9:00 AM daily until harvest.

Starting at day 8 the larvae are introduced to artificial diet. Cooked-brown flour is given twice daily, morning and afternoon. Likewise, powdered prawn feed is given five times a day, after natural food is given. Artificial feeds are given *ad libitum*. Three days before harvest, macerated boiled egg yolk is added to the ration.

On the day of harvest, no food is given to the fry.

The basic knowledge on hatchery engineering and designs is important in establishing a milkfish hatchery. The hatchery facility includes water supply, electricity, aeration and drainage. The design must consider various activities in the hatchery such as natural food production, broodstook management, egg production and larval rearing. Convenience in overall management and economic efficiency in production are important factors in ensuring the effectiveness of the design.

The hatchery design is influenced by location. Poor site selection may result to eventual failure of the project. The area must allow future expansion of the business. Site selection must secure the quality and quantity of water in the area for the sustainability of hatchery operation.

Knowledge on the biological requirements of spawners, developing eggs and larvae are very important in the hatchery of milkfish. Correct water management and feeding regime are primary factors to be observed in broodstock management and larval rearing of milkfish fry. The spawners are fed with high protein artificial diet, while the larvae are fed with natural food. Natural food consists of phytoplankton and zooplankton organisms grown in high quantity and fed to milkfish larvae until the harvestable age of 18 to 21 days.

Larval development in milkfish is a critical aspect of milkfish hatchery operation. High survival rate is attained when proper larval rearing procedures are followed. At larval stage, it is important that larvae are given the right quantity and quality of diet. Likewise, correct water management is necessary to maintain the water quality at optimum level in order to attain high survival rate.

PHIL-BANGUS DEVELOPMENT PROGRAM

The Phil-Bangus Development Program is an intervention project of the Department of Agriculture - Bureau of Fisheries and Aquatic Resources related to the problem of fry supply in the Philippines. It envisioned self-sufficiency in milkfish fry in the country in three to five years. The program is spearheaded by the National Integrated Fisheries Technology Development Center who developed a simple protocol to commercialize the production of milkfish fry. Under the program, available government facilities will be improved and re-tooled. Available milkfish breeders of the government and the private sector will be utilized. The local government units, academe and private sector will be encouraged to participate in the hatchery business. Good quality eggs will be made available to participating satellite hatchery operators at a minimum price. Central Hatcheries tasked to produce eggs will be established in Dagupan City (NIFTDC); Calape, Bohol; and, Guian, Eastern Samar. Satellite Hatcheries will be located in strategic locations in the country. The satellites will be tasked to do the larval rearing to last 18 to 21 days, after which the fry will be ready for market. The more satellite hatcheries that are encouraged to participate, the better for the program. Some of the satellites are expected to evolve into complete hatcheries in the future.

The objectives of the Phil-Bangus Development Program include the sustainability of the milkfish fry requirement in the country currently having a shortfall of more than 360 M fry annually. The program is expected to provide supply of locally produced fry and discourage importation. While the quality of fry is ensured, the price of fry may consequently drop significantly to the advantage of milkfish farmers. The Program

With small eggs, one ml contains about 680 eggs while about 520 large eggs are contained in the same volume.

Stocking of eggs

The eggs are stocked in the larval rearing tank at 20 to 30 eggs per liter. Lower density tends to give high survival rate and better quality of fry. Larval rearing period is found to be shorter at low density.

Larval rearing

The larval development starts when the eggs are fertilized to 5:00 AM. However, some eggs can still be collected until 9:00 AM. The eggs are transferred in a bucket with ten liters of filtered seawater. Stress and damage to the eggs are minimized during collection. Direct sunlight is avoided and soft scoop net is used. The egg collectors are cleaned and sun dried during daytime even when no egg is collected.

The eggs are transferred in a larger bucket with pre-measured water level. Water is stirred gently to accumulate the debris and bad or dead eggs at the center. The debris and bad eggs are siphoned out. Filtered seawater is added to the graduated pail to the desired volume of water. Gentle aeration is provided.

To estimate the number of eggs, 10 ml is derived from the pail using a beaker. The number of eggs in an aliquot sample is counted using a counting slide (Sedgewick rafter counting chamber) under a microscope. The total number of eggs is then calculated using the following formula:

$$TNE = \frac{\text{Total volume of collected eggs (ml)}}{\text{Average number of eggs/ml}}$$

$$BE = \frac{\text{Volume of “bad eggs” siphoned}}{\text{Average number of eggs/ml}}$$

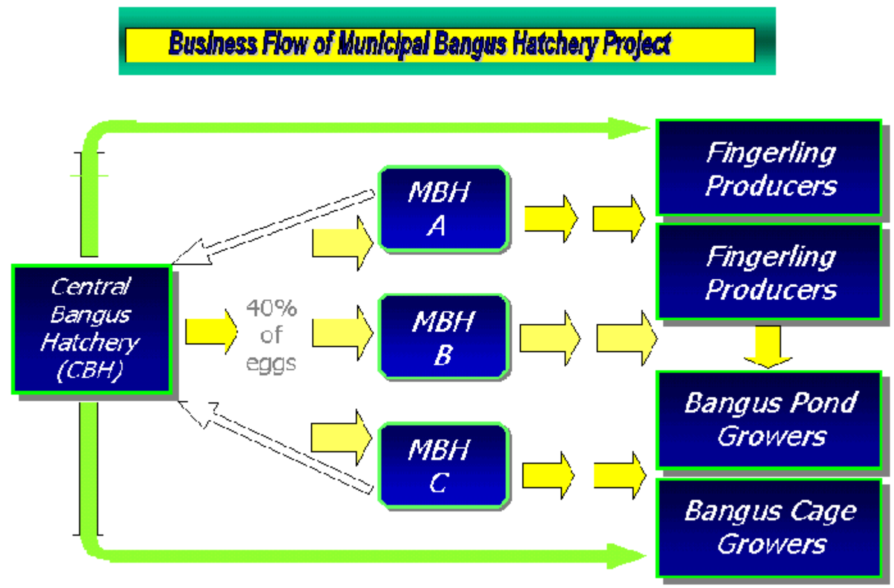
$$GE = TNE - BE$$

will distribute the opportunities and other bounties that can be generated from the technology such as livelihood and business from milkfish breeding, fry production, marketing and distribution and many others.

CONCEPT

The NIFTDC hatchery in Bonuan Binloc, Dagupan City and the Regional BFAR hatchery in Calape, Bohol and Guian, Eastern Samar, serve as the Central Bangus Hatcheries. These CBH will supply eggs to the satellite hatcheries, called Municipal Bangus Hatcheries, at nominal price.

Ideally, 40 % of eggs produced by CBH will be sold to MBH at P10 T per million of good eggs or D1 larvae. The remaining 60 % of eggs will be hatched by the CBH. Initially, MBH may be helped by the CBH in the marketing of fry. Private hatcheries who will agree to adapt this concept will be allowed to participate and ensured of technical assistance from BFAR-NIFTDC.



HATCHERY ENGINEERING

Hatchery engineering design is of primal importance in establishing hatcheries. Good project location and proper engineering design ensure effective and efficient operation of the hatchery.

The facilities including electricity, aeration, water supply, drainage of the hatchery must be taken into consideration. They must be installed in the most effective and convenient way with least cost requirement.

The cost of establishing the hatchery is influenced by the location and the simplicity of the design. Poor site selection may result to high construction cost and maybe eventual failure of the project. Other than suitability, the area must allow expansion of facilities and easy access to consumers.

Site Selection

- CBH and MBH must be located within a market area for fry.
- Distance from CBH to MBH must be considered. Ideally, shorter distance is much preferred. Transport problems must be carefully noted.
- There must be ample supply of clean seawater and freshwater. Areas near rivers and tributaries are avoided since the quality and salinity of seawater supply will be adversely affected during rainy season.
- Electricity must be available to run the life support systems in the hatchery such as air blowers and water pumps.
- The hatchery must be located within the convenient access to fry buyers.

Preparation of larval rearing tanks

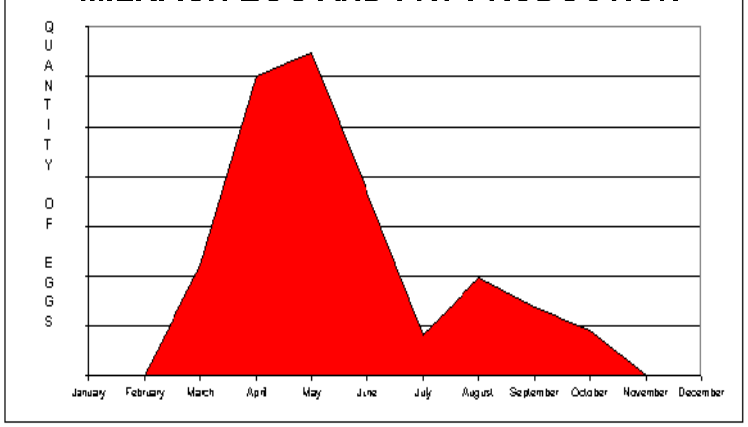
Larval rearing tanks are prepared a day before the stocking of fertilized eggs. Days ahead, they must be cleaned of algae and other debris using detergent and freshwater. Standpipes, air-stones and filter bags are likewise cleaned and dried under the sunlight when possible. The space between air-stones must be 0.70 cm to cause effective water circulation in the tank. Lead sinkers are attached to the air-stones to keep them in place. Newly filtered seawater is used to fill the tanks. They are aerated the whole night prior to the stocking of eggs. When a tank failed to get stocked, its water is discarded and replaced by new filtered water to avoid an early growth of algae.

Egg collection

Proper egg collection is important to achieve high hatching rate of the eggs. Some of the milkfish breeders may start to spawn at 1:00 AM. Eggs are collected between 4:00

when the quality of the water has deteriorated. Good water management is necessary to avoid problems related to water quality. The flow rate recommended must also met for high production of good quality eggs.

MILKFISH EGG AND FRY PRODUCTION



Spawning records indicate that milkfish starts to spawn beginning the last week of February to last until the first week of November. The egg collector is set at the onset of the breeding season at about 7:00 PM. The flow rate of seawater is maximized to about 300 per cent water change. The collectors are checked the next morning. The peak of egg production is expected during the first half of the year. It is necessary that preparation of the hatchery is done during the off-season months of November to January. Larval rearing tanks are cleaned with detergent and freshwater. Air-stones, filter bags and other hatchery paraphernalia are disinfected and exposed to sunlight. The production of natural food such as Chlorella or Nannochloropsis and rotifers are produced in advance.

Types of milkfish hatcheries

There are two types of hatchery being discussed, the complete hatchery and the satellite hatchery. They are defined as follows:

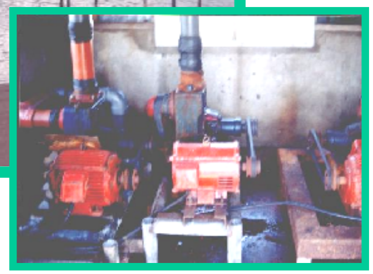
a. Complete Hatchery – is a milkfish hatchery complete with spawning tanks and breeders. Egg production is an integral part of the business operation. Land area requirement may exceed one hectare. Capital outlay and operational costs are higher than satellite hatcheries. Technical and management requirement is comprehensive. Functional role includes selling of eggs to the satellite hatcheries.

b. Satellite hatchery – is a milkfish hatchery that procures eggs from a complete hatchery, do the hatching and larval rearing until the market fry stage of 18 to 21 days. They maybe newly built facilities or old prawn hatcheries converted into milkfish hatcheries.

Water System

The site of the hatchery must have a good source of clean seawater and freshwater. Freshwater is used in cleaning of hatchery paraphernalia.

Water pumps are required to sustain the continuous supply of water for the hatchery operation. Pumps can be electric or diesel-driven with necessary back-ups. A pump house maybe provided to protect the pumps from corrosion.



A complete hatchery with 100 breeders requires a set of two water pumps of four-inch diameter water pipe running 24 hours. Another set maybe required as alternate or back-up units. A satellite hatchery (without breeders) will require just one unit of pump, preferably a diesel-run unit like Kubota or Yanmar.

A simple filtration system is necessary to remove silt and debris from the water. It is also effective in avoiding the entry of larvae and eggs of fish and other species. A more complex filtration system is necessary when the seawater supply is heavy with silt. The filtration system must be easy to clean and maintain.

Aeration System

Air blowers with sufficient capacity to supply air with required pressure is provided to maintain the needed oxygen requirement and water circulation of the spawning tanks and hatchery. Pipes and control valves are installed in convenient places.

by BFAR NIFTDC was more than 21 hours, from Bagacay, Albay to Dagupan City. The procedures on long distance transport is described by Rosario *et al*, 2000.

The breeders are stocked in 150-ton water-capacity spawning tanks at a density of one fish per two tons of water (76 breeders). The spawning tanks are prepared with lowered salinity level of about 20 ppt. Stressed breeders normally stay at the surface with some parts of the body exposed to sunlight. The purpose of decreased salinity is to make the fish less buoyant and consequently sink, therefore minimizing stress from direct exposure to sunlight. After five days, the breeders are expected to begin eating. The salinity of tank water is increased by continuous flow-through of seawater. When the breeders had regained their appetite, the water flow is increased and maintained at 200 to 300 percent water change. Greater flow is desirable at night to condition the breeders to spawn.

Broodstock nutrition and care

Starting three months before the expected spawning, the breeders are fed with high protein diet. Prawn feeds mixed with Vitamins C and E and fish oil is used. The feeds are given at about 3 to 4% of fish biomass twice daily. Good nutrition is necessary to increase the quantity and viability of the eggs for hatching.

Excess feeds and other debris in the spawning tanks are siphoned out twice a week. One half of the water in the tanks is changed during nights when spawning is absent or fist size ice wrapped in newspapers, are placed in the box to keep the temperature low during the trip. Two fish can be placed in each box. It is advisable to bring extra water, ice and spare oxygen bottles while waiting at the airport as contigency in case of flight delays. Upon arrival at the airport of designation, the fish are removed from the plastic bag and transferred to the hauling boxes at once. After a few minutes the fish will be observed to be active.

The level of survival of breeders transported is influenced by: where the breeders are reared or sourced, in ponds or pens and cages; the age of broodstock; and, the length of transport time. Breeders sourced in cages and pens are easier to prepare and transport than when breeders are collected from earthen ponds. Many times, the supply of water in ponds is limiting and moving the breeders is slow. Conditioning tank is needed for long distance transport, which may not be necessary when breeders are sourced from cages.

Old milkfish breeders are likely to be very long and big. Breeders more than ten years old are considered old and are still common in some BFAR farms. Finding plastic and styropor boxes for the breeders may become a problem. Also, the old breeders seemed to get stressed easily than younger breeders. For long transport, it is advisable to select younger and stronger breeders.

Mortality may not occur during short even in long transport as long as the correct protocol that will minimize stress to the breeders is followed. The longest transport time experienced

Roots Blowers are the most common air blowers used for hatchery operation. Some of the common brands of heavy-duty units are Westinghouse and LG. Taiwan or China models, which are cheaper, can also be used. When possible, an extra unit must be provided as alternate or back-up. The blower must be installed in an airy area where the blower intake will not suck contaminated air such as engine exhaust, and dust. Blowers are noisy and must be situated far from the breeder-spawning tanks and the working area.

Electrical System

A complete hatchery must have sufficient electrical power. A back-up generator set must be considered, to provide a round-the-clock electrical power. A powerhouse is required for the generator set and control system. Lights and outlets are placed in convenient places for easy but safety access to workers. Lights are required only in some working area but not in the periphery of the spawning tanks. Lights when blinking, excites the breeders and cause them to jump. The electrical system must be compatible with the requirement of the equipment to be used in the hatchery.

Drainage System

An effective drainage system is required since large amount of water is used daily in the hatchery. About 60 % of water in larval tanks is changed daily while the water change in the spawning tanks ranges from 200 to 300 percent in 24 hours. A good drainage is necessary in order to avoid flooding in the hatchery area, which may result to the growth of organisms that can cause diseases to fry. A wastewater treatment facility may be provided to filter out dirt and other waste materials from the used hatchery water before dumping back to the sea.

In a complete hatchery, the drainage of the spawning tanks can be integrated to the broodstock ponds and fry-to-fingerling or nursery ponds. This design will allow maximized utilization of water and lower operational cost..

Spawning Tanks

In a complete hatchery, concrete spawning tanks are provided to produce the eggs, and conveniently collect them. A circular tank, which has a water capacity

Transport of milkfish broodstock

The transport of breeders has to be planned ahead. Probable problems during the preparation of the breeders and transport that may inflict stress to the breeders are identified. Consequent actions must be conceived and logistics must be prepared.

For land transport, one ton-hauling boxes made of marine plywood on mini truck is used to haul the breeders. The boxes are filled with seawater with salinity lowered to about 15 to 20 ppt . Water temperature is, likewise lowered to about 20 to 25 C by adding blocks of ice. Bottled medical oxygen is used to supply oxygen to the tanks using airstones. When liquid oxygen is used, blocks of ice may not be necessary. Each box can accommodate 20 to 25 four kg breeders.

When fish are to be transported by plane, styropor boxes measuring 48x5 x 86 x 54 cm and 98.5 x 178.5 cm plastic bag are used. The salinity of seawater for transport is 15 to 20 ppt. Water temperature is lowered to 20^{o}C using blocks of ice. Two-

To determine the sex of the breeders, prepare a sampling tank, preferably 0.5-ton capacity. Half-fill with seawater with salinity lowered to 15 ppt and temperature to 20 C by adding blocks of ice. Anaesthetic (2-phenoxy-ethanol) is added to the water at 200 to 250 ppm to help immobilize the fish and minimize stress. A moderate aeration is also provided.

The fish are caught individually using fine-meshed or knotless net and placed in the tank. When immobilized, biometric measurements like weight and length are determined. The fish is turned belly-up and the abdomen is carefully pressed towards the anus. Males are determined by the presence of milt oozing out of the urogenital pore. Females are determined by inserting a polyethylene cannula (0.85 mm) to the urogenital pore. The gonads are aspirated while the cannula is slowly drawn out (Corre *et al,* 2000). Females are determined by the presence of spherical yolky oocytes.

Breeders whom no milt and egg-like oocytes are drawn are placed in separate tank or cage for future use. This is common when the breeders are young. It is easier to do the sex determination during the spawning months of March to October.

of 150 tons, should have a dimension of 10-m diameter, and a depth of 2.6 meters. The tank is provided with a sturdy net cover to keep the breeders from jumping out. A four-inch diameter water inlet and strong water aeration are provided. Attached to the spawning tank is a 1x1x1 m egg collection box situated at the outlet pipe. A fine-meshed net fitted to the egg collection box is hanged to collect the buoyant eggs. A wooden cover maybe provided to protect the eggs from direct sunlight and other harmful elements.

Tanks for Natural Food

The natural food for fish larvae is mass-produced in concrete or canvass tanks. The natural food consists of phytoplankton and zooplankton. The volume of tanks necessary to put up for natural food depends on the volume of tanks to be used for larval rearing. NIFTDC follows the ratio, one larval rearing tank: one rotifer (zooplankton): three chlorella (phytoplankton) tank. This means for every ton capacity of larval rearing tank, we need to built one ton capacity rotifer tank and three ton capacity chlorella tank (1 : 1 : 3)

Phytoplankton tanks

To culture algal species, such as *Chlorella vulgaris* and *Nannochloropsis*, tanks to be built can either be circular, square or rectangular in shape. It can also be made of concrete, fiberglass or canvass. For a circular tank, a diameter of five meters and depth of one meter is recommended. The total volume of this dimension is about 16 tons. The tanks are provided with strong aeration and sufficient supply of seawater. The drainage could be a stand-pipe situated at the middle for easy cleaning and draining. Roofing is not required for the chlorella tanks.

Zooplankton tanks

Rotifer or *Brachionus plicatilis* is the zooplankton grown to serve as food of the milkfish larvae. The tanks used for rotifer maybe deeper than one meter. The shape of rotifer tanks is usually rectangular. Tanks can be made of marine plywood, fiberglass or concrete. The tanks must have an effective and spacious drainage system to conveniently harvest the organism. The tanks must be provided with strong aeration and good supply of seawater. They must be roofed with plastic or galvanized iron sheets. The rotifer tanks must be situated far from the chlorella tanks to avoid contamination and consequently collapse of the algae (chlorella).

Harvest of rotifer begins on the fourth day when the tank is already full of rotifer. Fifty per cent (3.5 tons) of the rotifer is collected using 65-micron filter bag attached to one end of the siphon hose. Immediately after harvesting, 3.5 tons on algae is fed to the remaining rotifer. One or two days after, 50 % of the volume is again harvested and then replaced again by the same volume of algae. The total harvesting of rotifer is done on the sixth or seventh day, when some rotifers are used as starters for new or additional rotifer tanks. Harvested rotifers are fed to the milkfish larvae.

BROODSTOCK MANAGEMENT

Presently, broodstocks are derived from existing inventory available in some government and private farms. Many of such breeders are more than five years old and therefore sexually ready for breeding.

Selection of breeders

Breeders more than five years of age are preferred. They are expected to spawn readily one or two months after transport (during spawning months). Very old breeders are avoided for long distance transport because they are prone to stress.

The sex ratio of breeders can be 1:1 or 1:2 male to female ratio. It is therefore necessary to determine the sex of the breeders before or after transport. When few breeders are required the breeders can be sexed three weeks before the transport schedule. It has been observed that in a given population, there are more males than females.

in a 30-liter capacity tank filled with 23 liters of filtered seawater. The tank is fertilized with a mixture of commercial fertilizer (0.9 g urea, 0.9 g 21-0-0 and 0.9 g 14-14-14 wet in freshwater and mixed by kitchen blender). After three days, the volume is scaled-up to 90 liters, then to 180 liters, and 500 liters. The further scaling-up of volume is done in one-ton capacity tank, and eventually in a 16-ton concrete or canvas tank. Whenever the volume is scaled-up, the algae is fertilized by the fertilizer mix at .09 g per liter of culture volume. After three to four days in the 15-ton tank, the algae is ready for use as feed of the rotifer.

Mass-culture of rotifers (*Brachionus plicatilis*)

The rotifer tanks (7-ton capacity) are cleaned by brushing and air-drying. Three tons of algal culture is poured into the tank, then the 500 liters secondary culture rotifer. On the second day (after 24 hours), three tons of algae is fed to the rotifer when the density of algae is found to be insufficient (less than 10 X 10^{6}). On the third day, when the density of rotifer increases and that of algae decreases, six tons of algae is again added.

Phycology Laboratory

A small phycology room or laboratory is required to keep the primary stock (maybe sourced from government or bigger hatcheries) and to produce the secondary culture of natural food in the hatchery. The room temperature is kept low by a small air conditioner to avoid collapse of stocks. Forty-watt florescent lamps are fixed at the back of the culture containers to simulate 24-hour sunlight. Good aeration with control valves is also provided. The basic equipments required are Metler balance and simple microscope.

Larval Rearing Tanks

The bangus fry are reared and produced in larval rearing tanks (LRT). The common materials used to construct larval rearing tanks are canvass and cement. The shapes of LRT vary according to the desire of the farmer. In NIFTDC, larval rearing tanks are square and made of concrete. Each tank has a dimension of 3 x 3 and a depth of 1.2 meters, or a total water capacity of 10 tons. The LRT can be situated just adjacent or in between the chlorella and rotifer tanks. The tanks can be arranged and constructed to require the least construction cost. The tanks can be painted with a marine or epoxy paint, preferably yellow color, to water-proof the tanks and for easy visual monitoring of larvae.

Working Shed

This is optional, but a working shed maybe constructed near the larval rearing tanks to serve as working area during harvest, counting and packing of fry. Aeration connectors are provided to access for air during counting, packing and marketing of fry.

maintenance of primary and secondary stocks. For satellite hatcheries, it is more practical to forgo such a process and derive their stocks from existing government hatcheries to save costs.

Zooplankton rotifer (*Brachionus plicatilis*) is transported by use of 4 liter plastic bottles (empty mineral water bottles). One liter of *Brachionus* with a density of 70-100 individual per ml is mixed with three liters of *Nannochloropsis* (at density of 20 to 25 X 10^{6}). The bottles are placed inside a styropor box with ice (two-fists size) wrapped in used newspaper to keep the water temperature low. The transport time must not exceed 24 hours due to limited food of the zooplankton. Upon arrival, the Brachionus are transferred in a bigger container (30 liters capacity) and fed with eight liters algae. The container is placed in shaded area. In daily feeding, algal food is given double the quantity of rotifer (say if rotifer tank is 30 liters, 60 liters of algal food is given for the day until 500 liters of rotifer volume is reached.

Mass-production of algal species

The mass production of algae is done outdoor using 30 liter capacity plastic tanks at the start of culture, and then scaled-up up to 16 ton capacity tanks. Filtered seawater water is used. The procedure is similar to what has been done in carboys only that mass-production is done using larger tanks. Commercial fertilizers are used to fertilize the algae.

Tank is drained and solar dried. From the phycology room, a carboy filled with algae is taken outside and poured

Sourcing, transport and maintaining the primary and secondary stocks of Algal food and Zooplankton

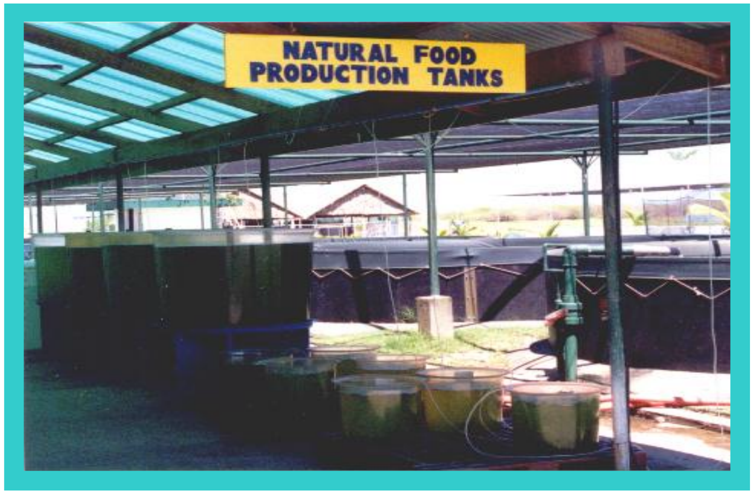
The primary (inoculum) and secondary stocks of algal species are derived from existing government hatcheries such BFAR NIFTDC, SEAFDEC, UP MSI and large fish hatcheries. Primary stocks are transported in agar plates and 5 ml test tubes or 50 ml screw cap vials placed in a styropor box or cooler with temperature of about 21 to 23 C. Upon arrival at the destination, the primary stocks are conditioned for two to three days in an air-conditioned room, after which it is transferred in 4 liter sterilized seawater, mixed with Conway media (Vitamin solution and other growth elements) at one ml Conway media to one liter sterilized seawater with inoculum. The inoculum is then kept in an air-conditioned room. The vessel is given moderate aeration at the start of the culture.

For secondary stocks, plastic containers like used plastic bottles of mineral water or plastic bags are used for transport. They are packed in iced styropor boxes with temperature of about 21 to 23 C. Upon arrival, the secondary stocks are conditioned for two days in air-conditioned room. Then they are transferred in bigger bottles or plastic carboys, aerated and kept in the same room. After three days, the secondary stocks are mass-produced outdoor using 30-liter fiberglass tanks using filtered seawater.

Complete hatcheries may opt to put up their own phycology laboratory and adopt the production and

NATURAL FOOD PRODUCTION

Sufficient and right quality food is a major requirement for the success of a commercial milkfish hatchery. In any hatchery operation, natural food is preferred over the artificial feeds. Natural food are specific plankton species isolated from their aquatic habitat and grown commercially in the fish and shellfish hatcheries to serve as initial food of larvae and fry being produced. Natural food organisms are alive and swim with the larvae, thus larvae does not exert much effort to look or locate their food. Natural food is small in size and could easily fit the mouth opening of the fish larvae. They are always present in the tanks for 24 hours and therefore the larvae do not have to wait for their ration unlike when artificial food is used. In addition, artificial food cannot proximate the nutritional efficiency of natural food organisms. It is a good pollutant and can easily deteriorate the quality of water in the larval rearing tank, thus cause heavy mortality of larvae. The use of live food organisms certainly influences the favorable growth and survival of fry during rearing.



The production of natural food is divided in three managerial stages: the maintenance primary stocks and production of secondary cultures in the phycology laboratory, the mass production of algal species, and the mass production of zooplankton.

In the mass production of milkfish fry, the larvae are fed with zooplankton rotifers (*Brachionus plicatilis*). Rotifers are produced in great quantity by feeding them with phytoplankton (algal species), such as *Nannochloropsis, Tetraselmis batan.* and *Isochrysis galbana.*

Physico-chemical requirements in the culture of natural food organisms

There are several factors that influence the production of natural food. These are nutrients, light, pH, turbulence, salinity and temperature. These maybe added, manipulated or controlled to exact the requirement of the natural food species.

Algal cultures must be enriched with nutrients to make up for the deficiencies in nutrient quality of seawater. Some 15-20 macro- and micronutrients are required for normal growth and reproduction. The light requirement varies with the density of the cultured medium.

Light is needed at least 18 hours each day and maybe supplied by natural sources (daylight or well illuminated windows, provided they do not receive direct sunlight) or supplied by fluorescent tubes. The required light intensity is 1000 lux. Culture in plastic containers of many algal species may tolerate full sunlight if they are dense. However, they must be shaded in earlier stages.

The water pH range for most cultured algal species is between 7 to 9. The optimum range of 7 to 8 is required for mass culture of algae.

Phytoplankton increases their growth rate with increasing temperature up to an optimum level after which growth rate declines often abruptly. The optimum temperature range for culture of phytoplankton is 18 to 25 C. Temperature lower than 10 ^{0}C may slowdown growth while temperature higher than 35 ^{0}C is lethal to the cultured stocks.

Aeration is provided to keep the algae in suspension, to partly supply carbon needed for plant growth, disperse dissolved materials, and to avoid adherence of plankton to the wall of culture vessels. For small volume cultures, vessels are swirled manually. For larger volumes, air blower, jet pumps or paddle wheels are used for aeration.

Marine phytoplankton is tolerant to change in salinity. The optimum level of salinity is between 14 to 30 ppt. Rotifers (*Brachionus plicatilis)* can tolerate wider range of salinity from one to 35 ppt.