# TECHNICAL CONSULTATION ON AVAILABLE AQUACULTURE TECHNOLOGY IN THE PHILIPPINES

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### FOREWORD

Aquaculture, an old traditional industry in the Philippines, has emerged to assume a strategic role in the socio-economic development of the country. Concerned national agencies, national and international research and educational institutions, and the private industry sector have developed research and development programs to accelerate and enhance its development. Over the years several studies and experiences have accumulated, but they are disparate, scattered, and not entirely documented or published so much so that it becomes difficult to get from a single source the available technology in aquaculture, and to identify the technology gaps which still need to be developed.

The sponsors of the consultation deemed it necessary and relevant to hold the technical consultation among researchers, scientists, academicians, technicians, and practitioners to exchange information and experiences. The consultation gave the participants the opportunity to assess more acurately the status of aquaculture technology in this country, identify technology gaps, and come out with a comprehensive package of aquaculture technology for the country. The results should be able to provide planners and policy makers a more rational and scientific basis for planning aquaculture development programs.

### **OBJECTIVES**

The technical consultation aimed to achieve the following objectives:

- 1. Upgrade currently available technology in given disciplines of a given commodity;
- 2. Determine the production potential of available technology;
- 3. Crystallize chronic technology gaps in selected aquaculture systems; and
- 4. Determine suitable linkage mechanisms for the transfer of appropriate aquaculture technology.

### METHODOLOGY

The consultation limited its area of coverage to four major commodities: milkfish, prawn, tilapia and molluscs. The problem areas discussed were: broodstock development and reproduction, larval rearing, nutrition, culture, pests and diseases, post-harvest handling and processing, aquaculture engineering and socio-economics. Briefs were presented as initial discussion points for the different work groups.

The participants were divided into four work groups, to discuss the four major commodities.

### OUTPUT

The technical consultation came out with the following outputs:

- 1. Updated technology package for milkfish farming in the Philippines.
- 2. Updated technology package for prawn culture in the Philippines.
- 3. Updated technology package for mollusc farming in the Philippines.
- 4. Updated technology package for tilapia farming in the Philippines.
- 5. Identified technology gaps in the farming of milkfish, tilapia, prawns, and molluscs.
- 6. Linkage mechanisms for the transfer of aquaculture technologies.

AVAILABLE TECHNOLOGY

AND

TECHNOLOGY GAPS

### AVAILABLE TECHNOLOGY AND TECHNOLOGY GAPS IN MILKFISH FARMING IN THE PHILIPPINES

### 1. Broodstock development and reproduction

Limited information now available are borne out of preliminary research studies undertaken locally and in Taiwan on age, migration pattern, and food habit of matured milkfish sabalo. Some environmental factors have been identified as influencing the gonadal development and migration of the maturing milkfish. Surveys of fry grounds and magnitude of occurence of eggs and fry have indicated possible spawning areas. Induced spawning has been achieved using acetone-dried Salmon pituitary together with human Chorionic gonado-tropic hormones, but rates of survival of fry are extremely low. Sex determination of sabalo based on external characteristics has been achieved.

### Technology gaps

Technology has to be developed to enable cultivation or rearing in captivity of broodstock to minimize dependence from wild spawners. More studies are needed in the following areas: food requirements for sexually maturing milkfish; environmental influence on migratory behavior; sexual maturation and spawning; and hormonal control of sexual maturation and spawning. Other areas for further studies include determination of spawning mirgration pattern, age determination at sexual maturity, development of an accurate method for monitoring ovarian maturation and sperm preservation.

### 2. Larval rearing in milkfish

Following the artificial spawning of the sabalo, limited successes have been achieved in rearing the larvae to fry stage using various types of natural foods, such as copepods, brine shrimps nauplii and oyster larvae. Rotifer was found most effective as food in the early stage.

### Technology gaps

Rate of survival achieved in larval rearing is low ranging from 8.8 to 46.8 percent. Recommended are further studies on the following areas:

- a) Effect of the environmental factors on the survival of larvae
- b) Evaluation of natural foods for larvae
- c) The use of natural organisms as agents to maintain good quality water in larval rearing tanks
- d) Types and size of tanks favorable for larval rearing
- e) Types of prophylactic agents and methods of treatment

### 3. Nutrition in Milkfish

There is no clear-cut technology available in milkfish nutrition. Present practices utilize single-ingredient materials as supplemental feeds. Feeding techniques are not standardized. Preliminary studies on feed formulation indicate that dietary level of 40-50% protein is required by milkfish fry for maximum growth, efficient feed conversion and high survival rate. Preliminary trials indicate feasibility of high-density rearing of fry to fingerlings in indoor system using purified diet with prophylactic treatment.

### Technology gaps

The nutritional requirements of milkfish at various stages of growth have not been established. This is a prerequisite to effectively formulate economically-viable fish pellets. The use of locally available materials as feed components should be explored. Supplemental feeding using traditional single-ingredient materials should be standardized.

### 4. Milkfish culture

Milkfish farming technology has moved out of the traditional level to that of fertilization. The benthic type of organism is the main feed base for the fry and adult milkfish. Supplemental feeding techniques are practised to some extent. Chemical poisons are commonly used to control pond pests and predators. Some well-managed fishponds have adopted the improvised method of stock manipulation.

Polyculture systems remain traditional using prawns and mud crabs. Deep-water plankton method is a recent innovation which has been adopted in some ponds.

### Technology gaps

- 1. Fertilization techniques are not location- or area-specific. Methods of application are not based on specific requirements dictated by local or situational conditions. Deliberate manipulation of nutrient level is virtually absent.
- 2. The persistent use of chemical pesticides and molluscicides poses a danger to natural productivity. The use of bio-degradable chemicals and locally available organic based poison must be studied. Methods of biological control should be explored.
- 3. Catching, handling, storage and transport of fry and fingerlings need be improved.

### 5. Parasites and diseases

Some species of parasites and pathogens to milkfish have been identified. Prophylactic treatments are known but only adaptable in small confined areas.

### Technology gaps

Environmental factors that may cause widespread infestation of fish in the pond are not known.

### 6. Post-harvest handling/processing of milkfish

Recommendable technology are available for pre-chilling, handling and transport of milkfish from pond to market. Thermal processing, e.g., canning of various bangus formulations and by-product utilization procedures using bangus offal, have been developed. Methods of smoking, salting, fermentation and drying have also been developed.

### Technology gaps

Available technology for handling, transporting and processing of milkfish meet only the requirements for local markets. Further improvement of the keeping quality of frozen and processed fish, e.g., using additives and improved packaging, will be needed as production increases and market outlets expand. Strict quality controls using objective and sensory methods of assessment will have to be employed. The lack of locally-designed equipment suitable for small-scale processing of milkfish hinders technology transfer.

### 7. Lablab culture

The present practice of pond preparation induces lablab growth by systematic water management plus application of organic and inorganic fertilizers. The lablab complex is allowed to develop without propagation of specific algal species or groups.

### Technology gaps

Although lablab in general is a superior food base for milkfish, growth response may differ according to particular group or species dominant in the food complex, which may be influenced by local environmental conditions. Such studies as the nutritive value, digestibility, effect on growth, and method of propagation for selected species or groups of algae may lead to yield maximization.

### 8. Aquaculture farming systems

The widely practised system uses shallow lablab ponds stocked with mono-sized fingerlings grown into marketable size over a single culture period. Recent innovations should lead to the modular or progression system and to the multi-sized stocking method. Plankton method is resorted to only when lablab is prematurely grazed.

Twigs and palm fronds are placed in rows inside the pond to serve primarily as wind and wave breaks and as additional substrate for lablab attachments. Recent studies using nylon screens serving as additional substrates indicated higher yields for small compartments.

The use of the so-called "kitchen pond," a separate pond solely for intensive lablab culture to supplement the food supply to the rearing ponds, has been demonstrated by a private fishfarmer as very productive.

### Technology gaps

The innovative progression and multi-sized stocking techniques have improved yields, but practices vary among farms. These two methods need be studied further to enable standardization of techniques. Selective harvesting method must be developed especially for the multi-sized stocking system to insure high quality harvest.

The use of artificial substrates to increase production needs verification trials in a commercial scale, including that of the "kitchen pond."

### 9. Milkfish culture in freshwater conditions

Milkfish are raised extensively in pens in Laguna Lake with production estimated to average about six times that of brackishwater ponds. The fish are supported mainly by the planktonic life of the lake and with limited amount of supplemental feeding.

Raising milkfish in commercial freshwater fishfarms is virtually absent. Experimental trials in freshwater ponds gave low yields.

### Technology gaps

High mortality in the handling, transport, storage, and acclimation of fry to freshwater condition is a major problem. Pen culture management practices vary widely because of limited information on density-growth relationships. Destructive effects of typhoons and inclement weather could be minimized if structural designs of pens are improved.

### 10. Milkfish pond engineering

Information on the following are already recognized which can be organized and referred to as the pond engineering technology for milkfish:

- (1) Criteria on site selection for fishpond
- (2) Relationship between the size of gate, pond water level and design tide curve
- (3) Design elevation of foundation
- (4) Relationship among the sizes of pond compartments according to their functions
- (5) Different types of layout schemes
- (6) Size and proportioning of dikes
- (7) Control of internal erosion and seepage
- (8) Methodology on pond construction and repair, including related facilities
- (9) Construction tools and machineries

### Technology gaps

The production figures from the different layout schemes under given conditions are missing. Where each schemes applies needs to be established.

The optimum size and carrying capacities of pond compartment for nursery and production/rearing.

# AVAILABLE TECHNOLOGY AND TECHNOLOGY GAPS IN PRAWN FARMING IN THE PHILIPPINES

### 1. Broodstock development and reproduction

Information on reproductive biology presently available includes size at first maturity and first mating, courtship and mating behavior, ovarian maturation stages, spawning, rematuration (subsequent spawning), fecundity, egg quality and hatching rates.

Current broodstock technology includes sources, transport and acclimation methods and the ablation process itself. To obtain good fecundity and hatching rates, ablated females should come from either pond stock at least one year of age or wild stock at minimum sizes of 90 g for females and 50 g for males. There are two broodstock systems — land-based tanks and off-shore pens — and the choice of a hatchery operator would depend on the conditions and requirements peculiar to his hatchery.

### Technology gaps

Gaps in the technology include kind of substrate, sex ratio, stocking density; use of hormones, pressure and other methods as alternatives to ablation; increasing rematuration rates; development of pen systems with decreased mortality due to reduced fouling; maturation of ablated females in ponds; and broodstock of other penaeids.

In some areas, wild spawners are abundant in catches from trawlers and various shrimp traps. Research should concentrate on minimizing stress on the prawns by appropriate handling and transport methods from the source to the hatchery.

### 2a. Larval rearing and sugpo hatchery

There are essentially two larval rearing systems for prawn. The fertilized system in which natural feeds are produced in the same tank used for larval rearing requires lower initial investment but has relatively lower efficiency and production levels. However, it is highly site-specific. In contrast, the unfertilized system, in which algal and zooplanton cultures are produced separately from the prawn larvae, has higher efficiency and production levels and a higher initial investment.

The Mindanao State University-Institute of Fisheries Research and Development hatchery in Naawan, Misamis Oriental, the first prawn hatchery to operate in the Philippines, utilizes the unfertilized system, although it resorts to the fertilized system when the algae are slow to grow. Both the large-tank and small-tank (barangay) hatheries of the SEAFDEC Aquaculture Department now depend on the unfertilized system although it started with the fertilized system. Barangay hatchery technology has been extended to other SEAFDEC Stations as well as the private sector with initial runs showing very promising results.

Among the more significant aspects of a barangay hatchery are source of spawners, seawater quality, seawater supply system, air supply system, larval culture tanks, culture of natural feeds and larval rearing.

### Technology gaps

Technology gaps include the use of preserved natural feeds for larval feeding, refinements of site selection criteria using indicator organisms, economical water treatment systems and engineering studies on larval and algal tank design and construction.

### 2b. Prawn pond engineering

Included under pond system layout and design are pond engineering, site selection, biological considerations, layout considerations and pond system structures. Pond structures and equipment include those for protection, water measurement, water conveyance, water impoundment, pumps and wells and others.

### Technology gaps

Although the subjects of water flow, levees and embankments, etc. are well-advanced in the field of hydraulics, soil mechanics and foundation engineering, there is a need to simplify these concepts and principles and to fully apply them in prawn pond layout, design and construction.

### 3. Nutrition

Experimental work include laboratory and field work on nutrient requirements (protein quality, protein levels, lipids), feeding practices, and diet preparation.

### Technology gaps

More laboratory experiments and pond tests are needed.

### 4. Nursery and grow-out ponds

The SEAFDEC nursery system at Leganes has demonstrated that it is economically viable to rear up to 150 P4P5/sq m for 30 days up to P35 with survival rates above 50 per cent. Some of the factors contributing to this successful rearing are the ability to change water, supplementary feeding, screening of predators by purely mechanical means and the use of vertical substrates. Similarly, recent experiments on the grow-out phase show that survival rates after 3 1/2 months above 85 per cent are possible even with densities up to 20/sq m with supplementary feeding.

### Technology gaps

Is growth site-specific? Is growth a function of stocking density? Although these and other questions are important for research purposes at SEAFDEC, pond culture of sugpo is already very profitable even at relatively low stocking densities of 0.3-1/sq m. Therefore, ways of increasing survival rates rather than maximizing stocking density per se might be more important to the private sector.

### 5. Cage farming in fresh water

Available technology includes transport and handling of fry, acclimation to fresh water, and lake farming.

### Technology gaps

Additional research is needed to improve transport, handling and acclimation; find more varied and economical supplemental feeds; determine optimum feeding rates and protein requirements at different stages; determine suitable management techniques; and develop typhoon-resistant structures.

### 6. Pest and diseases

Available technology covers the identification of most of the major larval diseases of P. monodon and the use of a Treflan spawner bath to control fungal diseases.

### Technology gaps

Gaps include testing of other chemicals for better control of Lagenidium, control of protozoan and bacterial diseases in larval rearing, identification of microorganism-caused mortality in pond stock and in spawners, ascertaining source of Lagenidium, etc.

### 7. Post-harvest handling

Available technology includes prechilling to 4°C, transport in polystyrene boxes with wooden frame, blast freezing at -40°C and sizing. These can now be promoted for adoption.

### 8. Socio economics - None

### 9. Artemia culture

Techniques for decapsulation of Artemia cysts for use as live food for fish and larvae of crustaceans are routinely used at SEAFDEC and other research laboratories. Mass production of Artemia cysts in salt ponds has been achieved by a private pond operator in Iloilo.

### Technology gaps

The technology should be tried in other salt ponds throughout the country.

# AVAILABLE TECHNOLOGY AND TECHNOLOGY GAPS IN MOLLUSC AQUACULTURE IN THE PHILIPPINES

### 1. Larval rearing of bivalve molluscs

Available methods and techniques are adaptations for tropical species of larval rearing experiences by aquaculturists in many countries. Probably no more than two species of commercially important marine bivalves in the Philippines have been cultured throughout their life cycle. Success in rearing larval stages of <u>Perna viridis</u> (<u>Mytilus smaragdinus</u>) has been described, with particular emphasis on larval density and feed composition. Although occurring naturally all over the country, spatfall may be predicted by monitoring larval appearance, and incidentally identify larvae of each species. Broodstock could be kept alive for 3 months in cold water at about 20°C if well fed. When ready to spawn, stock should be placed in warm water and fertilized eggs could be cultured in sea water.

### Technology gaps

Whenever possible, attempts should be made to utilize larvae of molluscs as feed for larvae of other commercially important aquatic species. The freshwater Cristeria, formerly known as Anodonta is being studied for possible harmful effects of the larval glochida on the host fishes. Being determined is whether its culture could affect man's health or whether this could be offset by its economic potentials.

### 2. Mussel and Oyster Framing

Various culture approaches involving growing in spatfall areas, fixing structures to the bottom, and no thinning done are being undertaken. Farming of green mussel is more lucrative than brown mussel because it has greater weight, is better tasting, can be transferred to other areas, and can be found where the brown mussel is also found. Greater mussel production can be obtained in areas of upwelling. A good indicator of a good feeding area is the presence of a large population of filter feeders. Research is ongoing in identified mussel farming areas. Farming methods (any of which must be above the bottom) for oysters include: hanging or 'bitin', stake, broadcast, stone, log, tray, long line, raft, monofilament, oyster sheets, and old rubber tires. Methods for farming mussels include the stake, hanging (preferred), and bamboo stationary plot from which synthetic rope netting measuring 2 x 5 m are tied. Molluscs must be conserved. Dwindling supply, especially of the commercial ones like kapis, must be revived by requlatory measures for gathering of such shells.

### Technology gaps

More studies are needed in the following areas: comparison of growth rate differences between Crassostrea iredalei and malabonensis; seasonal occurence of oyster spats in certain areas; spat collection; spatfall; handling and harvesting (cutting of byssus instead of pulling); distancing between stake posts; salinity tolerance for mussels; biology; age determination of kapis shells; total area for oyster and mussel farming; and hydrobiological studies in natural beds of oysters.

### 3. Post-harvest processing and handling

The three-fold problem of rapid spoilage, bacterial contamination causing food poisoning, and expensive transport has been identified. Detoxification and depuration procedures along with the prolonging of keeping time and quality have been described.

### Technology gaps

Studies are needed in processing technology and marketing.

### 4. Socio-economic survey of mollusc farming

A study has been made of the mollusc farm operator, his farming practices, farm production levels, product disposal and marketing practices and prices.

### Technology gaps

More information on the existence and activities of farmers' organizations and on marketing practices will be useful.

### AVAILABLE TECHNOLOGY AND TECHNOLOGY GAPS IN TILAPIA FARMING IN THE PHILIPPINES

### 1. Technologies for Population Control of Tilapia in the Philippines

Existing technologies already in use, although not extensively, are monosex culture, sex reversal technique and cage culture. Application of these techniques reduced the population of undesirable fish and increased significantly the yields of marketable-size tilapia.

Other methods that are still under evaluation are hybridization and use of piscivorous fish species as biological control.

A cross between mate <u>T. aurea</u> and female <u>T. nilotica</u> has been tried which yielded 75% male hybrids. Use of mudfish (Ophicephalus striatus) and catfish (Clarias batrachus) as species to serve as biological control was tried but there were problems such as poor recovery of the predator at harvest attributed to cannibalism and escape from the pond. In brackishwater, tenpounder and tarpon used as biological controls for controlling reproduction of <u>T. mossambica</u> have shown promising results.

### Technology gaps

- 1. Development of practical and economical facilities where artificially sex-reversed fry of tilapia can be mass-produced;
- 2. Evaluation of other species of piscivorous species as biological control for tilapia reproduction;
- 3. Techniques to maintain pure strain of desired tilapia for hybridization purposes particularly aiming at producing all-male tilapia; and
- 4. A more systematic and faster way of separating sexes.

### 2. Tilapia Nutrition Under Freshwater Conditions

Nutrition studies on tilapia under freshwater conditions were reviewed. Two approaches in feeding tilapia at CLSU were given as follows: feeding of materials that will supplement what is already available, and complete feeding of fish stocked at high densities in cages, raceways, pen and ponds.

Some major research findings on tilapia nutrition are as follows: (1) protein requirement of <u>T. mossambica</u> fry, fingerlings and all-male were 38-45%, 30-38% and <u>25%</u> respectively; <u>T. nilotica</u> and tilapia hybrid (male Nile and female Java) were 20-30% and 30% respectively and (2) several feedstuffs were tested for tilapia and the most promising ones identified.

### Technology gaps

A nutritionally adequate ration for tilapia is necessary so that the following should be investigated:

- a. Protein-energy ratio
- b. Levels of fats and essential fatty acids
- c. Vitamin requirements
- d. Essential minerals needed
- e. Utilization of non-conventional feedstuff
- f. Formulation of effective but economical feed

Development of practical feeds for tilapia raised in ponds, cages and other culture units should be attended to.

### 3. Some Advances on Tilapia Culture in the Philippines

The research on tilapia conducted at the Brackishwater Aquaculture Center in Leganes, Iloilo and some culture techniques practiced in some parts of the country were reviewed. Culture/hatchery techniques in raising fry to fingerlings were investigated at the BAC with promising results. Separation of sexes before and after spawning improved significantly the production of fry even at salinities greater than 20 /oo. Production of known age fry for sex reversal was also done successfully in batteries of hapas installed in ponds. Artificial sex-reversal has been attained in brackishwater using alphamethyltestosterone at lower salinities.

The use of tenpounder (Elops hawaiiensis) or bid-bid and tarpon (Megalops cyprinoides) or buwan-buwan as biological controls for tilapia reproduction in a mixed sex population of tilapia increased significantly the production of large tilapia. When tarpon was introduced in milkfish-mixed sexes tilapia populations total production was significantly increased. The ratios of 1:10 (tarpon-tilapia) or 1:6:10 (tarpon-milkfish-tilapia) were found effective in reducing the unsatisfactory-size tilapia in said populations.

Culture of tilapia using ipil-ipil leaves and distillery wastesricemill sweeping mixtures as feeds showed encouraging results. The
response of tilapia raised in ponds that received piggery wastes has
also shown promise. Rice bran and fish meal mixture (1:3:3 ratio) was
used as feeds for <u>T. nilotica</u> raised in cages at the FAC and conversion
rate of 2.02 was obtained. Tilapia in cages fed with rice bran only
yielded 15 tons/cage (20 x 25 x 2.5 m) in 6 units.

A significantly high net production was obtained at FAC by increasing the stocking rate for <u>T. nilotica</u> by 100% without additional fertilizer and material inputs.

### Technology gaps

The following were identified as necessary for effective culture of tilapia:

- a. An effective harvesting method;
- b. Refinement of existing technologies for tilapia culture;
- c. Culture of T. nilotica in brackishwater; and
- d. Evaluation of the Fish-Pig (or other livestock) culture in both fish and brackishwater systems

### 4. Post-Harvest Handling and Processing of Tilapia

Transport and processing technologies for tilapia were reviewed. Wooden boxes, tubs or baskets are the common containers. Ice remains the processing item for transport both for short and long distances.

Processing technologies presented were drying, smoking, fermentation and canning. Unutilized portion of catch could also be made into fish meal.

### Technology gaps

There is a need to develop a scaler for tilapia and more processing techniques. The need to test some chemicals that are safe to use to preserve the color of the fish was raised.

### 5. Case Culture of Tilapia in Laguna de Bay

The problems of cage culture of tilapia in Laguna de Bay were emphasized particularly the lack of fingerlings and the need for new designs of the cages. Cage culture appeared to evolve only as a modification of the pens when fishpen operators suffered losses due to the escape of their fishes resulting in poor harvest.

Two principal tilapia species are raised in cages in this lake, namely; T. mossambica and T. nilotica. The fingerlings are purchased from Malabon, Rizal and Bulacan (T. mossambica) and Calamba, Los Baños, and Bay (T. nilotica).

Tilapia production in cages was reported to be 10-15 tons/cage in six months. This level has declined lately for reasons yet unknown.

### Technology gaps

From the problems presented, the following have been found necessary for a successful cage culture operation:

- a. Improved design and construction of cages;
- b. Standardization of cage materials that are sturdy, attract less fouling organisms and are not toxic to both fish and consumers; and
- c. Proper layout and positioning of cages.

### 6. Socio-Economic Study of Tilapia Farming in the Philippines

Based on 1974 operations, 59% of 131 tilapia pond operators from Luzon adopted polyculture (tilapia-carp or tilapia bangos indicating that tilapia farming is a part-time operation.

Fertilization is not a common practice but where fertilizers were used chicken manure and carabao dung are applied. Inorganic fertilizers are also used such as urea, 16-20-0 and 14-14-14. Supplemental feeds are given where rice bran and white ant were used as feeds and other feeds.

Source of tilapia fry/fingerlings is mostly from BFAR. Stocking size determined the date of harvest.

Average production on a per hectare basis is 209 kg from mono-culture. Tilapia-bangos combination could produce more than 400 kg/ha (total yield). High yields were obtained from those using fertilizers than from those using supplemental feeds.

In all ponds surveyed, 76% practice pest elimination and 24% don't. The most common method used was "catch and kill" although pesticides were also used.

In general, tilapia farming appeared to be profitable, however only very few farmers are culturing tilapia in commercial scale.

Comparing crude profit estimates from tilapia and bangus production, a marginal profit in favor of tilapia was reportedly realized in one particular case raised during discussion. Acceptability of tilapia as food fish could be gauged from: (1) price of fish and (2) the percent of pond devoted to tilapia culture.

### Others

Potential Areas for Tilapia Verification Program

Region II

Central Luzon
Southern Tagalog
Eastern Visayas
Northern and Southern Mindanao

Possible Cooperators for Verification Program

Private Sector Government Agencies PRODUCTION POTENTIALS

OF

AVAILABLE TECHNOLOGY

# PRODUCTION POTENTIAL OF AVAILABLE TECHNOLOGY FOR MILKFISH

	Technology Level	Potential Yield 1/(tons/ha/yr)
1.	High-input (high yield) Intensive feeding Control of water quality Lablab or plankton (pond inoculation) Engineering systems Mechanization	2.5 - 3 and higher
2.	Medium-input (medium yield) Pond fertilization Supplemental feeding Pest and predator control Stock manipulation Lablab or plankton	1 - 2.5
3.	Low-input (low yield) Little or no fertilization Low stocking density Lumot method	l or less

 $<sup>\</sup>frac{1}{B}$  Based on total effective production area.

# PRODUCTION POTENTIAL OF AVAILABLE TECHNOLOGY FOR PRAWN

Production	<b>1</b>
Present	Potential
60 million fry/yr	72 million fry/yr (increase of 20% over over existing)
13 million (1978)	95 million (1981)
	1,000,000 per ha
	60%
1,000-3,000/ha 30%	10,000-15,000/ha 50%
15 pcs/kg 20-60 kg/ha/crop	25 pcs/kg 200-300 kg/ha/crop
3,000-5,000/ha 30% 15 pcs/kg 60-100 kg/ha/crop	15,000-20,000/ha 50% 25 pcs/kg 300-400 kg/ha/crop
	Present  60 million fry/yr  13 million (1978)  1,000-3,000/ha 30% 15 pcs/kg 20-60 kg/ha/crop  3,000-5,000/ha 30%

# PRODUCTION POTENTIAL FOR AVAILABLE TECHNOLOGY FOR PRAWN

	TRADI	TRADITIONAL		RESEARCH & DEVE Field	
	Primitive	Improved	Exp.	Test	Prod.
1. Seed catching/production					
Wild					
Gathering	x				
Holding	x				
Distribution					
Transport	x				
Storage	×				
Broodstock					
Diodes coon					
Collection	x				
Transport		x			
Maturation and rema-					
turation					
Ablation					x
Nutrition			x	×	
Environmental System	s				
Tanks					×
Pens					×
Diseases			x		
Hatchery					
Spawning					x
Hatching					×
Larval rearing					
Nutrition					
Natural feeds					×
Artificial feeds			x	x	
Environmental Systems					x
Diseases			x	X	

		TRADITIONAL		RESEARC	RESEARCH & DEVELOPMENT		
					Field		
		Primitive	Improved	Exp.	Test	Prod.	
2.	Nurgary						
2.	Nursery						
	Pond design & eng g					x	
	Environmental system						
	Water management					x	
•	Predator control					x	
	Aeration					×	
	Nutrition						
	Natural					x	
	Artificial			x	x		
	Diseases			, <b>x</b>			
	Harvesting		×				
•	Distribution						
	Transport					x	
	Holding		x				
3.	Transition						
			•				
	Pond design & eng'g		×				
	Water management		×				
4.	Grow-out		4.0				
	Pond design & eng'g				×	×	
	Environmental system				×	X	
	Stock manipulation		x				
	Nutrition						
	Natural			<u></u> .		<b>X</b> .	
	Artificial			x	X		
	Diseases						
	Harvesting		×				
5.	Post-harvest handling/prod	cessing				x	
_	No						
6.	Marketing				x		

# PRODUCTION POTENTIALS OF OYSTERS AND MUSSELS USING DIFFERENT TECHNIQUES CLASSIFIED ACCORDING TO INPUT LEVELS (in tons per hectare per year)

### A. OYSTERS

		Production	Input Level
	<ol> <li>Broadcast</li> <li>Stake</li> <li>Tray</li> <li>Hanging</li> </ol>	0.5-1.0 4.0-8.0 2.0-5.0	Low Medium High
	a) fixed b) raft c) long line	10.0-15.0 40.0-60.0 25.0-50.0	High High High Medium
в.	5. Rubber tires MUSSELS	5.0-10.0	Medium
	<ol> <li>Stake</li> <li>Rope web</li> <li>Hanging</li> </ol>	30-100 200-300	Medium High
	<ul><li>a) raft</li><li>b) long line</li></ul>	500-1500 500-1000	High High

It has been reported that best production potential would come from culture methods above the bottom where siltation cannot affect the spats and less predation can take place.

# STATUS OF AVAILABLE TECHNOLOGIES AND PRODUCTION POTENTIAL FOR TILAPIA CULTURE IN THE PHILIPPINES

	Technology	Experimental	Verification/ Field Testing	Potential Yield (kg/ha/yr)
Α.	Population Control of Tilar	oia .		
	1. Monosex culture of T. mossambica		x	4,000
	2. Sex reversal of <u>T</u> .  mossambica		<b>x</b> .	3,000
	3. Biological control of  T. mossambica with piscivorous fishes in			0.000
	brackishwater		x	2,000
	4. Cage culture of <u>T</u> . <u>nilotica</u> in freshwater		×	240 kg/m <sup>3</sup> /yr
	5. Hybridization	x x		
B.	Pond Culture of Tilapia			
	1. Culture of <u>T</u> . <u>nilotica</u>			
	in freshwater ponds with fertilization only		×	4,000
	2. Culture of <u>T</u> . <u>nilotica</u> in freshwater ponds with fertilization & supple-	<b>.</b>		
	mental feeding		×	6,000
c.	Lake farming of tilapia in	cages x		
D.	Diet development for tilapi	a x		
E.	Hatchery			
	1. Fishpond ( <u>T</u> . <u>nilotica</u> )		×	7 fry/m <sup>3</sup> /month
	<ol> <li>Fish paddies (<u>T. nilotic</u></li> <li>Net enclosures</li> </ol>	<u>a</u> )	<b>x</b> *	14 fry/m <sup>3</sup> /month
	a. <u>T. nilotica</u> b. <u>T. mossambica</u>		<b>x</b> :	250 fry/m <sup>3</sup> /month 2,500 fry/m <sup>3</sup> /month

# PRODUCTION POTENTIALS OF AVAILABLE TECHNOLOGY FOR FISH PENS IN LAGUNA LAKE

Technology Level	Potential Yields
High input (high-yield) High density intensive supplemental feeding Artificial aerations	4-8 tons/ha or more
Medium input (medium-yield) Average density, little supplemental feeding	3-4 tons/ha
Low input (low-yield)  Low density, inferior pen  structure	3 tons and below

LINKAGE MECHANISMS

# LINKAGE MECHANISM FOR THE TRANSFER OF APPROPRIATE TECHNOLOGY MILKFISH, PRAWN, MOLLUSCS AND TILAPIA

The linkage mechanism has three main components: technology generation, technology verification and packaging, and technology dissemination and utilization.

For technology generation, the lead agencies are the SEAFDEC Aquaculture Department, University of the Philippines, and Central Luzon State University. Support will be provided by the Philippine Council for Agriculture and Resources Research (PCARR), Bureau of Fisheries and Aquatic Resources (BFAR), Mindanao State University (MSU), Bicol University (BU), and Mindanao Regional School of Fisheries (MRSF).

In verifying and packaging the technology developed by the researchers, the BFAR will be responsible together with the private sector, regional research and educational institutions, and PCARR. To provide them the necessary support are the Asian Institute of Aquaculture (AIA) of SEAFDEC, and the National Food and Agriculture Council (NFAC).

The BFAR will also be the lead agency, together with the private sector, in disseminating and applying the technology. Support will come from action programs, regional educational institutions, the mass media and AIA-SEAFDEC.

The Consultation also came up with a listing of available technology, technology gaps, and research programs and proposals for aquaculture.

### 1. Technology Gaps

- a. Southeast Asian Fisheries Development Center
- b. Philippine Council for Agriculture and Resources Research
- c. Bureau of Fisheries and Aquatic Resources
- d. University of the Philippines System
- e. Central Luzon State University
- f. Private sector
- g. Other research/educational institutions

### 2. Verification/Packaging

- a. Asian Institute of Aquaculture
- b. Philippine Council for Agriculture and Resources Research
- c. Bureau of Fisheries and Aquatic Resources
- d. University of the Philippines System
- e. Central Luzon State University
- f. Private sector
- g. Southeast Asian Regional Center for Graduate Study and Research in Agriculture

- h. Development Academy of the Philippines
- i. Other educational/research organizations

### 3. Training and Extension

- a. Asian Institute of Aquaculture
- b. Bureau of Fisheries and Aquatic Resources
- c. University of the Philippines
- d. Central Luzon State University
- e. Southeast Asian Regional Center for Graduate Study and Research in Agriculture
- f. Development Academy of the Philippines
- g. Private sector
- h. Other Fisheries Colleges/Schools

### 4. Support Services

### a. Credit

Technical Board for Agricultural Credit Development Bank of the Philippines Rural Banks Other banking/lending institutions

### b. Fry/spawner sources

Sustenance fishermen/fry gatherers Baklad operators Commercial fishermen Others

### c. Marketing

Food Terminal, Inc.
Philippine Fisheries Marketing Authority
Concessionaires (middlemen)
Others

### d. Transport/Handling/Processing

Local transport companies Ice plant owners Others

### 5. Other international organizations

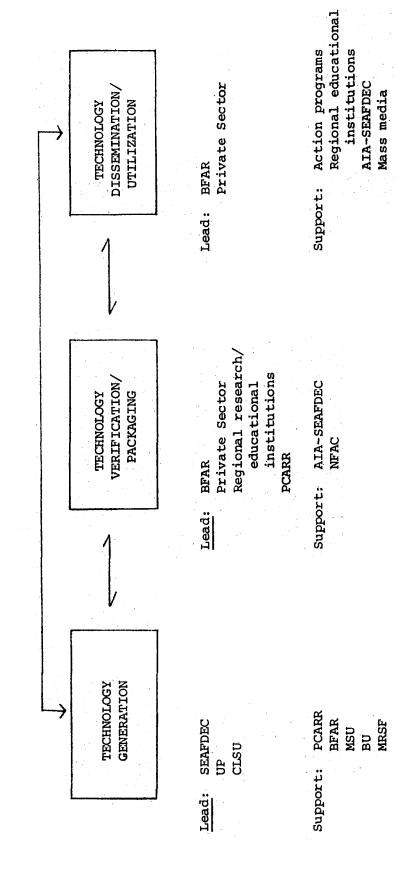
FAO/UNDP South China Sea Programme

Southeast Asian Regional Center for Graduate Study and

Research in Agriculture

International Center for Living Aquatic Resources Management

# LINKAGE MECHANISM FOR TRANSFER OF APPROPRIATE AQUACULTURE TECHNOLOGY



### Bases for classification:

- 1. Traditional usual practices of aquaculturist; has not been subjected to research studies.
- 2. Research and Development subjected to scientific investigations.
- 3. Primitive traditional practices in great need for improvement as evidenced by low efficiencies.
- 4. Improved traditional practices that have been successful.
- 5. EXP studies are on-going; research results are not yet conclusive.
- 6. FIELD TEST basic research studies conclusive; in the process of investigation in pilot-scale; technology available in other countries.
- 7. PROD pilot-scale studies successful; being widely practiced and consistently dependable.

### 1. Seed catching/production

Wild fry - The present methods used in gathering, storing and transporting wild fry are considered still primitive. With slight modifications and refinements, the total fry available for stocking in ponds can easily be raised by about 20 percent. There are existing methods used in other countries which may be tried directly in this country.

The estimated average number of fry caught from the wild actually stocked in ponds is about 60 million per year. This fugure assumes that 3 1/2 percent of total fish production is shrimps/prawns, with a survival rate of 30 percent during the rearing period in ponds and an average harvest size of 30 pcs per kg. With a 50 percent increase over the present estimate, the total available fry from the wild would be 72 million per year.

Hatchery-reared fry - Existing hatcheries in the country today have an average total production of about 12.3 million per year.

Assuming that in the next three years there would be a total of 30 hatcheries operated by the private sector with an individual average production of 2 million fry/year and assuming further that existing hatcheries would be able to increase production by making use of some recently developed technology, the total fry production would be about 95 million per year.

Hatcheries	Production, fry/year (million)		
	Existing 1978	Potential 1981	
SEAFDEC	. 8	30	
		(including those	
		to be included	
.*	•	in substations)	
MSU-IFRD	2	<b>,5</b>	
Private Sector	3	60	
TOTAL	13	95	

### 2. Nursery

A nursery system would be necessary for the hatchery  ${\bf r}$ eared postlarvae.

Bigger fry (1 gm) may be stocked directly into grow-out ponds. For smaller one (less than 0.1 gm), it would be desirable to stock them first in nursery ponds.

Average survival rate in nursery ponds is 60 percent at a stocking density of  $100/m^2$ .

At present, pond operators stock the fry directly into grow-out ponds.

#### 3. Grow-out

For polyculture with milkfish, the existing stocking density of prawn is 1000-3000 per ha with a survival rate of about 30 percent and a harvest size of 15 pcs per kg. With the available technology, stocking density may be increased to 10,000-15,000 per ha with supplementary feeding. Survival rate would be about 50 percent and stock may be harvested at size of 25 pcs per kg.

For monoculture, the existing stocking density ranges from 3,000 to 5,000 per ha. The stock is harvested at 15 pcs per kg with an average survival rate of 30 percent. Stocking densities could be increased by refinements on the existing system to 15,000-20,000 per ha. Survival rates could be 50 percent and harvest could be made for stock size of 25 pcs per kg.

BRIEFS

MILKFISH REPRODUCTION: BROODSTOCK DEVELOPMENT

Flor Lacanilao SEAFDEC Aquaculture Department

#### MILKFISH REPRODUCTION: BROODSTOCK DEVELOPMENT

#### Flor Lacanilao

### Relevant Research Areas and Available Information

Age determination at sexual maturity

There are indications that wild females are 4-5 years old (Tampi, 1957) or 5 years old (Liao, 1971). Tank-reared males matured in 6 years and females in 7-8 years (Liao and Chang, 1976); Liao, unpublished).

Determination of spawning migration pattern

No direct evidence, but there are some indications from milk-fish egg collections (Senta et al, 1976; Kumagai, 1978) and sabalo capture.

Food requirement of sexually maturing milkfish

Most of the examined sabalo had plankton in stomach (Kuronuma, 1976; Kumagai, unpublished). Fish in the stomach had been encountered. Sabalo are attracted to fish bait and floating small fishes killed by dynamite as indicated by experiences of fishermen.

Environmental influence on migratory behavior, sexual maturation, and spawning

Downstream migration at Naujan (Mindoro Oriental) occurs in relation with typhoons and changing direction of the moonsoon with peak in November (Kumagai and Sitoy, unpublished). At certain environmental and lunar conditions, milkfish held in natural brackishwater ponds show sings of migrating to the open sea (Nash and Kuo, 1976). Gonadal development proceeds at salinities below seawater (Liao and Chang, 1976; Nash and Kuo, 1976) or begins in freshwater (Naujan Lake) or Laguna Lake water (Lacanilao, 1973). Appearance of milkfish eggs and fry indicates that spawning occurs 200-1000 meters from shore and has lunar periodicity, the first and last quarters (Kumagai, 1978) when the tidal fluctuation is lowest.

Hormonal control of sexual maturation, ovulation, and spawning

Acetone-dried salmon pituitary together with human chorionic gonadotropin induce spawning in captured milkfish spawners (Vanstone et al, 1977; Liao et al, 1978).

Development of an accurate method for monitoring ovarian maturation

Egg sampling technique developed for mullet offers anatomical difficulty when tried in milkfish (Chaudhuri and Juario, unpublished).

Preservation of sperm

Attempts in refrigeration and cryogenic preservation of milkfish sperm have not been successful (Chaudhuri and Juario, unpublished; Vanstone, unpublished).

#### References

- Kumagai, S., Castillo, N.M. and Bañada, V.C. 1978. Spawning periodicity of milkfish, Chanos chanos. SEAFDEC Quart. Res. Rep. II(2):10-12.
- Kuronuma, K. 1976. Reviews and recommendations on current and future research activities for the biological investigations on milkfish. Proceedings of the International Milkfish Workshop-Conference, Iloilo, Philippines, May 19-22.
- Lacanilao, F. 1973. Hormonal induction of gonadal maturation in milkfish. Technical Report, UP-NSDB Integrated Research Program.
- Liao, I.C. 1971. Note on some adult milkfish from the coast of Southern Taiwan. Aquaculture 1:1-10.
- Liao, I.C. and Chang, Y.S. 1976. A preliminary report on the gonadal development of adult milkfish, <u>Chanos chanos</u>, reared in tank. Proceedings of the International Milkfish Workshop-Conference, Iloilo, Philippines, May 19-22.
- Liao, I.C., Juario, J.G., Kumagai, S., Nakajuma, H., Natividad, M., and Buri, P. 1979. On the induced spawning and larval rearing of milkfish, Chanos chanos (Forskal). Manuscript.
- Nash, C.E. and Kuo, C.M. 1976. Preliminary capture, husbandry and induced breeding results with the milkfish, <u>Chanos chanos</u> (Forskal). Proceedings of the International Milkfish Workshop-Conference, Iloilo, Philippines, May 19-22.
- Senta, T., Kumagai, S. and Ver, L. 1976. Occurrence of milkfish eggs in the waters around Panay Island, Philippines, in April and May, 1976. Proceedings of the International Milkfish Workshop-Conference, Iloilo, Philippines, May 19-22.
- Tampi, P.R.S. 1957. Some observations on the reproduction of the milkfish, Chanos chanos (Forskal). Proceedings Indian Acad. Sci. B46:254-276.
- Vanstone, W.E., Tiro, L.B., Villaluz, A.C., Ramsingh, D.C., Kumagai, S., Dulduco, P.J., Barnes, M.M.L., and Dueñas, C.E. 1977.

  Breeding and larval rearing of the milkfish, Chanos chanos (Pisces:Chanidae). SEAFDEC Tech. Rep. No. 3.

INDUCED SPAWNING AND LARVAL REARING OF MILKFISH

Jesus V. Juario SEAFDEC Aquaculture Department

#### INDUCED SPAWNING AND LARVAL REARING OF MILKFISH

#### Jesus V. Juario

Milkfish constitutes a major product of aquaculture in Indonesia, Taiwan and the Philippines. The only source of fry for stocking in ponds and pens is the coastal waters during the spawning season; consequently, the supply is irregular and inadequate. The need to have a dependable source of seed cannot be overemphasized.

## Induced Spawning

In the Philippines, early attempts to induce the sabalo to spawn in captivity by hormone injection failed (Angeles, 1968; Inland Fisheries Project Technical Report No. 5, 1974; Delmendo & Angeles, 1975). Liao and Chan (1976) were successful in inducing gonadal maturation in male milkfish reared for the past six years in concrete tanks. In 1976, at SEAFDEC and at the Oceanic Institute, injection of the semi-purified salmon gonadotropic hormones (SG-Gl00) to female sabalos resulted in the release of hydrated eggs (Nash & Kuo, 1976; Vanstone et al., 1976); the eggs, however, were not fertilized. In 1977, adult milkfish were induced to ovulate in captivity by injecting them with a mixture of acetone-dried pituitary gland of salmon (ADSP) and human chorionic gonadotropin (HCG) and the eggs were successfully artificially fertilized (Vanstone et al., 1977). In 1978, Juario et al. attempted to induce ovulation in sabalos by injecting them with either ADSP alone or a micture of ADSP and HCG. Results reveal that all fishes except those having eggs with a mean diameter smaller than 0.60 mm or those that are badly injured responded to the hormone injection of either ADSP alone or a combination of ADSP and HCG; ovarian eggs were found to be undergoing hydration. Better results were obtained when ADSP was used in combination with HCG.

From the results, it is evident that response of fishes to hormone injection is very much affected by their physical condition during acclimatization. Safe capture, handling and transport of spawners are essential to the success of induced spawning. Recently, Liao and Chan (1979) were successful in inducing maturation and ovulation of milkfish reared in concrete tanks for 5 to 6 years. They used either ADSP or acetonedried mullet pituitary (ADMP) with either Puberogen or HCG. But the eggs leased were not fertilized.

A summary of the hormones used to induce spawning in newly captured adult milkfish is presented in Table 1.

## Larval Rearing

Earlier attempts to rear newly hatched milkfish larvae failed. Of the several thousands of eggs that were artificially fertilized, only a few fingerlings survived (Vanstone et al., 1977) and in another experiment only 2 larvae survived for 6 days (Chaudhuri et al., 1977). In 1978, Liao et al. obtained a total of 2,859 fry from the 13,400 larvae that were originally stocked in experimental tanks. The highest survival rate obtained from different experimental groups was 46.8 percent; the lowest was 8.8 percent.

The better survival is attributed to the larval rearing technique used which is as follows:

Green water consisting mainly of marine chlorella is added to the 400-1 and 1 ton larval rearing tanks on Day 1. Fertilized eggs and larvae of oysters are given as food from Day 2-7; rotifers from Day 2-21. Copepods and brine shrimp nauplii are given from Day 14-21. One-third of the water in the rearing tanks is changed whenever necessary. The light green color of the water is maintained throughout the rearing period.

Results of the 1978 larval rearing experiments at SEAFDEC further indicate that milkfish larvae could be reared successfully until Day 14 by giving rotifers alone as food. The density of the rotifer, however, should be between 50-200 organisms/cc or more.

Table 1
Hormones used to induce spawning in wild adult milkfish

Hormones Used	Total Dose/Fish	Remarks	Reference
HCG (Ayerst)	10,000 IU	Fish did not spawn	Anon., 1974
SG-G100	30-60 mg	Hydrated eggs re- leased but unfer- tilized	Vanstone et al., 1976
SG-G100	50 mg	Eggs hydrated and fish partially ovulated	Nash & Kuo, 1976
ADSP+HCG (Ayerst)	150-240 mg ADSP+ 8,000-16,000 IU HCG	Hydrated eggs were stripped & fer- tilized	Vanstone et al., 1977
ADSP	150-720 mg	Ovarian eggs under- going hydration, all experimental fish died	Juario et al., 1978
ADSP+HCG (Ayerst)	84-360 mg ADSP+ 7,000-17,000 IU HCG	Two fish died with eggs undergoing hydration; two fish ovulated, eggs were stripped & ferti-lized	Juario et al., 1978
CPH+HCG (Ayerst)	12.5-50 mg CPH+ 1,250-20,000 IU HCG	Most of the injected fish died but ova- rian eggs were under going hydration; 4 out of 27 had eggs w/c were almost completely hydrated	- Kuo, 1978

HCG - human chorionic gonadotropin

SG-G100 - partially purified salmon gonadotropic hormone

ADSP - acetone-dried pituitary gland of salmon

CPH - carp pituitary homogenate

#### Literature Cited

- Anon, 1974. Inland Fisheries Project Technical Report No. 5 (1974): Jan. 1 through June 20, 1976, University of the Phil. College of Fisheries, 9-20.
- Angeles, H.G. 1968. A preliminary report on the observations and possibilities of induced spawning of mullet and milkfish. Indo-Pac. Fish Counc. Occas. Pap. 71:1-11.
- Chaudhuri, H., J.V. Juario, J.H. Primavera, R. Mateo, R. Samson, E. Cruz, E. Jarabejo and J. Canto Jr. 1977. Artificial fertilization of eggs and early development of the milkfish Chanos chanos (Forskal). Tech. Report No. 3, Aquaculture Department, SEAFDEC, pp. 21-38.
- Delmendo, M.N. and H.G. Angeles. 1975. Preliminary observations on the spawning of milkfish Chanos chanos (Forskal). Fisheries Forum, PCARR, FNRCA, Manila, 28 Jan. 1975, 22 p., mimeographed.
- Juario, J.V., I.C. Liao, J. Nacario, J. Almendras and J.T. Canto, Jr. 1978. Experiments on the induced spawning of milkfish, Chanos chanos (Forskal). In Press.
- Kuo, C.M. 1978. Report on the field work of the Milkfish Program at Christmas Island, 10 pp. (unpublished).
- Liao, I.C. and Y.S. Chan. 1976. A preliminary report on the gonadal development of adult milkfish, Chanos chanos, reared in tank.

  In: International Milkfish Workshop Conf., Tigbauan, Iloilo, Phil., 19-27 May 1976, 12 pp. mimeo.
- Liao, I.C., J.V. Juario, S. Kumagai, H. Nakajima, M. Natividad and P. Buri. 1978. On the induced spawning and larval rearing of milkfish, Chanos chanos (Forskal). In Press.
- Liao, I.C. and T.I. Chen. 1979. Report on the induced maturation and ovulation of milkfish (Chanos chanos) reared in tanks. 10th Annual meeting of the World Mariculture Society, Honolulu, Hawaii, Jan. 22-26, 1979.
- Nash, C.E. and C.M. Kuo. 1976. Preliminary capture, husbandry and induced breeding results with the milkfish, Chanos chanos (Forskal). International Milkfish Workshop Conf., Tigbauan, Iloilo, Phil., 19-22 May 1976, 21 pp. mimeo.

- Vanstone, W.E., A.C. Villaluz and L.B. Tiro, Jr. 1976. Spawning of milkfish, Chanos chanos in captivity. International Milkfish Conference, Tigbauan, Iloilo, Philippines, 19-22 May 1976, 5 pp. mimeo.
- Vanstone, W.E., L.B. Tiro Jr., A.C. Villaluz, D. Ramsingh, S. Kumagai, P.J. Dulduco, M.L. Barnes and C.E. Dueñas. 1977. Breeding and larval rearing of the milkfish, Chanos chanos (Pisces: Chanidae). Technical Report No. 3, Aquaculture Department, SEAFDEC, 3-17.

## NUTRITION IN MILKFISH

Arsenio S. Camacho
Brackishwater Aquaculture Center
U. P. College of Fisheries
Leganes, Iloilo

#### NUTRITION IN MILKFISH

#### Arsenio S. Camacho

The practical importance of bangus nutritional studies was discussed in earlier papers (Camacho, 1975; Leary, 1976). Both authors agreed that supplemental feeding would be an effective tool to grow more milkfish per unit area of fishponds except that there is an extreme scarcity of information on the nutritional requirements of this fish. Without adequate knowledge on the nutritional requirements of bangus, feed formulation becomes a hit-or-miss affair. The techniques so far developed to increase the natural supply of food in the ponds (e.g. fertilization, polyculture, agro-fishery) must, indeed, strongly complement studies on nutrition.

## Recent Developments

Nutritional studies in milkfish should be highly specific for a certain growth stage. To start with, there is wide recognition in the three main milkfish producing countries (Taiwan, Philippines and Indonesia) that increase in milkfish production, either by area expansion or by intensification, would heavily depend on the supply of fingerlings (Chen, 1976). Study trips in Panay revealed that a major constraint among many fishpond operators is the inadequate supply of fingerlings. Our low national yield of 600 kg/ha/yr is due partly to the under-utilization of pond areas on account of insufficient stocking.

The early developmental stages of milkfish have been recently documented (Chaudhuri, et al, 1978) and the milkfish industry would later on profit from this initial venture given the condition that the work is sustained. This "breakthrough" must become a practical means to solve the above-mentioned critical need of the industry. Obviously, the larval rearing aspect would require the provision of nutritionally adequate feeds, a research aspect that has barely started.

The research team at the Brackishwater Aquaculture Center has taken a slightly different but, nevertheless, complementary view regarding this problem area. The target are fry collected from the wild (15 mm total length) and how to best promote good growth and survival up to the stocking size of 1-2 grams per fish, using a total indoor system. It is a fairly new approach in our local industry but not in other places. Similar operations may be seen elsewhere, where private or government entities are engaged quite successfully in the large-scale production of shrimp juveniles, salmon or catfish fingerlings.

The premises on which the BAC project was based are as follows:
(a) the milkfish fry fishery in the Philippines, involving a great
number of small fishermen (fry gatherers) must be sustained for socioeconomic reasons; (b) there is a need to define a new culture system
to encourage high survival of the fry during a nursery phase or prior

to stocking in production ponds; (c) under controlled conditions, the fingerling supply would be assured on a whole-year basis; (d) there would be minimal constraint on feed cost since the selling price of fingerlings on a per unit weight basis is relatively high.

In 1978, with a grant from the National Science Development Board (NSDB), work was undertaken to formulate a chemically-defined artificial diet for growing milkfish fry to fingerlings. The development of an artificial test diet is a necessary prelude to studies on the nutrient requirements of other successfully cultured species, namely, salmon, trout, and prawns (Halver, 1976; Kanazawa, 1970). After examining the purified diets successfully formulated by the American and Japanese scientists, we were able to come up with a casein-gelatin mixture, fortified with vitamins and minerals. after work was concentrated on the determination of the optimum protein requirement by simply manipulating the components of this test diet. This project also envisions particular culture system that would allow the maximum exploitation of the test diet for this and subsequent objectives, i.e. optimum levels of fats, carbohydrates, vitamins and minerals. We have confidence that our simple design, consisting of all-glass aquaria, a recirculating unit and lifesupport systems (aeration and bio-filter) is fairly adequate as indicated by the physico-chemical characteristics of the water.

Some of the highlights of the work at BAC in 1978 are as follows:

- 1. The diet containing 50% protein (55% casein and 14% gelatin) produced the highest net gain (150 mg) and survival (90%) after a culture period of 28 days.
- 2. Acceptable levels of growth and survival were obtained at a high stocking density of 4,000/m<sup>3</sup>.
- 3. Prophylactic treatment significantly contributed to greater survival during the feeding trial.
- 4. The fry were observed to readily accept the purified diet and to actually grow on it under an artificial environment without any soil substrate.
- 5. Syndromes, characteristics of avitaminoses, were observed during the growth phase (35 mg 0.4g) and were attributed to some limitations in feed preparation and storage limitations.

This modest work has brought us closer to our main goal of eventually establishing a pilot milkfish fingerling distribution unit initially in Panay. The over-all culture operation would consist of indoor tanks and reservoirs, complete with the necessary life-support units and including fingerling counting, sorting and distribution facilities. Depending upon further results of our feeding trials we would be able to rationalize a feeding program using artificial diets or this in combination with natural food sources. Actual pilot testing is programmed by the middle of next year here in Iloilo in cooperation with a local resident who is willing to provide the appropriate facilities to hold about a million fingerlings during the fry season. A few representatives of banking institutions are now studying the possibility of granting loans for this type of project. It would be a happy sight to see a number of these fingerling distribution units established around the country to serve the needs of both the big and small fishpond operators.

#### References

- Camacho, A.S. 1975. Bangus nutrition studies. Proc. National Bangus Symposium, Manila.
- Chaudhuri, H., J.V. Juario, J. Primavera, R. Samson and R. Mateo. 1978. Observations on artificial fertilization of eggs and the embryonic and larval development of milkfish, Chanos chanos (Forskal). Aquaculture. 13: 95-113.
- Chen, T.P. 1976. Culture of milkfish (<u>Chanos chanos</u>) as a means of increasing animal protein supply. J. Fish. Res. Bd. Canada. 34 (4) Part II.
- Halver, J.E. 1976. Formulating practical diets for fish. J. Fish. Res. Bd. Canada. 33 (4) Part II.
- Kanazawa, A., M. Shimaya, M. Kawasaki and K. Kashiwada. 1970. Nutritional requirements of prawn I. Feeding on artificial diet. Bull. Jap. Soc. Sci. Fish. 36 (9).
- Leary, D.F. 1976. Bangus feeding The state of an art. Paper presented at the Twelfth National Convention of the Philippine Federation of Fishfarm Producers, Iloilo City.

## PRESENT STATUS OF MILKFISH FARMING IN THE PHILIPPINES

Melchor M. Lijauco SEAFDEC Aquaculture Department

#### PRESENT STATUS OF MILKFISH FARMING IN THE PHILIPPINES

#### Melchor M. Lijauco

In the mid-1950's milkfish farming in the Philippines achieved a major breakthrough of sorts. Commercial agricultural fertilizers was found to improve pond yields by promoting the growth of filamentous algae. This discovery ushered the Filipino fish farmers into the frontiers of scientific aquaculture.

A few years later, the industry saw an even more significant technological development. The benthic type of natural food complex, lablab, was demonstrated as superior to the traditional grass green algae. This technique, patterned after those practised in Taiwan, literally revolutionized the local milkfish farming system. With the prospect of higher yields, scores of milkfish farmers throughout the country adopted the new technique. Innovations were introduced to suit local conditions and practices.

These two major developments produced manifold effects. National average output from milkfish farms increased from about 500/kg/ha/yr in the late sixties to 640/kg/ha/yr in 1976. The culture system has transcended into the fertilization technology level.

The application of organic and inorganic forms of fertilizers, singly or in combination, has become a standard practice in pond soil and water conditioning along with the use of commercially prepared pesticides and molluscicides to eradicate pond pests and predators. There was a marked increase in the hectarage of developed milkfish farms as old and neglected ponds began to be improved and virgin swampland areas converted into new ponds. A sample survey completed in 1976 indicated that about 30% of existing fishponds was developed in the sixties and about an equal proportion after 1970.

However, industry constraints have recently become major considerations. Increased hectarage meant a proportionate increase in the demand for farm production inputs resulting to shortage in the supply of fry and fingerlings caught in the wild and of fertilizer materials. The alarmingly indiscreet use of agricultural chemicals poses a threat to natural pond productivity. Extensive proliferation of fishponds may lead to denudation of swampland and mangrove areas which endangers other aquatic species.

The trend of development in recent years has become more technology-specific. Intensive, rather than extensive farming systems are increasingly becoming the goal both in the micro- and macro-economic levels. Fertilization techniques are gradually being refined to suit location needs in order to maximize productivity and to cut down on fertilizer expense. Traditional and agricultural waste products are increasingly used in ponds in place of imported pelleted fertilizers and chemicals. A number of stock manipulation techniques and polyculture systems have gained wide acceptance among fish farmers.

Much hope is pinned on the artificial spawning of the sabalo and the advent of a hatchery system for milkfish. Simultaneously, milkfish farming is gradually inching towards another frontier—that of the feeding level. Within the forseeable future the mutritional requirement of the milkfish shall be established which will lead to production of economically viable fish pellets. Indications point to milkfish production in the near future surpassing even the target 2000/kg/ha/yr national average.

### Seed Production

Milkfish farming depends much on the supply of fry from the wild. The 180,000 hectares of existing ponds and 5,000 hectares of fish pens require annually some 4.5 billion fry assuming a 50 percent survival of the fry from capture in the wild to harvest in ponds and pens.

There have been reports of recurring shortage in the supply of fry and fingerlings brought about by abnormal fry runs and inclement weather condition. This problem will increase as production-oriented technologies improve.

The prospect of alleviating this major problems may be glimpsed from the following:

## a. Broodstock development

The Bureau of Fisheries and Aquatic Resources (BFAR) pioneered in the attempts to domesticate the sabalo in its experimental Station in Naujan, Mindoro in the late 1960's. In 1972, the UP/NSDB Inland Fisheries Project collected mature sabalo along the coast of Panay Island. Attempts to induce breeding by hormone injection failed.

To artificially spawn the milkfish, the SEAFDEC Aquaculture Department set up a breeding station in Pandan, Antique. Preliminary work in 1976 resulted in the development of methods of capturing and transporting wild adult milkfish. The spawners were domesticated in

tanks. The first scientific breakthrough came in 1977 when the station succeeded in inducing the female milkfish to spawn using acetone-dried Pacific Salmon pituitary powder. In the same year, the SEAFDEC Tigbauan Station was able to fertilize hydrated eggs although only a few larvae survived up to 5 days.

In both instances the major problem identified is the larval rearing of the newly fertilized eggs. Different species of diatoms and brachionus were tried as food supplement for the developing larvae.

Refinements of the spawning method bore results in 1978 when SEAFDEC Tigbauan Station again artificially induced milkfish spawning. Fingerlings numbering a few thousands are presently confined in tanks and ponds. The latter are already about 200 g in mean weight. In addition, the SEAFDEC Igang Station has about 1000 sabalo-size milkfish in fish pens at the Island of Guimaras.

#### b. Collection from natural habitat

The Philippines may be considered a natural fry ground. Known fry grounds are shallow sandy coasts, tidal creeks and river mouths.

Collecting grounds extend from up north in the Ilocos and Cagayan Region, along the western coasts of Luzon and the Bicol Region, the Central, Eastern and West Visayas including Oriental Mindoro and Masbate, to as far south as Mindanao and Jolo.

Generally, the collecting season starts in March lasting until June or July. In some areas a second wave of fry occurs in October to November. Still in some regions, fry occur throughout the year. The season is usually preceded by rainfall. A study conducted in Panay Island indicate that the peak of occurrence of fry comes 1-2 days before the new and the full moon.

## c. Fishing gears

Collecting gears used are generally common to all grounds consisting of stationary, pushed or dragged net and bamboo contraptions operated in coastal areas in waters knee-deep to neck-deep. Stationary gears are filtering traps provided with one-way opening and fitted with floats to rise and fall with the tide. Dragged or pushed contraptions are either simple seines or scissors net and portable traps (Bulldozer type) handled by one or two men. A rather exceptional gear is one found in Antique which consists of a large rectangular (bunted) seine operated like a beach seine.

#### d. Storage and transport

Fry collected by fishermen are generally sorted in the beach area and stored in pots or basins while awaiting purchase by fry dealers. In the fry dealer's establishment, the fry are picked up by fishpond owners, the rest stored in jars or basins. Care of stored fry consists of daily water exchange and feeding with mashed hard-boiled egg yolk.

Fry are transported in oxygenated plastic bags placed inside a pandan bag for extra handling and protection. Each bag, filled to about 1/2 to 1/3 full of diluted sea water, contains from 6,000 to 10,000 fry. Transport bag salinities range from seawater level to about 18 parts per thousand.

### Fry Rearing

Milkfish fry when caught in the wild measures from 10-15 mm in total length and weighs from 0.002 to 0.006 mg. Some still show traces of yolk sac indicating that fry migrate towards the coast at an early stage. Normally caught with these fry are those of other common species such as tenpounders, mullets, tarpons, and Penaeid shrimps.

Milkfish farms normally procure the whole year fry requirements in a single lot during the peak season when price is low. Others prefer buying in separate lots depending upon availability of pond space.

## a. Rearing in tank

The system of raising milkfish fry to fingerlings 1-2 g in weight in indoor or semi-indoor conditions in wooden or concrete tanks has not been developed commercially in the country. The lack of suitable feed formulation has probably confined in the experimental stage the use of indoor tank for mass producing fingerlings.

## b. Nursery ponds

Nursery ponds are built to receive and rear the fry into fingerlings for a period of 4-6 weeks.

Ordinarily, pond size ranges from 1,000 to 4,000 square meters. Prior to arrival of the stock, nursery ponds are carefully prepared to insure the highest possible survival. Stocking rate varies from 30 to 50 fry/m<sup>2</sup>.

During stocking the most important consideration is to avoid salinity and temperature shock. The newly arrived fry are acclimated to pond salinity level if transport bag water salinity differs widely with that of the pond. Ordinarily, acclimation is done in plastic basins under the shade lasting for about 4 to 6 hours. Tolerance of milkfish fry to abrupt salinity changes is known but extra precaution would favor gradual acclimation as physiological stresses are not readily detectable. The fry are stocked during the colder part of the day as in late evening or early morning.

A slightly modified method is the pre-stocking of fry in a small acclimation pond built within the nursery pond proper at a rate of 5,000/m<sup>2</sup>. Fed with patches of lablab daily (or with mashed egg yolk if they are visibly weak), the fry are released into the pond proper after about a week by breaking some sections of the dike. By this time the fry shall have grown larger and developed scales. The acclimation pond is provided with shade to keep water temperature cool especially during sunny days.

## Culture in grow-out ponds

Milkfish farming here is heavily influenced by methods practised in Taiwan. However, the difference in the physical, climatic and socioeconomic conditions of the two countries does not permit complete transfer of technology. As a result, innovative techniques proliferate. Intermingled with traditional practices and recent technological developments in the country and elsewhere, these developed into what may be called the milkfish culture system in the Philippines.

### a. Construction and lay-out of milkfish ponds

The extensive farming system still dominates the scene with fishponds running to several tens and in some cases hundreds of hectares. A recent survey estimated the country-wide average farm size at 16 hectares.

Non- or slighly-renovated fishponds reflect the traditional practices characterized by haphazardly oriented ponds and dikes, unlevelled pond bottoms and relatively large rearing compartments. The absence of well-placed supply-drain canals or head ponds suggests a decentralized mode of operation.

Newly constructed or renovated fishponds present distinct features such as well-built peripheral and partition dikes laid out in straight patterns, regularly shaped compartments or manageable size and well-situated supply-drain canals and sluice gates to enable independent water management by compartment, and relatively levelled bottoms cleared of tree stumps.

#### b. Liming and fertilization

Liming is little understood by some local fish farmers as an important soil conditioning process especially among those who own long-established ponds. Perhaps it is because the immediate effects of lime are not as readily perceptible as those exhibited by fertilizers. Satisfied with their production, others simply do not find any need for it. In contrast, owners of newly excavated ponds accept the need for liming to hasten stabilization and to neutralize acid-forming compound exposed or leached out.

The use of organic and inorganic fertilizers is widely accepted. However, the technique lacks the refinements to make possible recommendations of the type, dose and methods of application of fertilizer materials area-specific as to the type of soil and desired natural food organism. The potentials, as fertilizers, of other agricultural waste products such as those coming out of rice and sugar mills have not been deeply explored.

#### c. Pest and pradator control

Pests and predators in ponds cause high mortality of fry and fingerlings and contribute to low yields in grow-out ponds. Included are species of fish and other aquatic animals that directly feed on or compete with the stock for food. Others like snails and polychaete worms destroy the bottom substrate preventing luxuriant growth of benthic algae.

A survey of 1175 fishfarms showed that among the various methods of eradicating pests and predators, the chemical method was the most popular, followed by "catch and kill" and pond drying. Endrin was the most widely used followed by Brestan, Gusathion, Aquatin, tobacco dust and Thiodan in that order. The same survey revealed that fish production of chemical users was about twice that of non-users which indicates the substantial effect of pest and predator control. Oblivious or aware of the possible dangers of continued use of chemical poison in ponds, the farmers do not have much choice since plant-based or organic forms of pesticides are hardly available in commercial quantities.

This is a critical and immediate dilemma confronting the milkfish farming industry.

## d. Natural food in ponds

Lablab is the main natural food propagated in milkfish ponds. The relatively narrow tidal range of the Philippine waters favors propagating this type of food base which requires shallow depth. Besides, studies have shown that lablab is more palatable and nutritious than

the traditional grass green filamentous algae. The free-floating plankton method was recently demonstrated as a likely alternative but for its requirement of deep water (about 1 m) which is not possible in most areas. The same plankton method in shallow ponds was demonstrated as feasible. The present practice calls for preparing the pond to grow lablab and resorting to plankton when lablab is completely grazed before the stock reaches marketable size.

## e. Nutrition and feed formulation in milkfish

Supplemental feeding of milkfish raised in ponds is being practised but resorted to only when the natural food organisms being propagated have been prematurely grazed. Commonly used are single-ingredient feed materials such as rice bran, bread crumbs and corn bran. Dried grass green filamentous algae and "gulaman" (Gracillaria sp.) are reportedly being used. Other forms but less used are copra meal, hog mash, dried rice straw and ipil-ipil (Leucaena leucocephala) leaf meal.

Formulated feeds specifically for milkfish has yet to be developed. A preliminary study in a controlled environment indicates that a dietary level of 40 percent protein is required by milkfish fry for maximum growth, efficient feed conversion, and high survival rate.

#### f. Monoculture and Polyculture

Polyculture, in its true sense, is virtually absent. In fact, except for Penaeid shrimps all other species of fish in the milkfish pond are regarded as pests or predators. However, the potential is recognized for such a system using tilapia, spade fish and mullet, among others. Much research work has yet to be done to insure mass production of seedlings and establish culture techniques.

Local fish farmers practise a semblance of polyculture. When available, fry of Penaeus monodon are stocked directly in grow-out ponds with milkfish fingerlings. Rate of stocking varies with previous experiences or the availability of fry, but normally at a rate equal to that of milkfish. No extra care is given to the prawn except occasional feeding with chopped flesh of water snakes and slices of carabao or cow hides. Some fishfarmers stock their ponds with mud crab juveniles.

## g. Stocking rate

Ordinarily, the grow-out pond is stocked with a mono-sized stock of fingerlings to be grown into marketable-sized for a culture period of 60 to 120 days depending on the size of fingerlings initially stocked, the type of food grown, and the abundance of food. Density ranges from 1000-1500/ha in "lumot" ponds, 2000-3000/ha in lablab ponds, and about 5000/ha in deep plankton ponds.

Size of fingerlings varies from about 2-3 grams to as high as 20 grams. In a normal year-long operation, the late stocks are composed of larger and stunted fingerlings.

## h. Mixed size-group culture

This method is essentially a form of stock manipulation technique. The pond is stocked with three sizes -- 1500/ha of 2-35 g, and 3000/ha of 2-3 g fingerlings. Selective harvesting is done after the first 45 days and every 15 days thereafter. Two culture periods will be possible in this method and claimed to produce from 2200-2700 kg/ha/yr. BFAR demonstrated the technique in one of its experimental fishfarms in 1967 through 1969 obtaining a net production of about 1300 kg/ha for a culture period averaging 150 days.

The technique however has three major limitations:

- selective harvesting by gill nets entails extra cost for additional manpower
- 2) quality of harvest relatively poor as gilled fish bear marks and are often scaled
- 3) uncertainty of availability of fingerlings of desired size at appropriate time.
- i. Modular method of culture

One technique of stock manipulation that gained wide popularity among milkfish farmers in recent years is the so-called modular method, sometimes referred to as progression system.

First seen in practice in a large fish farm in Pangasinan, the method consists of a series of grow-out ponds linked to one another in operation and performing as unit, thus dividing the whole farm into sub-units or modules. The system is termed progression because in a module, the stock is transferred in succession from one pond to the next until harvest -- fish size and pond area progressively increasing. Correspondingly, density decreases after every transfer. Culture period in a pond leasts from 30-45 days; any one pond vacated is immediately prepared to receive an incoming stock. Commonly seen are modular units comprising three ponds with areas progressing in a 1:2:4 ratio.

#### j. Parasites and diseases of milkfish

The extent and kinds of diseases and parasitism in milkfish raised in brackishwater ponds have not been deeply studied. Preliminary work showed presence of fungus and bacterial infection in adult milkfish

primarily in the eye membranes, fins, and in lesions in the body region. The observations, however, were made on fish which had been subjected to severe physical and physiological stresses. Indications are that the occurrence of the parasites and diseases is more consequential than phenomenal. External symptoms of a deseased fish are aberrations of the fins, rhizoid growth clouding the eye membrane, and inflamation and lesions at fin bases and peduncle regions.

There is no other documented report of mass kills of milkfish in ponds attributed to disease or parasitism except those that occurred in Central Luzon in 1969 to 1972 which were believed caused by parasitic isopods.

An unidentified species of ectoparasite (Caligus sp.) was found heavily infesting a number of sabalo spawner caught from the wild.

#### k. Harvesting

Harvest may be partial or total. With partial harvesting, only part of the stock is collected and the remainder is allowed to grow further. Total harvest means the whole stock is sold and the pond readied to receive a new batch of fingerlings.

Decision to harvest is dictated by economic and operational considerations such as: 1) prevailing market price; 2) phase of the tide; 3) weather conditions; 4) state of food supply in the pond; and 5) desired size.

## Culture in Freshwater Fishpens

The large-scale culture of milkfish in pens in Laguna Lake adds a new dimension to world aquaculture. Portions of the lake are enclosed using semi-permanent structures and stocked with milkfish fingerlings at densities reaching as high as 10-12 times those used in brackishwater ponds. Feeding only on the natural planktonic life of the lake water, the fish attain market size in 5-6 months. Studies estimate that the yields obtained range from 2-4 tons per hectare and in some cases as much as 10 tons. Considering the productivity of natural open waters, these yields are phenomenally high which is attributed to the unusually rich and unique environmental conditions in the lake.

Pen culture in the lake is a fairly recent development. Successfully demonstrated in 1970 by the Laguna Lake Development Authority in a 38-hectare enclosure, the pens proliferated rapidly. Recent estimates place the total pen area at about 5000 hectares with potentials for expansion 3 to 4 times as much.

However, objections have been aired over such expansion, arising from social and ecological considerations. Pen enclosures are gradually displacing natural grounds for open water fisheries which affects the means of livelihood of thousands of fishermen in the area. There has been an increasing fear of an eventual and total ecological imbalance. Periodic occurrences of mass or near-mass kills have been experienced.

## Post Harvest Handling

About 90 percent of the catch from milkfish ponds and pens go to the domestic market as fresh fish with a minor volume as marinated or smoked. The local major market outlets are concentrated in Metro Manila and a few other population centers. Bringing the catch to these centers takes from a few hours to about 2 days depending on the mode of transportation used. Handling of the catch includes pre-chilling, packing and actual transport.

Pre-chilling or immersion of fish immediately after harvest in iced water accomplishes the following: 1) serves as a convenient killing medium, thus preventing excessive physical damage and resulting to attractive looking fish; 2) slows down autolysis or enzymatic breakdown activities; and 3) removes blood, slime, dirt and bacteria from the skin of the fish, thus minimizing further deterioration.

A recent study on handling, icing and transport of milkfish found no advantage in chilling to 0°C over the 4°C if icing is applied immediately after harvest. The latter requires about 450 kg of ice to a ton of fish in two hours of immersion as against 900 kg of ice and four hours of immersion in the former. The same study recommended types of containers and ice to fish ratios to insure good quality fish reaching the market.

#### References

- Ballesteros, O.Q. and S.P. Mendoza, Jr. Brackish Fishpond Management. In: Pond Construction and Management. Published by Western Visayas Federation of Fish Producers, Inc.
- Barica, J. Nutrient Dynamics in Eutrophic Inland Waters Used for Aquaculture. SCS/76/UP/24. South China Sea Fisheries Development and Coordinating Program, Manila, Phil., March 1976.
- Chaudhuri, H., J.V. Juario et.al. Artificial Fertilization of Eggs and early development of the Milkfish, Chanos chanos (Forskal). Technical Report No. 3, Aug. 1977, SEAFDEC Aquaculture Dept.
- Dolendo, A.L. et al. Standardization of handling, icing and freezing of milkfish. In: Milkfish (Bangos) as Food. Published by NSDB, Manila, Phil. 1978.
- Garcia, D.M. Observations on the use of plastic bags for transporting bangos fingerlings. mimeo. Fisheries Gazette, Vol. 4, No. 12.
- IFP Inland Fisheries Project, Technical Report No. 2, First Half, FY 1972-73. Technical Report No. 3, Second Half, FY 1973-74. Technical Report No. 5, Second Half, FY 1964.
- Juario, J.V. and C. Dueñas. Salinity preference of the milkfish Chanos chanos (Forskal). Quarterly Research Report, 2nd Quarter (Apr-June) 1977, SEAFDEC Aquaculture Department.
- Kumagai, S., A.C. Villaluz et al. The occurence of milkfish, Chanos chanos fry in Pandan Bay, Antique from 21 May to 25 June, 1975.

  Proceedings: International Milkfish Workshop-Conference, Iloilo, Phil., May 1976.
- Laviña, E.M. The Biology and control of caligus sp. as ectoparasite of the adult milkfish Chanos chanos (Forskal). Quart. Res. Rep., 2nd quart. 1977, SEAFDEC Aquaculture Department.
- Librero, A. et al. Research Paper Series No. 4, Nov. 1976, SEAFDEC-PCARR Research Program.
- Lim, Chhorn. A preliminary study on the protein requirement of <u>Chanos</u> chanos (Forskal) fry in a controlled environment. Quart. Res. Rep., 1st quart., 1978, SEAFDEC Aquaculture Department.

- Padlan, P.G. Improved techniques of milkfish farming in Iloilo Province.

  Pond Construction and Management, pub. by WVFFP, Inc.
- Potter, T. Seminar on fishpond soil quality. Pond Construction and Development, Pub. WVFFP, Inc.
- Rabanal, H.R. et al. Studies on the rate of growth of milkfish or bangos, Chanos chanos (Forskal) under cultivation. Indo-Pacific Fisheries Council Proceedings, 4th meeting, Q.C., Phil., Oct.-Nov. 1952.
- Ronquillo, I.A. and P. Cases-Borja. Notes on the Infestation of Chanos chanos by a parasitic isopod. Proceedings of National Bangus Symposium, Manila, July 1975.
- Santos, C. de los, Jr. Modern Aquaculture for the Phil. Yuhum La Defensa Press, Iloilo, Phil., 1978.
- Tang, Y. and T.L. Huang. Suitability of various groups of algae as food of milkfish produced in brackishwater ponds. Proceedings: National Bangus Symposium, Manila, July 1975.
- Tang, Y. Improvement of milkfish culture in the Phil. Current Affairs Bulletin, IPFC/FAO, No. 49, Aug. 1967.
- The Philippines Recommends for Bangus. 1978 (draft).
- Vanstone, W.E. et al. Induced spawning, artificial fertilization of eggs and larval rearing of the milkfish <a href="Chanos chanos">Chanos (Forskal)</a> in the Phil. Tech. Report No. 3, Aug. 1977, SEAFDEC Aquaculture Department.

## MAJOR TECHNOLOGY GAPS IN MILKFISH CULTURE IN THE PHILIPPINES

Melchor M. Lijauco SEAFDEC Aquaculture Department

## MAJOR TECHNOLOGY GAPS IN MILKFISH CULTURE IN THE PHILIPPINES

### Melchor M. Lijauco

Exuberant optimism is what may be described of the prevailing attitude toward the development of aquaculture in the Philippines. Firstly, the 1970's started out with a fresh momentum for technological improvements in view of significant advances gained in the sixties. Secondly, the establishment in 1972 of the national UP-NSDB Inland Fisheries Project and the SEAFDEC Aquaculture Department provided strong backstopping by the academic communities in solving problems related to aquaculture through well-organized research undertakings.

Quick technology transfer is assured with the Philippine Council for Agriculture and Resources Research monitoring the results of research and the Bureau of Fisheries and Aquatic Resources extension network disseminating the information to the fish farmers and other end-users.

In milkfish farming, early benchmark information indicated two foremost problem areas as needing priority considerations because of their immediate and long-range effects. These are 1) standardization of fertilization techniques in pond and 2) fish nutrition and utilization of animal feeds.

The first recognized the fact that prevailing fertilization techniques were inexact and indeterminate. The second saw the importance of complete or supplemental feeding in increasing pond yields. Later, high priority was given to the artificial breeding of the sabalo and related studies to improve fry and fingerling survival as a result of recurring shortage in the supply of fish seeds following the boom of fish pen culture in Laguna Lake and unusual floods in Central Luzon.

Other priority areas included: 1) polyculture, 2) pest, predator and disease control, 3) post-harvest handling, f) utilization of agricultural waste products and 5) aquaculture engineering.

Production wise, a fairly substantial gain was attained. The national average output from milkfish ponds increased from about 500/kg/ha/yr to 640/ka/ha/yr in 1976. The figure for 1978 may be reasonably estimated to be somewhere in the vicinity of 800 kg/ha/yr.

However, there are clear indications that fields of fully developed and well-managed fishponds reach as high as 2000 kg to 2500 kg/ha/yr. The same tends to indicate that mediocre operations still prevail to bring down the national average by so much.

A look at some aspects of the present milkfish farming system provides indications of technological gaps.

Pond operation is still extensive. One single major factor for a successful operation is fertilization. The key is to grow natural food as abundantly as possible. Supplemental feeding using single-ingredient materials is resorted to only when the natural food communities are grazed before the fish are harvested. Up to this point, fertilization techniques are not yet so location-or area-specific as to enable manipulation of nutrients to desired levels depending on prevalent type of soil or climate or on desired food organisms.

Economically viable commercial pellets for milkfish fry or fingerling are yet to be developed. Present research studies have not established the nutritional requirements of the fish. Within the immediate future however pelletized feeds for milkfish may eventually be commercially manufactured.

The deep-water plankton method has not attained a level of perfection that would make it popularly accepted like the lablab method. Production from plankton ponds remain unpredictable ranging from very low to very high yields.

Polyculture is almost wholly confined to milkfish and prawn (P. monodon). The practice borders on the traditional since stocking ratios (milkfish to prawn) have not been fully evaluated. Potentials of other species such as tilapia, spadefish and mullet have not been tapped.

Improvements in fry and fingerling survival during transport, handling and rearing are noted. A number of stress factors like salinity, temperature, pH, have been identified. Culture, handling and transport techniques are gradually being modified.

The artificial spawning of the sabalo has been achieved, but much work has to be done before a hatchery operation becomes feasible. The development of broodstock has surfaced as a major problem.

One major problem is the control of pond pests and predators. The dangers are recognized in the continued use of inorganic pesticides and other forms of chemical poisons, but the unavailability of comparatively effective substitutes remains unresolved.

As a whole, technology gaps in some aspects of milkfish farming have been narrowed. In the others the gaps remain unchanged. The important thing is that they are recognized.

# PEST/PARASITES AND DISEASES OF MILKFISH IN THE PHILIPPINES

Carmen C. Velasquez National Institute of Science and Technology

## PEST/PARASITES AND DISEASES OF MILKFISH IN THE PHILIPPINES

#### Carmen C. Velasquez

Attempts to increase productivity in fish farms, to improve stocks and acclimation of fish to new environments require detailed knowledge of parasites inhabiting the different localities.

Knowledge of the development and biology of the parasites of fishes is needed to devise successful prophylactic measures. With endoparasites, many effect their entry into the fish host by being swallowed with food. Invertebrate food fauna in the areas new to the fish may cause outbreaks or epizootics. On the other hand, ectoparasites develop externally and are more influenced by the conditions of the macroenvironment (environment of the fish host).

The parasite fauna in fishponds differ greatly from those inhabiting natural environments due to a number of factors: 1) reduced salinity and 2) methods involved in the management of pond fisheries which enhance mass infestation or infection.

However, conditions in pond fisheries allow for preventive and control measures of parasitic diseases. Methods of treatment can be done in confined areas but not in large bodies of water.

Upon arrival of the fry from the spawning grounds to fishponds, changes in their physiology are bound to have an effect on their resistance to parasitic diseases. The number of parasitic species in ponds is small compared with those harbored by the same fish in its natural environment. Parasites with direct life cycles usually survive in ponds as flagellates, ciliates, myxosporidians, coccidia, and parasitic arthropods.

This paper presents all known parasites of <u>Chanos chanos</u> (Forskal) in the Philippines. All came from affected farms in different parts of the country.

## Major Parasitic Groups

#### Parasitic Copepods

Lernaea - Infected fingerlings from the Himlayan Filipino fishponds and that of the fish pens from Laguna de Bay have been referred to me for diagnosis. The copepods protrude wormlike from the nostrils or skin of the infected fish usually at the base of the fin. The visible portion is cylindrical, whitish, often with two eggs extending from its posterior end. When carefully dissected out of the fish, the modified head appears anchor-like, giving it the name "anchor worm." This parasite goes through developmental stages from fish to fish resulting in considerable damage to the host. Mass infestation results in great economic loss.

Salt solution of about 3-5 percent concentration was found effective for the larvae. However, because adilts were difficult to kill, dessication of infected ponds and liming was recommended before re-stocking of healthy fish.

Calique - Very recently, I had the opportunity to diagnose the Caligue infected Sabalo reared in the SEAFDEC experimental tanks in Pandan. Calique has its second pair of antennae provided with claws and two sucker-like organs located at the anterior end of the cephalotorax. The latter, being flattened, acts somewhat like an adhesive disc when applied to the surface of the water. The final metanauplius stage being negatively phototropic finds its host at the lower level near the bottom. The copepodid stage, generally known as chalimus is characteristic in caligids. It is attached to the tissues of the host by a long filament formed by the hardened secretion from a gland located in front of the eyes. The larvae undergo several molts before they become adults. When the adult male emerges from its final molt, it breaks off the thread and immediately searches for a female which remains attached until it is fertilized. Then it breaks away to lead a planktonic life. The caligids never stray far from their hosts, and are found wandering over the body and with the aid of a tubular mouthpart suck their feed from the fish.

The source of water for the Sabalo experimental tanks in Pandan is directly from the sea and is without adequate filters. Concentration of the planktonic caligids resulted in the infestation of the Sabalo and death of a number of them.

For treatment, I recommended the use of 1-3 percent formalin since it is not harmful to other organisms in the tank. Laviña used Neguven (Dylox), an acarocide, with positive results. However, Neguven (Dylox) in sea water dissipates faster.

## Parasitic Isopods

Rocinella typicus and Ichthoxyenous are vicious killers. They kill not only the fry and fingerlings but also fish of marketable size. Observations under laboratory conditions showed that they attack, traumatise fish, and eventually kill them. The case of mass infestation of the Iloilo fishponds was referred to me. Mass killing of fish in the fishponds resulted in great mortality.

Direct life cycle and fast multiplication enhanced the intensity and incidence of infection. Recommendations were made to remove all infected fish. Survivors and non-infected fish were placed in clean ponds. All ponds with infected fish were dried and limed for several weeks before use.

### Heterophyidiasis

The disease is caused by very small flatworms with indirect life cycle (Digenea) belonging to the family Heterophyidae. The larvae (metacercaria) of Haplorchis varium, Haplorchis yokogawaia and Procerovum calderoni have been found encysted in the muscles of the bangus obtained from the fishponds in the BFAR Dagatdagatan Experimental Station, Malabon, Rizal (1973, 1973a).

Wild birds, dogs, cats and man become infected by eating raw or not well cooked bangus. In man, the infection may cause mild diarrhea. However, continuous practice of eating not well cooked infected bangus may result in cardiac and visceral complications. To date, the only heterophyid life cycle known in the Philippines (Velasquez, 1973a) is that of Procerovum calderoni. The snail's intermediate host is Thiara riquetti. The eggs are eaten by the snail and develop into the early developmental stages in the hepatopancreas. Emerged cercariae penetrate and encyst in a suitable fish as the bangus.

Infection of fish can be avoided by proper waste disposal and strict observance of preventive measures.

## Acanthocephalosis

The Acanthocephala form a clearly defined group of worms. They are cylindrical, provided with spines in the proboscis hence are called "spiny headed worms."

Sexes are separate. Intermediate hosts are arthropods.

Numerous worms were found in the intestinal walls of Sabalo from Nasugbu, Batangas and the BFAR Station in Mindoro.

Ulcerations of the intestinal wall was evident with the proboscis of the worm securely attached.

## Conclusion

The composition of the parasitic fauna of <u>Chanos chanos</u> is affected not only by physiological and biological features of the host but by proper management in the case of pond fisheries.

Prophylactic measures, treatment, prevention and control should be in accordance with the ecological conditions existing in the locality. Chemotherapy of fish for human and farm animal consumption should be employed in accordance with Food and Drug rules and regulations. POST-HARVEST OPERATIONS AND PRODUCT UTILIZATION STUDIES ON BANGOS

Florian Magno-Orejana National Science Development Board

## POST-HARVEST OPERATIONS AND PRODUCT UTILIZATION STUDIES OF BANGOS

#### Florian Magno-Orejana

The most perishable of all protein foodstuffs, fish deteriorates in quality soon after harvest. The operations that follow harvesting must then be carefully considered, knowing that the market price of fish is partly determined by its state of quality when it reaches the consumer. To assure its availability and ease of transport, a portion of the harvested fish should be converted to products that keep better.

Bangos utilization studies have been the subject of interest of various food researchers, largely due to its special flavor and popularity as a food item in the Filipino diet. Local investigations on the handling, processing and quality control of bangos maybe classified into the following areas:

- 1. Handling, chilling and freezing
- 2. Preliminary operations, smoking, salting and drying
- 3. Canning of bangos formulations
- 4. By-product utilization

#### Handling and Icing

The use of low temperature as in chilling or icing is the simplest and cheapest method by which the onset of spoilage is retarded. Studies on icing bangos for transport by boat, by air, or by land were conducted recently by the Food Terminal Inc. (Dolmendo, et al, 1975).

Four types of containers with the same dimensions were studied for use in boat transport at a travel time of 24 hours. Fish were pre-chilled prior to packing in containers. Results showed that the insulated 1 cu m containers provided with drainage outlets at the bottom, with bañeras separated from each other by wooden dividers, gave the best quality of fish and negligible loss in weight.

For air transport, at a travel time of 1 hour, if fish were pre-chilled prior to packing and with the center temperature of fish at 0°C, good quality could be obtained at a low ice to fish ratio of 1:20 or without ice at all. Styrofoam boxes with a net capacity of 60 kg were preferred for air transport.

For land transport, bañeras provided with holes for drainage of fish fluids and melted ice were found to preserve the quality of the fish and are much cheaper and more durable than styrofoam boxes. However, styrofoam boxes are preferred over bañeras when fish which are not pre-chilled are transported by land.

Modified containers for handling and transport of bangos were also compared with the typical bañera. Quality assessment was made by objective tests correlated with sensory evaluation. Results are shown in Table 1 (Buenafe, et al., 1974).

Table 1. Quality assessment of chilled bangos (Chanos chanos Forskal) stored in three types of containers.

A.	Using container	insulated with	styrofoam and
	provided with d	rainage outlet.	

Time (Hr.)	: Temperature : of : Fish, °F	: VRS	: Crganoleptic Evaluation
. : O	71.3	6.82	fresh, odor characteristic of bangos
1	45.8	nd	nd
5	36.5	nd .	nd
10	32.7	7.02	fresh, no off-odor whatsoever
20	32.5	7.89	fresh, texture firm as before
30	33.4	8.52	fresh, pale color with slime
40	. 37.0	9.73	still fresh, with somewhat fishy odor
50	45.2	17.50	acceptable, slimy and fishy
60	79.1	29.34	definitely unacceptable

B. Using modified bañera provided with drainage holes and a platform to prevent melted ice and leached fish fluids from soaking fish.

1 37.3 nd nd 2 32.2 nd nd	: Organoleptic Evaluation :		
0	71.2	7.01	fresh, odor typical of fresh bangus
1	37.3	nd	nd
2	32.2	nd	nd
10	46.8	16.93	acceptable, little fishy odor, firm
15	78.9	23.62	spoiled, not acceptable

## C. Using typical bañera

	:	Temperature	:		:
Time	:	of	:	VRS	: Organoleptic Evaluation
(Hr.)	:	Fish, °F	<u>:</u>		*
0		71.3	-	7.01	fresh, odor typical of fresh bangos
1		37.5		nd	nd
5		32.7		nd	nd
10		56.9		19.6	acceptable, with little off odor, softened
15		78.5		27.3	spoiled, not acceptable

The market quality of chilled bangos was assessed by objective tests and found to fluctuate within the same batch of samples (Table 2). This indicates the heterogenous quality of fish sold in the market which reflects the varying quality of handling operations used by the industry.

Table 2. Market quality of randomly sampled bangos (Chanos chanos Forskal) as assessed by VRS (Volatile reducing substance).

Days of	storage	Temperature (°F)		VRS*
3		8°	ı.	23.09
			II.	23.46
5		20°	I.	37.46
			II.	40.92
10		20°	ı.	35.34
			II.	32.46
			III.	33.69
3		8°	ī.	41.21
_			II.	40.93
5		20°	ı.	27.51
			II.	26.63
			III.	27.23
10		20°	ı.	38.46
			II.	40.11
* .			III.	

<sup>\*</sup>VRS - microequivalents/5 ml press juice. It is an objective index of quality which increases with increasing degree of spoilage.

## Freezing and cold storage

The loss in weight of bangos during frozen storage may be minimized by the use of polyphosphates to decrease the amount of "thaw drip" from frozen bangos. Preliminary studies on the effect of various combinations of sodium chloride and polyphosphates on the quality of frozen bangos have been made.

Data on bangos commercial freezing, including time required for sensible heat removal, thermal arrest time, freezing time and weight before and after freezing were also studied (Dolendo, et al, 1978).

Peroxide values and indices of rancidity of fat extracted from bangos after varying periods of frozen storage have been studied and correlated with the amount of NaCl and traces of cupric salts in the aqueous solutions where the fish samples are soaked for several hours (Bigueras, 1971).

In a recent study, the deterioration on the quality of bangos at frozen storage was assessed using the VRS test. The VRS (volatile reducing substances) content of the fish increases with increasing spoilage in a direct relationship which makes this chemical test an objective index of quality (Table 3).

Table 3. Data showing the relationship between the VRS

(Volatile reducing substances) and the log bac-

		terial	numbers	of	fro	zen	bango	ວຣ	with storage time
Samples:	Days of Storage	: Tem	perature (*F)	:		VRS		:	Log Bacterial Number
I	0				А. В. С.	17. 16. 17.	26		6.6727
II	26		14°		A. B.	19. 21.			7.1468
III	29		16°		A. B.	21. 21.			7.1789
IV	35		12°		A. B.	34. 43.			8.1633
V	39		19°		А.	48. 43.			6.3880
VI	41		12°	··· _ 1.	A. B.	53. 33.			6.8037

Source of fish: Pond No. 2, U.P. College of Fisheries, Diliman, Quezon City

Using the VRS test to assess the effect of antibiotics and antioxidants, preliminary studies show the improvement of the shelf-life of frozen fish by the use of some additives.

## Preliminary operations, (Deboning), salting, smoking, drying and other products

The weight of bangos ranging from 32 g to 1,345 g and length from 6.1 cm to 53 cm were studied in relation to meat yield against round weight. Meat yield of bangos increased with round weight up to 600 grams, beyond which the curve levelled off (Arroyo, 1975). The percentage yield of edible portion of bangos as compared to some species of fish has also been determined.

The preparation of boneless bangos has received popular attention due to the convenience and better edibility resulting from the complete deboning operation. In the process, when the backbone is separated from the flesh, the neural, haemal and some pleural spines attached to it are removed. Skill is required however, to remove the several spines embedded in the muscles -- 38 branching spines at the dorsal portion, 14 spines from the nape along the lateral line, and 16 fine branching spines along the ventral muscels (Arroyo, 1974; BFAR leaflet).

Fish curing such as salting, smoking, drying and marinating maybe employed to improve the keeping quality of bangos. A review of the research on fish processing in the Indo-Pacific area was made recently (IPFC studies, 1967) (Orejana, 1973).

Studies have been made on the development of smoked soft-boned bangos and its storage qualities as related to the physico-chemical characteristics of the product while stored at various temperatures. Preparation of smoked soft-boned bangos involve the following operations: cleaning and eviscerating, soaking at desired salt concentration, pressure cooking, drying, and smoking at optimum temperature. Brining at 95°S, pressure cooking at 10-20°C yielded a product of good quality as indicated by objective and subjective tests (Baclig, 1970).

Preliminary studies on the effect of salt impurities, duration and temperature of smoking, brine concentration and type of fuel on the quality of smoked and salted bangos have been completed.

Unlike soft-boned bangos which is pressure cooked without deboning, smoked boneless bangos has been prepared and its quality correlated with storage temperature, method of packing and brine concentration. Microbiological and chemical tests were correlated with sensory evaluation to assess the quality of the product (Guevara, et al, 1978).

Fish protein concentrate (FPC) has also been prepared from bangos. This protein-rich powder maybe used as a flavoring agent or food supplement and can be stored indefinitely due to its low moisture and fat content. FPC prepared from bangos has an advantage over those prepared from other species due to its light color and good flavor. No organic solvent is necessary if mechanical pressing operations are done efficiently. This drastically reduces the cost of FPC preparation. The amino acid content of the unprocessed bangos has also been compared with the FPC prepared from it and both have been found to be rich in essential amino acids (Orejana, 1974).

## Canning of bangos

The canning of bangos has been the subject of investigations by several research agencies. Product formulations have been made for canned bangos sardine style; bangos in oil, with tausi, with pork, escabeche-style; salmon-style; and many others. Recently, the development of canned fish sausage with skinned bangos, as well as the paksiw na bangos packed in glass jars has been done (Arroyo, et al, 1975). French sardine style formulations have been prepared (Gonzales, et al, 1970) and Marfori, et al, in 1974 conducted a storage life study of canned bangos.

As early as 1957, Sulit et al published procedures on the canning of bangos and the preparation of some bangos by-products.

The steps involved in canning essentially include dressing of bangos, cutting into can-length size, brining, pre-cooking, filling into cans, exhausting, sealing, processing at required temperature and time, cooling, and labeling. The ingredients added during the filling operations depend on the formulations desired.

## By-product utilization

The conversion of waste materials of bangos processing to stable by-products may spell the difference between profit or loss in the bangos processing industry. Fish meal and fish silage, hydrolysate (bagoong and patis) and oils, and guanine extracts are a few of the more important by-products prepared from bangos offals.

In a recent study, fish meal and silage were prepared from bangos offals. Fish meal was prepared by steaming followed by drying and grinding while fish silage was prepared by using varying concentrations of sulfuric acid to hydrolyse the tissues and dissolve the bones. The two types of products which can both be used as feed ingredients were compared, based on proximate analyses and pepsin digestibility test.

Proximate analyses -- protein, moisture and ash content, and NPU values of fish meal and fish silage are shown in Table 4 and 5. Statistical analyses showed that the difference in the digestibility values expressed as percentage nitrogen was significant at 10 percent level (Flores, et al).

Table 4. Proximate analyses of fish silage and fish meal from Chanos chanos Forskal

Samples :	% Moi	sture	% Pr	otein	* *	Fat	: % P	sh
	A	: B	: A	: B	: A	: B	: A :	В
Fish Silage	56.50	130.33	18.83	43.32	11.85	27.33	4.14	9.53
Fish Meal	10.53	11.80	45.13	50.83	15.20	16.20	11.77	13.11

A - Wet weight basis

Table 5. % NPU of fish silage and fish meal from Chanos chanos Forskal

Samples	:	Pepsin digestibility % protein	:	Solubility % protein	:	% NPU of total protein
Fish silage		1.1156		18.3145		36.91
Fish Meal		1.3499		15.8625		33.34

Various methods of preparing by-products from bangos offals have also been studied (Orejana, et al). Fish meal samples prepared by sundrying and artificial drying have been compared as to percent moisture, protein and ash content. Peroxide and iodine values were used to assess rancidity. The use of the wet reduction and dry reduction processes was also studied.

The amino-nitrogen, Total Volatile Base (TVB) and pH of fish silage prepared from bangos offals have been determined in a recent study.

B - Dry weight basis

The pH, solid to liquid ratio, percent NaCl and amino-N of hydrolysate (bagoong) from bangos offals were measured, using salt to fish ratios (1:3, 1:3.5, 1:4).

The internal organs (viscera) of bangos can be formulated into an easy-to-prepare snack item by the use of flour and eggs, and can also be incorporated in kropeck.

Fish oils have found industrial uses in other countries. In a recent study, oils from bangos offals were prepared by different methods of extraction. The percentage yield, specific gravity, free fatty acid value and peroxide and iodine number of the oil samples extracted were compared.

This paper reviewed the recent investigations made locally on the utilization aspects of bangos. Cost-analyses and feasibility studies on the manufacture of various products require more intensive study.

Finally, the development of the bangos processing industry will depend initially on the quantity of raw material made available to the fish processor.

#### Literature Cited

- Arroyo, P. T. et al. 1970. Standardization of Canning procedures for bangos and other fishes (NSDB) Proj. No. 7402.1 Ag Technical Report).
- Arroyo, P. T. 1974. Fish. In the science of the Philippine Foods. First ed. Araneta Center, Quezon City, Philippines, 321 p.
- Bigueras, C. M. 1971. Peroxide and Iodine values as indices of fat rancidity in <u>Chanos chanos</u> (Forskal). Undergraduate Thesis Report. Dept. of Fisheries Technology, U.P. College of Fisheries.
- Buenafe, B.A. and F.M. Orejana. 1974. Improved containers for handling and storage of fresh fish. PCAR Monitor. Vol. 2 No. 4.
- Dolendo, A. et al. 1975. Standardization of handling, icing and freezing of bangos and other fishes (NSDB Proj. No. 7402.2 Ag Technical Report).
- Flores, P.F. 1973. The Nutritive value of fish silage compared with fish meal (Chanos chanos Forskal). Department of Fisheries Technology. U.P. College of Fisheries, Diliman, Quezon City.
- Guevara, G. et al. 1978. Standardization of drying, smoking and curing of bangos and other fishes (NSDB Proj. 7402.3 Technical Report).
- Orejana, F.M., R. O. Juliano and C.M. Bigueras. 1973. An Evaluation of FPC prepared by isopropanol and ethanol extraction. Proceedings, 8th Annual PAFT Convention November 27 and 28, 1973.
- Orejana, F.M. 1973. Handling, preservation and storage of fish and fishery products. Workshop Session No. 14, PCAR, Fisheries Research Division. February 12-17, 1973. Los Baños, Laguna.
- Orejana, F.M., L.M. Santos and M.N. Bautista. 1978. Utilization of by-products of bangos processing and those of other pond-raised fishes (NSDB Proj. 7402.4 Technical Report).
- Sulit, J.I., B. Datingaling and F. Gonzales. 1957. Studies on the Processing of Bangos, Fisheries Gazette. Nov., 1957.
- . 1967. Fish processing in the Indo-Pacific Area.
  Indo-Pacific Fisheries Council Regional Studies No. 4 FAO
  Regional Office for Asia and Far East. Bangkok, Thailand.
- \_\_\_\_\_. Bureau of Fisheries and Aquatic Resources (BFAR)
  Leaflets. Utilization/research division. BFAR, Manila.

## MILKFISH POND ENGINEERING

Catalino R. de la Cruz Central Luzon State University

#### MILKFISH POND ENGINEERING

#### Catalino R. de la Cruz

Today's modern engineering technology began in a trial and error fashion. It took years before the numerous engineering designs and formulas and a rational approach to the design and construction of establishments were developed. It also took continuous refinements and painstaking effort before the developed status in engineering science and technology in various disciplines was achieved.

Milkfish pond engineering is a young and specialized field. It would require putting together appropriate principles and techniques from various engineering disciplines in order to establish functional fishpond facilities. For years, fish culture did not benefit from the advancement and development in engineering technology; in the past both fish culturist and engineer ignored each other in working towards the progress of the industry. Very few engineers had ventured in this kind of occupation.

As a result, instead of putting together and modifying engineering technology that were already available, early pond developers resorted to the costly trial and error method of designing and constructing the facilities.

At the very beginning, many of the pond owners were not fully aware of the relationship between the engineering design considerations in ponds and the biological requirement of milkfish as a cultured animal. Gradually, however, a few innovative pond owners began to recognize the benefits derived from properly engineered ponds.

The experience in the development of milkfish ponds is long enough to provide information and draw workable recommendations on pond engineering.

#### Milkfish Pond Engineering Technology

At present, information on the following are already recognized which can be organized and referred to as the pond engineering technology for milkfish: 1) Criteria on site selection for fishponds; 2) Relationship between the size of gate, pond water level and design tide curve; 3) Design elevation of foundation; 4) Relationship among the sizes of pond compartments according to their functions; 5) Different types of layout schemes; 6) Size and proportioning of dikes; 7) Control of internal erosion and seepage; 8) Methodology on pond construction and repair, including related facilities; and 9) Construction tools and machineries.

The papers of Denila (1, 2), the FAO report of Jamandre (3) and the book of delos Santos (5) were the products of their experiences in milkfish pond engineering. The information they have presented can be considered vital contribution to the milkfish pond industry. They have discussed extensively the various factors to consider in the site selection, size and layout of pond compartments, canal system and their specifications, construction methods for dikes, including the necessary implements and machineries, and the technique in the construction of pond water control structures.

The techniques in determining the size of fishpond gate in relation to the design depth or level of water in the pond and design tide curve as presented by the three authors was further elaborated and strengthened by Katoh (4). Katoh showed how the size of gate opening can be analytically determined through iterative process. The method of determining the design elevation of gates and ponds was also discussed. Although the idea is not new to our fishpond operators, it was observed that only a few of our ponds were constructed in accordance to the required elevation.

Like any engineeering project, economy of construction, aesthetics, environmental impact, and functionality are the four major considerations in the layout and design of ponds. Functionality connects the engineering know-how in satisfying the environmental or biological requirement of milkfish in various stages of growth. This includes location, size and shape of each compartment, water supply and drainage system, and the projected fish culture management scheme. There are three layout schemes now existing — the conventional, progressive and radiating. While the scheme looks all right, the report on comparative production of each scheme under a given set of conditions is missing.

The problem of controlling internal erosion in fishponds was one of the areas covered during the regional workshop on aquaculture engineering sponsored by SEAFDEC and the South China Sea Fisheries Programme. A number of ways including the materials considered useful for controlling erosion were reported.

On seepage problem, proper construction of dikes is the key to minimizing it. Denila (1, 2) has illustrated how to construct the dikes properly. Should the problem of seepage exists, however, there are also remedial ways and information that may be tapped.

#### Conclusion

The subjects briefly discussed are the main concern of milkfish pond engineering. In other related areas where engineering is needed, I am almost certain that information from other engineering disciplines are already available. We only need to harness and modify these information if necessary to fit our purpose.

There is a need to compile and synthesize the information on hand about milkfish pond engineering into one package of technology.

#### References

- Denila, L. Improved methods of manual construction of brackishwater fishponds in the Philippines. In-Workshop Report, Joint SCSP/SEAFDEC Workshop on Aquaculture Engineering. December, 1977.
- 2. Denila, L. Layout, design, construction and levelling of fishpond. In - Readings on pond construction and management. pp. 73-83.
- Jamandre, T. Engineering aspects on brackishwater aquaculture.
   FAO report.
- 4. Katoh, J. Guide to coastal aquaculture engineering.
- 5. Santos, C. de los. 1978. Modern Aquaculture for the Philippines.

# SOCIO-ECONOMIC ASPECTS OF MILKFISH FARMING IN THE PHILIPPINES

Aida R. Librero & Elizabeth Nicolas Philippine Council for Agriculture and Resources Research

## SOCIO-ECONOMIC ASPECTS OF MILKFISH FARMING IN THE PHILIPPINES

## Adia R. Librero and Elizabeth Nicolas

This paper attempts to assess the present technology in milkfish farms including fish pens, in the Philippines. Data were based on a survey of 1394 milkfish pond operators, 1175 of whom were adopting monoculture of milkfish and 219 adopting polyculture system, throughout the country. For fish pens, 170 operators were interviewed.

## The fish farm and the operator

Milkfish ponds in the country averaged 13.39 ha for monoculture and 8.11 ha for polyculture farms (Table 1). Rearing ponds occupied the biggest area, 85 percent and 84 percent of the farm area respectively. Moreover, majority had 2 nursery ponds with total area of 0.57 ha.

Fish pens were smaller, averaging 6.5 ha with the smallest area at 0.16 ha and the largest 45 ha.

Table 1. Area and type of ponds in milkfish farms, Philippines

74.00	F	Fish			
Item	Monoculture Polyculture		Both	Pen	
Ave. Operational area (ha)	13.39	8.11	12.56	6.50	
Nursery pond	0.59	0.45	0.57	-	
Transition pond	1.41	0.78	1.31	-	
Rearing pond	11.32	6.78	10.61	6.50	
Others	0.07	0.10	0.07	-	
Presence of different pond	type (%)				
Nursery	79	71	78	-	
Transition	59	39	56	-	
Others	34	35	34	-	

A majority of the operators were male between 40-50 years of age and had some formal education (Table 2). Fish pen operators were slightly younger than those operating fishponds.

Aside from fish farming, the majority of fishpond operators were enaged in other occupations such as fishing and farming. Still, more than one-half of the year (full time equivalent) was devoted to fishpond operation. In contrast, fish pen operation is labor intensive thus, most operators were engaged full time in the operation requiring about 9.1 months of work from the operators.

The respondents already had experience in operating fishponds the length extending to 16 years. However, the present fishponds had been managed by them for about 10 years, indicating that some had acquired experience either from family fishponds or other farms. Operators of fishpens, a new enterprise, had 2 years experience in the present fish pen and one year elsewhere.

## Cultural practices

Regular checking of dikes for leaks and seepage, repair of gates and other pond accessories, cleaning, drying and leveling of pond bottom are among the various activities in preparing the pond for fish culture. In some farms, pond plowing is done mainly to bring sub-surface nutrients to the surface and to eliminate predators and other nuisance that tend to burrow in the soil.

Table 2. Some characteristics of milkfish farm operators in the Philippines

Item	F		Tital man	
1 CGRI	Monoculture	Polyculture	Total	Fish pen
Sex (%)				145 146
Male	95	89	94	98
Female	5	11	6	2
Average age (years)	50	51	50	43
Educational Attainment (%)				
None	6	6	6	5
Primary	20	17	20	24
Intermediate	20	28	21	24
High School	27	23	26	27
College	27	26	27	20
Ave. yrs. of schooling	7.5	8.0	7.6	7.3
Operator with other				
occupation (%)	62	66	63	43
Labor use (months)				
Fishfarm	6.7	5.1	6.4	9.1
Other occupation	4.2	5.0	4.3	2.8
Not gainfully employed	1.1	1.9	1.3	0.1
Yrs. in fish farm operatio	n 16	16	15	3
Yrs. operating present far	m 10	11	10	2

General pond repair, cleaning and levelling of pond bottom were usually done only when deemed necessary. Drying of ponds, however, was a common practice in milkfish ponds (87%).

If the pen structure can no longer hold the stock, either the weak parts are replaced or the whole structure is changed. Many of the fish pens were relatively new; about three-fourths had not been changed. Eleven percent reportedly changed their pens once a year, the rest every two or three years at most. Checking of pen structure both above and below the water surface was done almost daily.

All sample fishponds and fish pens reported having pests and predators; fishes, lizards, water snakes, snails, frogs, and birds were the most common. Majority of fishpond operators eradicated pests commonly with the use of pesticides. Endrin, Brestan, Gusathion, Aquatin and tobacco dust were the most preferred pesticides (Table 3). Endrin, Gusathion and Aquatin were used at the rates of 7.0, 11.7 and 13.2 ounces per ha, respectively. On the other hand Brestan was used at the rate of 0.6 kg/ha. Treatment with pesticides lasted for about 8 days (for Gusathion) to 12 days (for tobacco dust). Generally, ponds were treated once prior to stocking. Liquids and emulsifiable concentrates like Thiodan, Gusathion, etc. were poured, sprinkled or sprayed on the pond soil while tobacco dust and other dry pesticides were broadcast or spread with rakes.

Table 3. Type and rate of pesticides used in milkfish farms in the Philippines

Item	Fishpond	Total	
T CGIII	Monoculture	Polyculture	IOLAI
Used pesticides	perc	ent <sup>a</sup> /	
Yes	73	66	72
No	27	34	28
Types of pesticides used			
Endrin	50	64	52
Brestan	35	17	32
Gusathion	17	10	16
Aquatin	15	9	14
Tobacco dust	12	-	10
Thiodan,	5	***	3
Others D	8	10	8
Rate of application			
Endrin (oz./ha)	7.4	4.4	7.0
Brestan (kg/ha)	0.7	0.4	0.6
Gusathion oz/ha)	9.5	25.0	11.7
Aquatin (oz/ha)	12.4	18.0	13.2
Tobacco dust (kg/ha)	126.0	19.0	110.0
Thiodan (oz/ha)	7.3	12.0	7.9

a/Total percentage may not equal 100 since some respondents used more than one type of pesticides.

b/Others include, sodium cyanide, folidol, eradex, aquavit, creoline, endox, resitox, tubli, shelltox, levacide, hytox and d'penethron.

To rid the fish pens of unwanted fishes, the seine net is usually passed across the water in the pen enclosure once or twice. Sometimes, electric shock was employed.

Application of fertilizers was more commonly practised in monoculture farms (67%) than in polyculture farms (40%) (Table 4). Inorganic fertilizers applied singly or in combination with organic fertilizers was more preferred. Of the inorganic fertilizers the incomplete types especially the nitrogenous-phosphorus were more popular than the complete formulations. The former was applied at the rate of 11 kg N and and 16 kg P per ha while the latter at 13 kg N, 13 kg P, and 9 kg K per ha. Nitrogenous fertilizers were applied at the rate of 23 kg N per ha.

Table 4. Fertilizer use in milkfish farms, Philippines.

Thom	Fishpond				
Item	Monoculture	Polyculture	Rate		
pe	rcent				
Jsed fertilizer					
Yes	67	40	63		
No	33	60	37		
Type of fertilizer used					
Organic	19	19	19		
Inorganic	53	57	54		
Combination	28	24	27		
Rate of use per hectare		•			
Chicken manure (sacks)	31	3	29		
Stable & hog manure (sacks)	11	141	31		
Guano (sacks)	5	-	5		
Sagana 100 (kg)	67	-	67		
Nitrogen (N)	24	14	23		
Phosphorus (P)	13	-	13		
Nitrogen-Phosphorus					
N	11	14	11		
P	16	16	16		
litrogen-Potassium					
N	· <b>7</b>	-	7		
K	7.	-	7		
complete					
N	13	13	13		
P	20	13	18		
K	7	13	9		

Organic fertilizers used were chicken, stable and hog manure, guano, compost, rice bran, night soil, mudpress and Sagana 100. Of these, chicken droppings was most widely used at an average rate of 31 sacks/ha in monoculture farms and 3 sacks in polyculture farms.

Only 2 percent of the monoculturists and 3 percent of the polyculturists employed the platform method of application which according to the Philippines Recommends for Bangos, 1976 is the most efficient and effective method of applying fertilizers. The most common practice of fishpond operators was to spread the fertilizers on watered or wet pond surface or to broadcast them randomly.

According to the Laguna Lake Development Authority, "there must be any addition of any kind of chemical or organic fertilizers in the lake. Such can trigger the occurrence of algae bloom which can very seriously affect water quality that three pens used chicken droppings intensively.

#### Stocking and cropping practices

In the Philippines, ponds were stocked either with fry, fingerling or both. Seventy one percent of the monoculture ponds stocked fry while only 36 percent used fingerlings, mostly from Central Luzon and Southern Luzon. The amount of fry stocked in monoculture farms was about 70 thousand pieces equivalent to 6.21 thousand per hectare of rearing area while for fingerlings, it was 46 thousand pieces/farm/year or 3.91 thousand per hectare.

Milkfish fry was also commonly used in polyculture farms except in Southern Luzon where fingerlings were preferred (81%). Milkfish comprised about two-thirds of the total stock in polyculture farms; the stocking density of these farms are: milkfish-prawn farms 4.43 thousand pieces; milkfish-prawn-crab, 4.95 thousand and milkfish-siganid, 7.21 thousand pieces.

Fingerlings were used in fish pens and stocked at a rate of 35.56 thousand per hectare. Two operators stocked fry. These, however, were first nursed to fingerling size in half-submerged inverted mosquito nets before they were released to the rearing pens.

Very few operators, 17 percent in monoculture and 18 percent in polyculture farms practiced acclimation of stock lasting for some 30-50 hours. In contrast, most fish pen operators acclimatized newly arrived stock in pen nurseries for about six hours. Stocking was done during the cooler hours of the day mostly in early morning or early evening.

The average mortality rate from purchase to stocking in monoculture farms was 11 percent for fry and 13 percent for fingerling while from stocking to harvest, it was 34 and 26 percent, respectively.

Majority of the milkfish farm operators considered the size of fish in deciding to crop (Table 6).

Table 6. Cropping practices in milkfish farms in the Philippines

Item	Fis	Total	Fish pen		
ı cen	Monoculture	Polyculture	1000	- TUI. PO.	
Factors considered in deciding to harvest	<u>per</u>	percent.			
Size of fish	71	84	73	79	
Demand for fish	26	<b>3</b> 3	-27	41	
Weather condition	5	13	6	29	
Others	29	33	30	-	
Manner of harvesting					
Selective	20	32	22	35	
Total	79	68	77	48	
Both	1	•••	. 1	17	
Method of harvesting			•		
Pond draining	53	79	5 <b>7</b>		
Gill netting	37	86	45	83	
Pasubang	32	92	41	_	
Seining	21	17	20	33	
Fish corral	13	19	14	-	
Others b/	3	3	3	-	

a/ Percentage total more than 100 since some respondents reported more than one answer.

b/Others include cast net, dip net, drive-in-net, filter net,

Pond draining was practiced by most (57%) ponds in harvesting the crop. This was followed by gill netting and pasubang as employed by 45 and 41 percent of the farmers. On the other hand, most fish pen operators used gill nets (83%) and seine nets (33%).

## Production

Table 7. Annual cropping rate of milkfish farms in the Philippines, 1974

Item	Number of farms_/	Quantit Per Farm	y Produced Per hectare
Fishpond			
Monoculture	1092	6484	580
Polyculture	187	6246	636
Bangos-sugpo	135	3159	481
Bangos-sugpo-alimango	31	13715	740
Bangos-malaga	11	1488	827
Bangos-alimango	10	6624	498
ish pen	148	26015	3798

a/Some farms were damaged by typhoons.

It seems that the fishpond becomes more productive when milkfish is cultured together with other fishes particularly, siganid, prawn, and crab. Milkfish-siganid farms obtained a yield of 827 kg/ha, 70 percent of which was milkfish and 30 percent siganid. Milkfish-prawn-crab fishponds were also a high yielder, 740 kg/ha with milkfish comprising 78, prawn 7, and crab 15 percent.

Table 8. Annual cropping rate per farm and per hectare, 1092 bangos fishponds, Philippines

	37	Danish a 3200	Quantity produced		
Region	Number	Rearing Area	Per Farm	Per Hectare	
		hectares	<u>ki</u>	los	
Ilocos	249	3.26	2307	709	
Cagayan Valley	10	10.28	3402	330	
Central Luzon	268	17.34	10608	611	
Bicol	52	9.21	2323	471	
Western Visayas	178	13.17	11888	260	
Central Visayas	81	4.87	1407	289	
Eastern Visayas	15	33.33	10613	318	
Western Mindanao	37	17.28	2921	168	
Northern Mindanao	35	34.98	13988	399	
Southern Mindanao	53	9.23	4769	516	
Philippines	1092	11.17	6484	580	

Table 8 shows that Western Visayas, Ilocos and Central Luzon were the high producers of milkfish in the country. Medium productivity regions were Cagayan Valley, Southern Luzon, Eastern Visayas and Northern Mindanao. Low productivity regions were Bicol, Central Visayas and Western Mindanao.

Table 9. Distribution of annual yields per hectare by yield groups and region, 1,092 bangos farms, 1974

<u> </u>	<del></del>	NY 1	Yield	Group (	kilos p	er hect	are)
Reg	ion	Number	Less than	100-	300-	700-	1,500 &
_		reporting	100	299	699	1,499	above
				Pe	rcent		
r.	Ilocos	248	5	15	39	33	8
II.	Cagayan Valley	10	10	10	50	10	10
III.	Central Luzon	268	7	23	31	26	13
IV.	Southern Luzon	115	14	35	27	19	5
٧.	Bicol	52	6	57	27	10	
VI.	Western Visayas	178	3	13	29	36	19
VII.	Central Visayas	81	29	38	22	10	. 1
VIII,	Eastern Visayas	15	<del>-</del>	53	33	14	-
IX.	Western Mindanao	37	46	24	24	6	-
х.	Northern Mindanao	35	20	31	40	6	3
XI.	Southern Mindanao	53	9	30	32	21	8
	Philippines	1,092	10	25	32	25	8

The annual yield per hectare for each monoculture farm was computed to give an indication of how the yields were distributed among and within regions. Yields ranged from less than 100 kilos per hectare to as high as 5000 kilos or more. The average annual production per hectare was 580 kilos.

About one-third of the bangos farms in the Philippines obtained yields within the range of 300 to 699 per hectare. Another one-third had less than 300 kilos and the other one-third had more than 700.

The availability in individual farm yields as presented in Figure 1 indicate the skewness of the yield distribution. Farms which yield more than 4000 kilos per hectare were found in Ilocos, Central Luzon, Southern Luzon and Western Visayas.

In Western Visayas, more than one-half of the fishponds studied yielded more than 700 kilos per hectare. In fact, 19 percent obtained yields of 1500 kilos or more with the highest being 5,813 kilos per hectare, an exceptional yield obtained by one operator in the region. However, there were 5 farms which produced less than 100 kilos of bangos per hectare. The lowest yield was 20 kilos.

Ilocos, likewise, was a high yielder of bangos with 41 percent of the fishponds producing more than 700 kilos per hectare. A few (5%) obtained yields below 100 kilos.

On the other hand, almost one-half of the sample farms in Western Mindanao were not even able to produce 100 kilos from a hectare of pond area. The highest yields obtained in the region were 926 and 700 kilos obtained by two farms. Bicol was another low producer with almost two-thirds producing less than 300 kilos per hectare.

Production in fish pens, 3798 kilos per hectare was more than six times that of fishponds.

About two-thirds (725 farms) of the milkfish ponds used fertilizer (Table 10). Of these, 54 percent used inorganic fertilizer only, 18 percent used the organic, and 28 percent used both.

Fertilizer-users obtained higher yields, 688 kilos on the average, compared with the 308 kilos for the non-users. In almost all regions, fishponds applying fertilizers obtained higher yields, the difference of which ranged from 10 percent in Eastern Visayas to as much as 194 percent in Central Visayas. In Southern Luzon yields of fertilized farms were more than twice those obtained by the non-users and in Central Luzon, the difference was 294 kilos per hectare.

Figure 1. Distribution of annual yield per hectare by yield group and region, 1092 fishponds, 1974

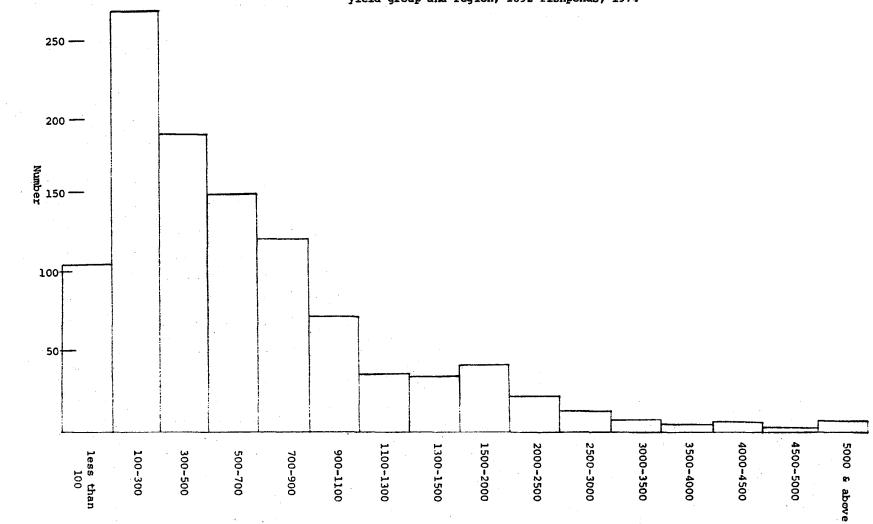


Table 10. Annual cropping rate per hectare by use of fertilizer by region, 1,091 bangos fishponds, 1974

Region			Used Fertilizer		Used Organic Fertilizer		Used Inorganic Fertilizer		Used Both Types of Fertilizer		Did not use Fertilizer	
region	No.	Cropping Rate	No.	Cropping Rate	No.	Cropping Rate	No.	Cropping Rate	No.	Cropping Rate		
I.	Ilocos	172	723	9	728	143	712	20	834	76	608	
·II.	Cagayan Valley	8	290	2	297	2	395	4	281	1	-	
III.	C. Luzon	211	696	53	688	92	575	66	910	57	251	
IV.	S. Luzon	43	565	16	832	19	388	8	691	71.	271	
v.	Bicol	30	239	22	231	5	254	3	277	22	291	
VI.	W. Visayas	154	918	7	597	61	977	86	901	24	575	
VII.	C. Visayas	42	373	5	307	32	354	5	677	39	127	
VIII.	E. Visayas	3	341	1	257	2	350	-	-	12	309	
IX.	W. Mindanao	11	157	5	282	4	90	2	100	27	177	
x.	N. Mindanao	12	465	7	395	3	260	2	1112	23	382	
XI.	S. Mindanao	39	542	2	916	31	548	6	384	14	361	
	Philippines	725	686	129	570	394	623	202	844	366	308	

Among the users of different types of fertilizer, it seemed that those applying both organic and inorganic types realized higher yields, 844 kilos per hectare, than those using only one type. Users of inorganic fertilizers obtained a yield of 623 kilos, more than 50 kilos higher than that of organic fertilized farms.

In Cagayan Valley, Central Visayas, Eastern Visayas, Western Mindanao and Southern Mindanao, all sample farms studies stocked with fry. All other regions had farms using fry and fingerlings but a greater proportion used fry except in Central and Southern Luzon which are really the seat of nursery ponds in the country. In general, ponds stocked with fingerlings had higher productivity per hectare compared with those stocked with fry (Table 11). The difference was about 34 kilos. However, in Southern Luzon, Western Visayas and Northern Mindanao, fry stocked farms produced 921 kilos per ha compared to 707 kilos in fingerling stocked farms.

Supplementary feeding was not a common practice in milkfish fish-ponds with only 20 percent of the operators supplementing the natural food in the pond. These farms obtained an average production of 658 kilos per hectare while those not supplementing got only 540 kilos, a difference of 118 kilos per hectare.

The effect of pesticides could be substantial as indicated by the yield of farms using pesticides which was 628 kilos per hectare, a difference of 338 kilos over farms not using chemicals.

Two methods of harvesting are employed when the milkfish are ready for market. One is total harvesting where the whole crop is harvested at one time and the other is selective harvesting where several partial croppings are done until the stock is completely cropped. It seemed that total harvesting was the better method as indicated by the 615 kilo-per-hectare yield of those employing this method. In contrast, farms using the selective method of harvesting realized a yield of only 426 kilos, a difference of 189 kilos.

Among the farm size groupings, highest yield per hectare was obtained by farms with sizes of 5-10 hectares. As farm sizes further increase, the yields went down, that is, for farms larger than 5 hectares fish productivity per hectare was inversely related with farm size.

#### Cost and returns in milkfish farms

Annually, an average monoculture milkfish farm in the Philippines realizes a gross income of about \$\mathbb{P}2294\$ per hectare. Polyculture farms grossed about \$\mathbb{P}3432\$ per hectare (Table 12). The combination milkfish-prawn-crab obtained the highest receipts, \$\mathbb{P}4312\$ per hectare followed by the milkfish-siganid farm, \$\mathbb{P}4238\$ per hectare.

Table 11. Annual cropping rate and costs and returns in monoculture milkfish farms

	No. of			Cost/	Returns/	Net Income/
	Farms	Per Farm	Per Hectare	ha.	ha.	ha.
ype of stock						
Fry	713	6511	585	1215	2179	964
Fingerling	305	7125	619	1007	2550	643
Fry/fingerling	73	5333	544	1683	2167	484
Jse of fertilizer		v				
Did use	725	8322	686	1755	2668	913
Organic	129	8356	570	1760	2358	598
Inorganic	394	6284	623	1473	2628	1155
Both	202		844	2123	2914	791
Did not use	366	2850	308	646	1270	624
Jse of supplementary feeds						
Did use	323	8583	658	1744	2711	967
Did not use	769	5605	540	1304	2067	763
Jse of pesticides						
Did use	729	7355	664	1726	2514	788
Did not use	313	4322	379	854	1802	948
Method of harvesting						
Selective	213	5739	426	1129	1674	545
Total	863	6453	615	1547	2471	924
arm size					,	
1.0 & below	171	356	647	1905	2727	822
1.01 -5.0	356	1450	630	1705	2570	865
5.01 - 10.0	181	4636	741	1877	2933	1056
10.01 - 20.0	189	7401	621	1426	2425	999
20.01 - 50.0	140	15102	594	1448	2315	867
50.01 & above	55	39038	495	1317	1968	651

Table 12. Costs and returns per hectare in milkfish farms, Philippines, 1974

· · · · · · · · · · · · · · · · · · ·		,, <u>, , , , , , , , , , , , , , , , , ,</u>	Rate o	f return
Gross	Total	Net farm	Over operating	Over fixed
returns	exp.	earnings	expenses	Capital
•	<del></del>		· · · · · · · · · · · · · · · · · · ·	
pes	os per	hectare	perce	ent
<u> </u>			#	
2294	1458	836	57.4	16.0
3432	1480	1952	131.9	46.7
•				
3183	1380	1803	130.7	34.0
			_	
4312	1576	2736	173.6	80.4
		2222	05.5	20.4
4238	2146	2092	97.5	39.4
1006	910	1177	143 7	46.7
1990	919	11//	エネン・/	20.7
15580	11731	3849	32.8	50.0
10000	22,01		22.0	
	2294 3432 3183	pesos per       2294     1458       3432     1480       3183     1380       4312     1576       4238     2146       1996     819	returns         exp.         earnings           pesos per hectare           2294         1458         836           3432         1480         1952           3183         1380         1803           4312         1576         2736           4238         2146         2092           1996         819         1177	Gross Total returns         Net farm exp. earnings         Over operating expenses           pesos per hectare         percent           2294         1458         836         57.4           3432         1480         1952         131.9           3183         1380         1803         130.7           4312         1576         2736         173.6           4238         2146         2092         97.5           1996         819         1177         143.7

Gross income in fish pens, \$15,580 per hectare, was approximately 6.8 times higher than what was obtained in ponds.

An annual operating capital of more than \$1,450 per hectare was required to operate a milkfish pond.

The value of stock, hired labor, fertilizer and commission were the major items of expenditure in milkfish ponds comprising 31, 18, 14 and 14 percent of the total cost respectively.

The milkfish-siganid farms incurred the highest operating capital mainly due to the high cost of "padas" or siganid fry. The cost of seeds amounted to \$200 per hectare in these farms, almost twice the cost of stock in other farms.

Approximately \$11731 was required to operate a hectare of fish pen in Laguna de Bay. The cost of fingerlings was the primary item of expense comprising 69 percent of the cash expenditures.

Net farm earnings was computed by subtracting the total farm expenses from the total receipts. This measures the return to the operator's labor, capital and management. The net farm earnings in monoculture farms amounted to #836 per hectare or a rate of return over operating expenses of 57.4 percent or a return over fixed capital of 16 percent. Among the regions, net returns was highest in Ilocos where approximately #1.03 of net profit was returned for each peso spent.

Polyculture farms realized a net farm earnings of more than twice that of monoculture farms (P1952/ha). Rate of return over operating expenses was rather high, 131.9 percent and return over fixed capital was 46.7 percent. Among the 4 combination of fishpen, milkfish-prawn-crab realized the highest net returns, P2736 per hectare and milkfish-crab the lowest with P1177.

The net farm earnings in fish pen operation amounted to \$\psi\_3,849\$ per hectare or about 4.6 times more than milkfish ponds. The rate of return over operating expenses in fish pen operation was only 32 percent due to big operating capital required to operate a fish pen, however return to operators fixed capital was higher, 50 percent.

## By type of fertilizer used

Fertilizer-using farms profited by about 46 percent more than those which did not apply fertilizer. The additional cost of fertilizer was more than compensated by a greater production and therefore, income. The use of inorganic fertilizers generated more income compared with the organic or both type of fertilizers. However, among those three farm groups, highest gross return was reported in the latter amounting to \$\mathbb{Y}2,914\$ per hectare. Coupled with the high gross returns was high operating expenses resulting in a low rate of return (37%) to operating capital.

## By use of supplementary feeds

Supplementing the natural food by artificial feeds substantially increased fish production and consequently the income generated. Users of supplementary feeds obtained a net income of 1967 per hectare, 27 percent higher than that of the non-users.

## By use of pesticides

The use of pesticides to eradicate pests substantially increased the level of production. However, the marginal increase in yield was lower than the incremental change in operating costs. Thus, the earnings of farms using pesticides was lower by 17 percent compared to the non-users. Those using pesticides spent about \$2.60 to produce a kilo of fish while it was \$2.20 without the use of these chemicals.

## By Farm size

The total receipts, expenses, and net income per farm generally increased with farm size. However, on a per hectare basis, those measures increased from the smallest to the farm size group of 5-10 ha then started to decline as the farm becomes larger. The annual receipts per farm among farm size groups increased at an increasing rate from 1 hectare and below to 5-10 hectares, then continued increasing but at a decreasing rate. Comparatively the operational expenses per hectare were higher in the three smaller size groups than in the bigger farms. It costs more to operate a hectare of a small farm than a big farm. Highest net return was obtained by farms of 5 to 10 hectares.

## Credit practices

Table 13. Credit requirement of fish farm operators by type of farm

Item		77.5 -1		
ı cem	Monoculture	Polyculture	Total	Fishpen
Source of operating capital (%)				
Owned	77	87	79	89
Borrowed	2 <b>3</b>	13	21	2
Both	-	-	-	9
Sources of credit				
Friends/relatives	36	44	37	47
Rural banks Others <u>a</u> /	28	26	28	40
amount borrowed	20888	7994	18862	55200

 $<sup>\</sup>frac{a}{c}$ Others include commercial banks other than the rural banks.

A majority of the milkfish fishpond operators relied on personal resources to finance their business operations with more of the polyculture farmers (87%) using their own capital than the monoculture farmers (77%). This could mean that most operators were either self-sufficient or the scope of their operations was limited to their financial capabilities.

More of the milkfish fish pen operators relied on their own savings as source of their capital (89%) than the milkfish fishpond operators (79%).

Friends/relatives were more preferred by milkfish fishpond and fish pen operators as source of credit, however monoculture fish farms preferred banking institutions as source of credit (64%) than polyculture farmers (56%).

Fishpen operators acquired the biggest loans averaging \$55,200 used mostly for operational purposes. Monoculture milkfish ponds acquired a higher loan of \$20,888 per operator than the polyculture milkfish farms (\$77,994).

Some operators encountered problems in borrowing. The problems cited by the fishpond operators were high rate of interest (20%) and delayed release of loan (22%) while fish pen operators reported too much red tape/paper work (13%) and high rate of interest (13%).

## Extension and other services

About one-fourth of the fishponds and 41 percent of the fish pens were reached by government extension workers. For those who were reached by these technicians, questions were asked on what information were provided to them and whether the recommendations were followed. One-half of the operators received information on cultural practices particularly on the use of fertilizer, production and use of plankton, and improved care of fingerlings. One-fourth were given information on the availability of fry at the BFAR office and still 9 percent reported that extension workers conducted seminar in fishpond operations.

Fishpond operators were more receptive to improved techniques with 71 percent following the recommendations extended to them compared to only 45 percent of the fish pen operators.

Probably because of lack of extension assistance, fishpond operators tended to become observant of other operators. In some areas neighboring fishponds may be far but 59 percent followed what they consider as "better methods" used by others.

Only a few fishermen's organization exist. Of the 1396 sample fishponds and fish pen operators very few were members of an organization. Of the members, two-thirds reported that they actually did not get any benefit from the association.

A majority of the operators find the industry wanting of government assistance. According to them the primary assistance the government can give to improve the industry is on credit, the control of prices of inputs as well as output and the provision of technical support.

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		Fishpond		
Item	Monoculture	Polyculture	Total	Milkfish
Cash farm receipts		·		
Fish sold	2206	3290	2378	15442
Other fishes sold	34	78	41	4
Other cash receipts	1	- -	<u>a</u> /	<u>a</u> /
Total cash receipts	2241	3368	2419	15446
Non-cash farm receipts				
Value of fish sold at home	18	30	20	66
Value of fish given away	18	29	20	48
Value of fish for other purpos	ses -	5	1	20
Increase in inventory	13	••• ,	11	-
Other non-cash receipts	4	-	. 3	134
Total non-cash receipts	53	64	55	% <b>-</b>
Total farm receipts	2294	3432	2474	15580

 $<sup>\</sup>frac{a}{}$  Less than P0.50.

Appendix Table 2. Expenses per hectare in fish farming by type of farm

Item		Fishpond		Fishpen	
1 Celli	Monoculture	Polyculture	Total		-
Cash farm expenses					
Stock bought	447	470	451	7562	
Fertilizer	220	122	206	5	
Chemical	32	24	31	-	
Supplementary feed	18	34	20	276	
Hired labor cost	250	349	266	1360	
Value of commission	179	33	203	258	
Food for laborers	10	26	12	137	
Ice	5	3	5	73	
Equipment purchased	44	33	42	807	
Lease	135	26	118	-	. •
Interest on borrowed capital	16	-	13	~	
Transportation	-	-	-	282	
Miscellaneous	81	55	77	198	
Total cash expenses	1437	1472	1444	10958	
on-cash farm expenses					
Fry gathered, given free	2	1	2	-	
Unpaid family labor	15	4	13	30	
Decrease in inventory	<b>S</b> AN	***		529	
Others	4	3	4	214	
Total non-cash expenses	21	8	19	773	
otal farm expenses	1459	1480	1463	11731	

POSITIVE BLUE-GREEN ALGAE SEEDING PROCYSS

Carlos S. David Lecturer, Researcher

# POSITIVE BLUE-GREEN ALGAE SEEDING PROCESS (Philippine Patent Pending Process 1978)

#### Carlos S. David

This seeding process was devised by the author to effect an even dispersion of blue-green algal cells in the desired suspension media which contain all the known macro and micro nutrients necessary for optimum plant growth.

The seeding operation must be done mechanically as any other process will prove to be too arduous and time consuming. The desiccation of the blue-green cell mass is of primary importance and it requires the use of a special water pump for thorough dispersion.

This operation accomplishes three advantages:

1. The original seed mass when broken up will cover a greater area thus serving and acting as the benthic algal base;

The pseudo-vacoules of blue green algae or phytoplankton are either oil- or gas-filled and act as floatation device for these plants. When deflated or collapsed, they sink and form part of the benthic stratum re-surfacing when the vacoules are again filled with gas or oil. This is brought about by the process of photosynthesis and/or the increase in water temperature.

- 2. The original cells when desiccated are given optimum opportunity for growth for the whole cell area is exposed in the suspension media which contains all the nutrients required for optimum growth.
- 3. Aeration is effected simultaneously. Oxygen is introduced while carbon dioxide is reduced. Seeding is best during the evening or late afternoon at the stage when phtosynthesis is reversed, imbibing oxygen and releasing carbon dioxide. The plants having been released in the water containing supersaturated oxygen are given the optimum factors for survival and growth.

In the experiments I have conducted, this procedure resulted in time saving. If it took me 28-40 days under the traditional method to grow the food for the fish, this method needed only amout 16-24 days or a saving of at least 40 percent of food growing time.

More research is required as many other factors must be considered. The seeding site and its physical and chemical parameters must be considered and monitored to produce optimum algal growth.

While conditions of salinity, photosynthesis and the nutritional requirements of the plants must be met by the fish farmer, the seeds introduced as well as the seeding process in the pond, the soil, the nutrients, the bottom mud, and the water interact.

Finally, plasmolytic reaction appears negative if these plants are gradually conditioned to temperature, salinity, dissolved oxygen, acidity, alkalinity, etc. Neither will the cell walls rupture under low osmotic pressure, although at times some mutation may occur, if conditioning is properly done.

Some other subjects related to the study are: photosynthesis, wind action, wave action, absorption, reflection, suspension, turbidity, stratification, salinity, and DO (N2 CO2 Phosphates, etc).

In all cases disease and parasites and predators are limiting factors in fish production.

The author has tested all methods <u>vis</u> a <u>vis</u> this seeding procedure and he has, with almost absolute certainty, induced the growth of algae where they say it could not grow. He has induced growth in salinities of +05 and higher but finds that in the country they can grow best at 28 to 32 ppt.

For this reason, the author has deemed it necessary to protect his process locally and internationally as this was achieved only after years of untiring research.

There are at least 15000 different species of algae. The blue greens have no differentiated roots, stems or leaves. They vary in size, habit, and reproductive process but belong to the heterogenous group of organisms. They proliferate everywhere from oceans to puddles. Basic in the food chain are (Phytoplankton triconomi). If these plants are enveloped in a gelatinous sheath as are the blue greens, they are referred to as filaments. These algal cells are basically similar to (Thallophyte) resembling bacteria in shape and arrangement. Blue greens are semi-rigidly structured, pliable and will not normally break even in rough handling. The nuclei are normally present in most algae except the blue greens which are gelatinous. Starch grains, oils, and vacoules in blue greens have no chloroplasts and pigmentation is limited to the peripheral portion of the protoplast which assists its growth in photosynthetic process. Reproduction is done usually by fragmentation or fisshion.

# AQUACULTURE FARMING SYSTEMS

Virgilio A. Dureza
Brackishwater Aquaculture Center
U. P. College of Fisheries
Leganes, Iloilo

## AQUACULTURE FARMING SYSTEMS

#### Virgilio A. Dureza

Aquaculture, fish culture, fish farming, marine farming, mariculture and aquatic husbandry are terms used to describe the water-based equivalent of agriculture. The basics are the same as animal husbandry on land. The goal is maximum production with minimum inputs through proper development and utilization of the latest information available guided by the responsibility of conserving and maintaining a wholesome environment for human existence.

Milkfish farming in the Philippines has a long history of over 400 years. For several centuries this non-carnivorous species continued to be cultured because of its fast rate of growth, low cost of production and high acceptability as food item.

At present milkfish farming can be done in freshwater, brackishwater, and marine water, either in monoculture or in polyculture systems. This paper discusses briefly the aquaculture farming systems for milkfish in all the aforementioned environment specifically on earthen fishponds.

## Update of Available Technology

The early and traditional system is characterized by obtaining the stock on whatever fish seeds accidentally get into the ponds with the admitted water. The stock depends on whatever natural growth of food to feed upon which are mostly filamentous green algae. The fertility of the environment is limited and average production was 300 kilograms per hectare per year.

Following this was an improved system in which the number of fish stocked was monitored - the number varies with the available natural food (still mostly filamentous grass green algae), the size of fish stocked and the projected size that should be harvested. This slightly increased the national average production to 350 kilograms per hectare per year.

Next was a much more improved system where little inorganic fertilization was introduced and planting of filamentous grass green alage was practiced to replenish overgrazed fishpond. This system brought up the national average production to 400 kilograms per hectare per year.

With the emphasis given to aquaculture many recent aquaculture farming systems have been developed and claimed to be highly profitable.

In shallow water milkfish farming where the food base is composed essentially of a biological complex of benthic organisms the main bulk of which are filamentous blue green algae mixed with diatoms and protozoans locally known as lablab, the following systems have been developed:

- 1. The conventional system which made use of shallow ponds from 30 to 45 cm water depth and of conventional pond designs through established procedure, can grow enough lablab to support a standing crop of about 600 kilos per hectare and can produce 2 to 3 crops per year depending on the size of the fingerling used to stock the grow-out ponds.
- 2. The stock manipulation system is carried in two ways: the first is stocking of different size groups and frequent partial harvesting. This is made by initially stocking three size groups of milkfish fingerlings with a combined weight of about 200 kilos per hectare. In this case the partial stock can efficiently feed on the available natural food without overgrazing until the initial stock reaches a weight of about 600 kilos and at which point partial harvesting of marketable size fish is done to bring down the stock to the original weight of about 200 kilos per hectare. A new stock of small size fingerlings is introduced simultaneously. This partial stocking and partial harvesting cycle is repeated about 8 times a year and could produce more than 3 tons per hectare per year.

The second is the progression or modular method where the fish is moved from one compartment to the other by water management, the compartments progressively becoming larger as the fish grow bigger usually in four stages. The sizes of the smaller compartments depend on the size of the final stage pond, the stocking rate, and the desired size of harvestable fish. With this method about 5 total harvest from the final stage pond is possible with a total harvest of over three tons per hectare per year.

3. The "kitchen pond system" is the reverse of the modular system because instead of moving the fish stock from one compartment to the other it is the natural food grown from one pond ("kitchen pond") which is transported, by water management, to the culture ponds. A basic observation regarding this system is that the water environment suitable for the luxuriant growth of lablab organism is not compatible

with the general well being of the growing fish. Growth of lablab requires a shallow pond for maximum penetration of sunlight, a pond bottom rich in decaying organic matter which is closely associated with the production of hydrogen sulfide gas and oxygen depletion, a condition which is lethal to the cultured fish and a water containing plenty of essential nutrients and higher salinity, about 45°/00. In contrary, fish needs a clean freshly aerated sea water not less than one meter depth with a salinity of 15 to 25 /oo. With this system it is possible to stock more fish in a greater volume of water, about 22,000 per hectare, and obtain production of not less than 4 tons per harvest or 12 tons per year at three croppings of fish per year.

4. Increased substrate system. This system was developed at the BAC. Artificial substrate is introduced into the pond where the lablab organisms can attach and grow to provide additional grazing area for the fish in addition to the food that grows on the pond bottom. This system was conceived to anticipate the trend of growing milkfsih from extensive culture to intensive culture. With this system it is possible to increase fish production based on conventional system to about 15 to 20 percent at 60 percent added artificial substrate. This system was found to be good not only for growing marketable fish but also for fingerling production where increased survival was observed. Even for holding the fingerlings stunted for nine months without artificial feeding, the health of the fingerlings was maintained.

Meanwhile, in the deep water milkfish farming, (water depth from 75 to 120 cm) only one system is being developed which makes use of planktonic organisms as food base. In this system it is possible to attain a production of 1.2 tons per cropping or 3.6 tons per hectare per year. But the technology developed for this system is meager and production is unpredictable ranging from 300 to 1,200 kilos per hectare per harvest.

In addition to the systems mentioned there are others that are associated with the non-conventional types of aquaculture farming which are mostly still in the drawing board and on which no sufficient data are available.

#### References

- David, C. 1978. Personal communication.
- Dureza, V. A. 1977. Production Response of Milkfish, <u>Chanos chanos</u>
  Forskal in Brackishwater Ponds to Additional Substrate for
  Fishfood Organisms. Paper presented at the PCARR Fisheries
  Research Forum, Manila.
- Cousteau Society Inc. 1978. Aquaculture The State of the Art. Suppl. to Calyp. Log, Vo. 5 No, 2, 10 p.
- Rabanal, H. R. 1974. Technological Innovation in Characteristics,
  Design and Management of Ponds Used in Brackishwater Aquaculture.
  F. I. FAO, 19 p.
- Rabanal, H. R. 1977. Aquaculture Management. CP BFAR/FAO-UNDP Training of Reg. Trainor Aquaculture, Lucena, Quezon, 12 p.
- Rabanal, H. R. 1977. Recent Trends in Aquaculture. CP Sem. Work. Fish. Sch. Manila, 13 p.

# MILKFISH CULTURE IN FRESHWATER PENS

Benjamin Cer. Gabriel Freshwater Fisheries Station SEAFDEC Aquaculture Department

#### MILKFISH CULTURE IN FRESHWATER PENS

#### Benjamin Cer. Gabriel

The culture of milkfish in fish pens in Laguna de Bay was introduced by the Laguna Lake Development Authority (LLDA) in 1970. This method of culture has the following advantages: (1) an annual potential yield of about 4000 kg/ha or over ten times the open water catch; (2) abundance of natural food in the lake which makes supplemental feeding unnecessary; (3) areas between pens serve as refuge and breeding grounds of fish; and (4) source of livelihood of people in the lakeshore towns and barrios.

In 1972, fish pens proliferated in Laguna de Bay, with some 15 percent in Rizal and 17 percent in Laguna. As of 1973, about 993 fish pens were constructed in the lake with a total area of 4802 ha (Delmendo and Gedney, 1974). Of the 993 pens, 793 or 80 percent are located in Rizal and 207 in Laguna. Later figures show that about 7000 ha of fish pens exist in the lake (Guerrero, 1977). This was reduced by typhoons in 1977 to about 2600 ha (LLDA, 1978). The pens vary in size from less than one ha to more than 100 ha, with those in Laguna having a median size of 5-10 ha and those in Rizal being in the 10-20 and 20-50 ha size categories. This reflects larger investments in fish pens per unit of ownership in Rizal (LLDA, 1973).

The fishpen industry in Laguna de Bay has an investment of about \$100-M (Mane, 1976). A total milkfish fishpen production from Laguna Lake amounting to 20-25 million kg was reported in 1975 (Guerrero, 1977). Fishpen owners in Laguna de Bay are said to derive some \$24,863 in annual income while the caretakers received \$8,085/yr (Nicolas, et al., 1976). Fishpen operators in San Pablo Lakes earn a relatively small annual income of \$2,252 due to the small sizes of their pens.

In a 1974 study on the costs and returns of milkfish production in fish pens (Guerrero, 1975), the highest average net income of \$1,941/ha was obtained from fish pens of 1-5 ha. Fish pens of less than 1 ha and those of 6-10 ha had net losses.

The present fishpen hectarage of about 3000 ha is estimated to produce some 16,000 MT of fish annually or 16-20 percent of the total milkfish production in the country, and supplies about 60 percent of the consumption of Metro Manila (Mane, 1979, personal communication). The LLDA (1973) claims that with improved methods, the lake fishpen industry can grow to about 15,000-20,000 ha or a total lake fishery production of 80,000 MT annually.

#### Cultural Practices

Prior to the arrival of fingerlings, the nursery and grow-out pens are checked, repaired, and cleaned to eliminate predators and competitors.

Fingerlings for stocking are usually purchased from Dampalit, Malabon, Metro Manila, or from Obando, Bocaue, Malolos, Caloocan, and Navotas. The quantity of fingerlings purchased depends on the frequency of stocking or cropping. Most fishpen operators purchase fingerlings only once a year, at the time when the supply is abundant. Other factors being considered include: pen capacity, weather conditions, anticipated demand, expected mortality, and available capital.

Fingerlings are usually transported from source to fish pen in water by means of a live fish boat ("pituya") or on land by busses or jeepneys. The stock transported by land is placed in oxygenated, water-filled plastic bags in buri baskets.

Mortality of fingerlings in transport is due mainly to stresses in catching, handling, and counting. Under good transport conditions, mortality is nil. However, when conditions are rough or stressful, mortality rate may be as high as ten percent.

Milkfish fingerlings transported via the "pituya" are gradually acclimatized in freshwater with the entrance of lake water into the boat and its free circulation once inside. Fingerlings transported in plastic bags are kept in the nursery pens for 5-6 hours or for as long as 2-3 weeks after transport to prevent further stress and reduce the chances of predation. Mortality in the nursery pens immediately after transport may vary from 1-3 percent during fine weather to 20-30 percent in inclement weather.

From the nursery pen, the fingerlings are stocked at 30,000/ha in the rearing pen where they are grown to marketbale sizes. Mortality rates of 20-40 percent are usually obtained after transferring the fingerlings from the nursery to the rearing pen.

Supplemental feeding is not practised in the majority of the fish pens. Some operators however resort to giving bread crumbs, rice bran, broken cones, fish meal, egg yolk in small quantities, ipil-ipil (Leacaena leucocephala) leaves, or kangkong (Ipomoea reptans) leaves.

Loss of stock in the grow-out ponds may result from predation by "bid-bid" (Elops hawaiiensis) and "buwan-buwan" (Megalops cyprinoides) or by minor destructions of the pen caused by floating poles or similar objects. Thus, only about 40-50 percent of the stock is recovered upon harvest.

Fishpen operators differ in number of croppings per year. Some stock their pens once a year, usually in May or June, and harvest the fish in May or June of the following year. Others stock twice a year -- the first stocking is done in March and April and harvesting in July or August; and the second stocking in July or August (immediately after the first harvest) and harvesting after eight months in February or March. The number of croppings depends on capital and availability of fry or fingerlings. Partial harvest during the rearing period may be done to catch up with the high price of fish.

Harvesting of marketable-sized fish is done by the use of seines ("pukot") or gill nets or both. Seines are usually used for total harvest of fish while gill nets are used in selective or partial harvest.

# Problems of the Milkfish Fishpen Industry

The major problems that hold back the full development of the Laguna de Bay fishpen industry include:

- (1) Fry shortage or scarcity of seed stock. There is an annual milkfish fry shortage to meet the annual stock requirement (1300 M fry) of the 176,000 ha of fishponds in the country. The annual fry catch levels are estimated to be 60 percent below annual stocking requirements.
- (2) High mortality rates in transport and storage. Improvements on the traditional methods of handling, transporting, and rearing of milkfish have to be made to reduce mortality in nursery and grow-out pens.
- (3) Destructive typhoons. Severe financial losses have been experienced by fishpen operators as a result of typhoons that pass the Laguna de Bay area. Typhoons in 1976 reduced the total fishpen area by about 50 percent. In 1978, a series of strong typhoons wreaked havoc on the majority of existing fish pens, causing a loss of \$80 M worth of fish and a sizable amount in infrastructure. Col. Nicanor Garcia (1978) reported that 70 percent of the destroyed fish pens could salvage only 20-30 percent of the bamboo poles and nets.

## FFS Research Findings Relevant to Milkfish Freshwater Culture

The SEAFDEC Freshwater Fisheries Station has successfully evolved the technology of acclimating milkfish fry in fresh water. Gradual and continuous acclimation and gradual acclimation by removal of brackish water gave high survival values of 88 percent and 83.6 percent, respectively. The application of these methods on a commercial scale would enable the fishpen operators to cut down on production cost by

by raising their own fingerlings instead of buying them from brackish water nurseries. Moreover, percentage of survival in fish pens is expected to improve because of the acclimation process prior to stocking.

Preliminary studies on milkfish fingerling production in cages in Laguna de Bay gave the following results:

- (1) Survival rates and mean weight and length of fingerlings reared in Diablo Pass ("amihan") were higher than those reared in Tapao Cove ("habagat").
- (2) Survival rates and mean weight and length of fry stocked at 1/L were higher than those at 5/L.
- (3) Faster growth rates and higher percent survival were shown by fry reared to fingerling size during the warm months (June to July) as compared to those reared during the cold months (December to January).

Experiments on growth of milkfish fingerlings reared to marketable size in cages gave the following initial results:

- (1) Body weight and length measurements after two culture months increased with a decrease in stocking density from 10 to  $2/m^2$ . Comparatively high mean body measurements and survival rates were obtained at densities of 2 and  $6/m^2$ .
- (2) Faster growth rates were exhibited by fish stocked in cages with substrate.
- (3) Decreasing weight and length measurements were obtained with increasing depth, except a stocking density of  $10/m^2$ . (There seems to be an interaction between depth and stocking density).

Exploratory studies on the development of a seed bank for milkfish in fresh water gave the following results:

- (1) Fingerlings stocked in plastic-lined ponds at 1 fry/L and given supplemental feeds (Scenedesmus sp. comprised 80 percent of the bulk) produced a mean weight and length of 1.5 gms and 58 cms, respectively, and a survival rate of 42 percent.
- (2) No considerable increases in weight and length of fry were observed after a 31-day stunting period in marine tanks at densities of 10 and 14 fry/L. Survival rates were 51.02 and 44.48 percent, respectively.

Stunted milkfish fry when grown to fingerling size in the lake at stocking densities of 10 and 14 fry/L showed comparable body measurements and survival rates after 28 culture days.

# FFS Proposed Studies on Milkfish Freshwater Culture

Among the FFS research proposals for implementation in 1979, the following deal with various aspects of freshwater culture of milkfish in Laguna de Bay:

- (1) Observation study of the transport and handling of milkfish fingerlings by live fish boat ("pituya").
  - (2) Acclimation of milkfish fry in fresh water.
  - (3) Milkfish fry to fingerling production in fresh water
    - (a) Effect of stocking density and length of holding period on survival of milkfish fry;
    - (b) Effect of stocking density, culture season, and location on growth and survival of milkfish fry reared to fingerling size in cages; and
    - (c) Growth compensation of milkfish after stunting in cages
  - (4) Growth of milkfish in fish pens
    - (a) Bottom soil cultivation
    - (b) Effect of stocking density, location, and season
    - (c) Selective and periodic harvesting
  - (5) Supplemental feeding of milkfish

#### Conclusion

Innovations and continuing efforts towards the improvement/ refinement of technology on milkfish are all designed to increase the production of this fish. With multi-agency efforts injected into the technology-oriented development process, bright prospects for milkfish culture in the Philippines are assured.

#### References

- Bulletin Today. Vol. 72, No. 10. Oct. 1, 1978.
- Delmendo, M. N. and R. Gedney. 1974. Fish farming in pans; a new fishery business in Laguna de Bay, LLDA Technical Paper No. 2.
- Guerrero, C. B. 1976. Bangus production in fish pens. Nat. Food Agric. Coun. Phil. 19 p.
- Guerrero III, R. D. 1977. Recent Developments in Freshwater Aquaculture (Tech. Rept). Semarang, Indonesia. 31 Jan-6 Feb. 1977.
- Mane, A. M. 1976. The development of the fishpen industry system of research for central and southern Luzon. Paper presented at the First Regional Agriculture & Resources System Research Congress for Central and Southern Luzon. Parañaque, Metro Manila, Philippines. 26-29 July, 1976. 6 p.
- Nicolas, E. S., et al. 1976. Socio-economic survey of the aquaculture industry in the Philippines. Phil. Res. Paper Series No. 5.
- Philippine Daily Express. Vol. 7, No. 150. Oct. 3, 1978.
- SEAFDEC Freshwater Fisheries Station. 1978. Annual Reports
- . 1978. Feasibility Studies.
- Smith, J. R., et al. 1978. Preliminary Analysis of the performance of the fry industry of the milkfish (Chanos chanos Forskal) in the Philippines. Aquaculture 14.3 (199-220).

# THE EXPERIENCES OF A MILKFISH FARMER

Concordia P. de Goco Private Sector

#### THE EXPERIENCES OF A MILKFISH FARMER

#### Concordia P. de Goço

I started on fish culture in May 1964. Then, the technology known to fishpond operators was the growing of lumot. The only fertilizer used was chicken droppings and stocking rate per hectare was very low.

In 1965, BFAR, then Bureau of Fisheries, through Dr. Tang, a Taiwanese, introduced the lablab culture. Aside from chicken droppings, inorganic fertilizers like ammonium sulphate and 16-20-0 were used. Endrin was used as pesticide. Since tobacco dust was still available, we also used this as pesticide. Why? We don't know, but it was effective and we appreciated the results. Due to language problem, the fishpond operators were rather hesitant in absorbing the technology being introduced by the Bureau, but because of good results, the operators became interested and the Federation was formed with Dr. Sanglay as its first president.

Dr. Smithou and Dr. Grover of the USAID came to the Philippines and gave a series of seminar-workshops in cooperation with the U.P. College of Fisheries. The Seminar-Workshops were so effective that: every fishpond operator took notice. Here, the new layout which was later called the modular system was introduced. Plankton was: taught. These new technologies were put to practice by operators and the stocking rate rose to 1500-2500 per hectare and later some operators here in Panay were stocking as much as 5000 per hectare, as Dr. Tang envisioned.

By now many agencies started to do research on aquaculture. These are BFAR, U.P., NSDB, USAID, PCARR and private sector. The SEAFDEC Aquaculture Department was organized. All agencies started to release the results of their research but the results reaches only few operators, so transfer of technology was ineffective. Language was still the problem. Results could not be understood by the operators especially explanations using scientific and technical terminologies.

BFAR made the results easy to be assimilated by using language understood in their areas, in other words, plain layman's language. Production zoomed to a record high but shortage of fry supply began to be felt. SEAFDEC claims a breakthrough in the artificial spawning of sabalo but until now we do not know whether it really can solve fry shortage and when.

PCARR gave a seminar-workshop at Legaspi and there the private sector brought out the problem on engineering and its importance. U.P. included engineering in its curriculum. PCARR made researches in engineering. To the private operators, engineering spells the success or failure of their venture.

With the increase in production came the following problems:
(1) financing, (2) marketing, (3) transportation, (4) processing.

During the later part of 1978 NSDB called a meeting for project evaluation. In that meeting, the private sector suggested to U.P. and NSDB to study the length of time needed for a finished area to earn sufficiently for the operator to be able to start paying his loans so that the banks can determine the length of grace period to be given. This can help make paying of loans more realistic.

With the help of all these agencies, the production required of the industry for the year 2000 can hopefully be met.

# PRAWN BROODSTOCK DEVELOPMENT AND REPRODUCTION

Jurgenne H. Primavera SEAFDEC Aquaculture Department

#### PRAWN BROODSTOCK DEVELOPMENT AND REPRODUCTION\*

#### Jurgenne H. Primavera

# I. Reproductive Biology

A. Size at first maturity and first mating

Table 1. Minimum size at first maturity and mating of P. monodon

		Pond	Wild
1.	First maturity		
	a. male (+ sperm in spermatophores	<b>4</b> 0 g	<b>4</b> 0 g
	b. female (stages III and IV)	- (only up to stage II)	87 g
2.	First mating		
	<pre>a. female (+ sperm in thelycum)</pre>	40 g	63 g

- B. Courtship and mating behavior (PCB and CB)
  - 1. one-half to three hours
  - 2. involves 3 distinct phases
- C. Ovarian maturation stages
  - 1. 5 maturation stages (I, II, III, IV and V)
  - criteria for classification external examination, dissection, histology

<sup>\*</sup>Mainly for sugpo, <u>Penaeus monodon</u>, although the biology and technology apply to a certain extent to other local species, e.g. <u>P</u>. merguiensis and <u>P</u>. indicus.

## D. Spawning

- 1. between 8:00 p.m. and 6:00 a.m.
- 2. female swims upward in circles
- 3. lasts 2-7 minutes
- 4. may be partial or complete
- 5. minimum of 1 week and average of 3 weeks after ablation

#### E. Rematuration

- rematuration rates 14% 2nd spawning;
   4% 3rd spawning; 0.4% 4th spawning
   (ablated only)
- 2. minimum of 3-5 days for a subsequent spawning after the preceding one

## F. Fecundity

- 1. ablated: 20,000-500,000 eggs/spawner
- 2. wild (unablated): 50,000-1,000,000 eggs/spawner

#### G. Egg quality

- 1. 5 types (A<sub>1</sub>, A<sub>2</sub>, B, C and D)
- H. Hatching rate
  - 1. 40-50% average

## II. Broodstock Technology

## A. Sources

- 1. wild females at 90 g; males at 50 g
- 2. pond at least one-year old of same sizes as above

# B. Transport

- 1. in one-ton PVC/canvas tanks provided with aeration
- 2. up to 400 prawns/ton for 1 hr or shorter; 100-200 prawns for 4 hrs or longer
- 3. early morning or late afternoon for low temperatures

#### C. Acclimation

- in water with same salinity and temperature as transport container/pond source
- 2. up to 100 prawns/ton without feeding if period is 1 day or shorter
- 3. decrease density and provide feeding if period is longer than 1 day

#### D. Ablation

- 1. stock has recovered from transport stress
- 2. hard-shelled
- 3. only for females P. monodon; female P. merguiensis and P. indicus mature in captivity without ablation as with male penaeids
- 4. either left or right eye
- 5. methods include incision-pinching, cauterization, cutting, and ligation or tying

# III. Maturation tanks vs. pens

Table 2. Comparison of tank and pen systems for prawn broodstock

	Land-based tank	Offshore pen
1. Dimensions & shape	4m Ø x lm; circular	16m x 16m x 6m; rectangular
2. Volume	12 cu m	500-1,500 cu m
3. Total stock	50-80 at 1 male; 1 female	300 at 1 male: 1 female
4. Stocking density	4-7/sq m	l/sq m
<pre>5. % mortality/month:    female (ablated)    male (unablated)</pre>	40-50% 20%	
6. % actual spawners/mo	30%	
<ol> <li>Ave. no. eggs (Ablated): pond wild</li> </ol>	180,000 (n = 86) 246,000 (n = 53)	191,000(n = 19)
8. Ave. no. nauplii: pond wild	32,000 (n = 86) 94,000 (n = 53)	108,000(n = 19)
9. Ave. % hatch. rate: pond wild	18% 38%	56%

Table 2 con't

	Land-based tank	Offshore pen
Site requirements	power for 24-hr flowthrough	protected cove
Unit cost (materials)	₹5,000 (ferrocement)	F10,000 (bamboo & monofilament nylon
Longevity	minimal depreciation	<pre>2 yrs; repairs costing after 1 yr</pre>
Sampling	at night w/ under- water light; 2x/wk	lifting net during day; lx/wk
Manpower requirements: maintenance sampling	1	l 2-4 divers + 2 samplers
	Longevity  Sampling  Manpower requirements: maintenance	Site requirements power for 24-hr flowthrough Unit cost (materials) p5,000 (ferrocement)  Longevity minimal depreciation  Sampling at night w/ underwater light; 2x/wk  Manpower requirements: maintenance l

## IV. Gaps

# A. Technology

- substrate (tanks only); sex ratio; stocking density; age of pond stock
- 2. alternatives to ablation hormones; pressure; light quality; etc.
- increasing rematuration rates (by decreasing spawner mortality)
- 4. developing pen systems with reduced mortality due to lifting stress and fouling of substrate
- 5. maturation of ablated females in ponds
- 6. broodstock of other penaeids

## B. Biology

- 1. molting stages
- 2. histology of ovarian maturation stages
- 3. biochemistry of eyestalk and other maturation hormones

# PRAWN HATCHERY TECHNOLOGY IN THE PHILIPPINES

Rolando R. Platon SEAFDEC Aquaculture Department

#### PRAWN HATCHERY TECHNOLOGY IN THE PHILIPPINES

#### Rolando R. Platon

The development of a hatchery system for prawns was started 30 years ago in Japan. Although the earliest prawn hatchery was developed for P. japonicus, it was adopted in other countries to produce postlarvae of other penaeids. This early system involved the production of natural feeds in the same tank used for larval rearing (Sigueno, 1972). Tanks ranged in capacity from 10 to 200 tons. The phytoplankton and zooplankton bloom in the tank was induced by addition of fertilizers. A highly diverse biological population was thus maintained in the larval rearing tank as larval feed while supplementary feeds were given during the postlarval stages. Differences in environmental conditions and economic systems led to different modifications of the earlier hatchery system for each country's specific needs.

The most significant modification of the early system was made in the United States 15 years later. In this system, instead of inducing a plankton bloom in the larval rearing tank, pure algal cultures were produced separately and then fed at predetermined amounts to the larvae in the larval rearing tanks (Cook and Murphy, 1966; Mock and Neal, 1974). The rearing tanks were of 2-ton capacity while algal tanks for mass production of algae were of 200-300 liter capacity. The sea water used for larval rearing was treated thoroughly to get rid of all suspended matter. For algal production, the medium was artificial salt dissolved in tap (fresh) water. This method is now used in other countries like Panama, Tahiti and Brazil.

Based on the method of providing plankton feeds to the larvae, the earlier system is often referred to as the fertilized or ecological system and the later system as the unfertilized or feeding system.

Because the phytoplankton and zooplanton production in the larval rearing tanks depends on the quality of sea water taken into the hatchery tanks, the fertilized system is highly site-specific. Before deciding on using this hatchery system in a specific location it would be necessary to ascertain the occurrence and seasonal fluctuation of the biological population of the seawater intended to be used for at least one year.

Since there is no selective production of natural feeds, some organisms coming with the water into the larval rearing tank may be undesirable. They also get to be propagated in the tank. This explains the low dependability and low larval survival rate in the fertilized system.

The production of natural feeds is limited by the concentration of fertilizers placed in the tank; higher fertilizer concentration is toxic to the larvae. Thus, the stocking density is normally low at 30-50 larvae per liter with survival rates averaging about 20 percent from nauplii to postlarvae.

This system is highly dependent on weather; sunlight is essential for natural feed production in the larval rearing tank.

The unfertilized system is more sophisticated and involves a number of independent processes, namely: mass production and storage of pure algal cultures, mass production and storage of pure rotifer cultures, and larval rearing operations. The natural feed production is independent of the larval rearing operation and may be done during the off-culture period of the larvae. The feed may be stored for later use. These feeds are normally stored in frozen form and thawed before feeding. The use of only selected desirable species of natural feeds explains the higher dependability and higher larval survival rate with the unfertilized system. A much higher technical expertise is however required for the maintenance and production of pure algal cultures. Stocking densities for this system may be as high as 200 larvae per liter with survival rates ranging from 60-80 percent from nauplii to postlarvae.

This system has been used for the larval rearing of P. aztecus, P. duorarum and P. setiferus (Cook and Murphy, 1966).

Figure 1 shows the hypothetical relative efficiencies of the fertilized and the unfertilized systems. The slope of each line represents the efficiency of the system, i.e., postlarval production per investment cost. The unfertilized system has a higher efficiency but requires a higher initial investment cost ( $I_u$ ) and a higher production level ( $P_u$ ), for an economically viable operation. On the other hand, the efficiency of the fertilized system is lower but requires a lower investment cost ( $I_f$ ) and a lower production level ( $P_f$ ) for an economically viable operation.

As the hatchery capacity increases and goes beyond  $P_{\rm O}$ , it would be cheaper to shift to the unfertilized system. It is important to note, however, that since the fertilized system is highly site-specific, the point  $P_{\rm O}$  may vary from one location to another.

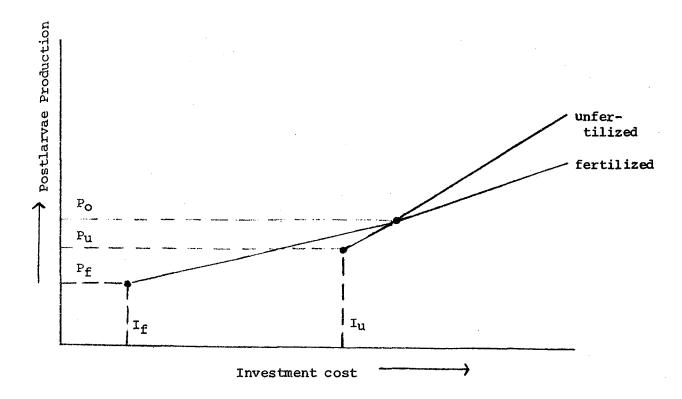


Fig. 1 Relative Efficiencies of the Fertilized and Unfertilized Systems

# Hatchery Technology in the Philippines

#### 1. MSU-IFRD

The first successful prawn hatchery operations for the mass production of postlarvae in the Philippines was at the MSU-IFRD in Naawan, Misamis Oriental which started operations in 1973. Its highest annual production was 2.75 million achieved in 1974.

The MSU-IFRD hatchery consists of eight 16-ton and four 60-ton concrete tanks under a translucent plastic-roofed structure. Three 180-ton circular and four 10-ton rectangular tanks are without roofing. One-half ton rectangular wooden tanks are used for the culture of natural feeds for the larvae.

The feeds used in the hatchery consist of mixed diatoms,

Brachionus and minced clam or tuna fish. The mixed diatoms are

introduced from the zoea stage throughout the rearing period.

Brachionus is given from the mysis stage throughout the postlarval stages.

The mixed diatoms consisting of Chaetoceros, Skeletonema, Thalassiosira, Nitzchia and Rhizosolenia are propagated in one-half ton wooden tanks. This is done by pumping sea water into the algal tank and adding fertilizers. A good phytoplankton bloom is normally achieved in 2 to 3 days. Portions of this highly concentrated diatom culture are then transferred as starters in other tanks. Programming of the diatom production is observed in order to supply the diatom requirement in the rearing tank at the various stages during the rearing period. Portions of diatom cultures which are ready to be fed to the rearing tanks are left behind and transferred into other algal tanks to serve as starters for subsequent culture.

In case of shortage of diatoms, i.e., when the mixed diatom cultures would not bloom in algal tanks, bread yeast is introduced into the rearing tanks or fertilizer is added in the rearing tank to induce phytoplankton bloom.

Brachionus is cultured in separate tanks using Chlorella as feed. Pure culture of Chlorella is always maintained from where the portions are obtained to feed the Brachionus.

Minced clam or tuna fish is blended finely and homogeneously before introducing into the rearing tanks during the postlarval stages.

#### 2. SEAFDEC Aquaculture Department

The prawn hatchery of the SEAFDEC Aquaculture Department in Tigbauan, Iloilo started operations in 1975. The hatchery complex consists of six 50-ton and six 120-ton rectangular concrete tanks under a structure with translucent plastic roofing. There are also four 200-ton rectangular concrete tanks located outside the roofed structure.

During the early operations, the larval rearing techniques used were similar to those used in MSU-IFRD. However, it was observed that the bloom of the desirable diatom species was not always obtained. There was much fluctuation of the biological population in the sea water such that during some periods of the year the desirable diatom species were practically absent.

The modification of the hatchery operation has resulted into one which now involves the mass production of unialgal cultures as larval feeds. The algae which are mass produced are <u>Chaetoceros</u>, <u>Skeletonema</u> and <u>Tetraselmis</u>. The mass production of these algae involve a series of culture volumes from one-liter dextrose bottle to 3-liter jar, 200-liter tank, 1-ton tank and finally 40-ton rectangular concrete tank. Except for Tetraselmis which is introduced

directly from the algal tank into the rearing tanks, Chaetoceros and Skeletonema are concentrated and washed with the use of sand filters before feeding into the rearing tanks.

<u>Chaetoceros</u> and <u>Skeletonema</u> are fed starting from the earlier zoeal stage, while <u>Tetraselmis</u> is introduced starting from the later zoeal stage. All these are continuously given until harvest.

Brachionus is introduced starting at the mysis stage until the time when brine shrimp is introduced in the early postlarval stages.

Finely blended mussel meat or shrimp meat may be used as substitute for brine shrimp. However, the rearing water quality deteriorates faster when feeding with mussel or shrimp meat.

In 1978, the Department's big concrete hatcheries produced a total of 8.2 million with an average survival rate of about 15 percent from nauplius to  $P_5$ .

# 3. Barangay Sugpo Hatchery Project

The Barangay Sugpo Hatchery Project was organized in January 1977 and charged with the function of developing a small-scale compact hatchery system for P. monodon which would serve as a model for fish farmers in adopting a prawn hatchery technology that is within their economic and technical capabilities. It also serves as a training facility around which rectangular training programs can be conducted on all phases of hatchery operations.

The Barangay Hatchery Project also conducts studies aimed to further simplify the available hatchery technology in order to minimize the capital and technical inputs for small-scale viable operations.

The design and operation of a small-scale hatchery system has been prepared and published as the Department's Aquaculture Extension Manual No. 1. The use of 2-ton tanks is appropriate for small-scale operators. It allows flexibility in hatchery operation and is easily manageable when it comes to disease prevention and control.

Barangay Hatchery runs in Tigbauan gave a highest production of 70,000  $P_5$  per tank of 2-ton capacity with s survival rate of about 60 percent from nauplius to  $P_5$ . The average survival rate is about 30 percent with an initial stocking of 100,000 nauplii per 2-ton tank. In Batan, the highest survival rate from the Barangay Hatchery runs was more than 90 percent from nauplius to  $P_5$ , with an average of 50 percent. In the Zamboanga SEAFDEC-MRSF experimental station, preliminary barangay hatchery runs have shown promising results (Gutierrez, personal communication).

Aside from P. monodon, hatchery runs were also conducted for P. japonicus, P. indicus, P. merguiensis and M. ensis in Tigbauan.

During September and October 1977, 10 fishpond operators from West Visayas participated in a training program on Sugpo Hatchery Management in Tigbauan, Iloilo. Of the 10, five have built their own hatcheries.

The second group involving seven trainees underwent a similar training program from October to November, 1978 held in the Department's substation in Batan, Aklan.

# State-of-the-Art of Hatchery Technology in the Philippines

The SEAFDEC Aquaculture Department's Aquaculture Extension Manual No. 1 presents the basic guidelines on the design and operation of a small-scale hatchery. Among the more significant aspects are:

## 1. Source of Spawners

The hatchery should be near the source of spawners because -while there are existing techniques for transporting spawners over long distances -- the quality of eggs is greatly affected by the transport stress.

Transport of nauplii contained in a continuously aerated tank or in oxygenated plastic bags have been tried and may be better alternatives to transporting spawners.

## 2. Seawater Quality

The biological quality of seawater intended to be used in the hatchery depends on the type of hatchery system to be adopted. With the fertilized system, it would be desirable for the seawater to contain an abundance of small sized diatoms, e.g., <a href="Chaetoceros">Chaetoceros</a>, <a href="Skeletonema">Skeletonema</a>, etc. throughout the year.

For the unfertilized system, the above requirement for seawater is not necessary.

For any system however the seawater must not be affected by agricultural or industrial wastes. Turbidity should be as low as possible with salinity in the range of 28-32 ppt.

#### 3. Seawater Supply System

Intake systems

Pipe extending into the sea

The seawater may be pumped directly from the sea into the hatchery facility or the seawater may be allowed to flow by gravity through a pipe extending to the sea into a sump from where it is pumped to the hatchery facility.

#### Inshore well

Water from a well near the shoreline is already prefiltered to eliminate the need for a filtration unit. However the salinity of some inshore wells are easily affected by heavy runoff. This intake system is desirable only if unialgal cultures are maintained in the hatchery for larval feeds.

## Intertidal sump

This involves the use of a sump normally made of concrete culverts placed in an intertidal area. Pumping is done only during high tide. The top portion of the sump should not be reached by the highest tide. The bottom should be higher than the low tide to enable complete draining. The inlet hole at the bottom which also serves as a drain hole may be fitted with a detachable and rotating PVC pipe-and-elbow assembly by which water may be allowed into the sump only when the tide has risen to a level when its scouring effect on the ground is minimal. From the sump, water is pumped to the hatchery facility. From this type, it is necessary to have a reservoir which is capable of holding water adequate to supply the needs in the hatchery until the next high tide.

#### Filtration

Except for seawater from a well, it is necessary to filter from the seawater larger organisms such as fish and jellyfish, as well as silt and mud during heavy runoff. A fine sand filter is adequate for this purpose.

#### Distribution lines

All pipes and fittings should be made of PVC and should be fully exposed for easier maintenance.

#### 4. Air Supply System

A blower or compressor provides the oxygen requirement to the culture water and induces circulation and agitation necessary for the uniform suspension of cultured organisms.

For light feed particles, ordinary airstones evenly located inside the culture tanks would be adequate for uniform feed distribution. However, for heavier feed particles which settle at the bottom even with the use of airstones, airlift pipes would be desirable in the culture tank.

Distribution lines should also be made of PVC.

#### 5. Larval Culture Tanks

Larval culture tanks may be made of concrete, fiberglass, marine plywood or any material resistant to seawater and without toxic properties. The tanks may be of any capacity depending on the projected volume of production and availability of spawners.

For the fertilized system, it would be desirable to have shallow tanks for efficient natural feed production in the tanks.

#### 6. Culture of Natural Feeds

Techniques for the mass production of unialgal cultures used for algal rearing have been developed. Unialgal cultures of Chaetoceros, Skeletonema, Isochrysis, Tetraselmis and Chlorella are available at the Phycology Laboratory of the SEAFDEC Aquaculture Department.

Although there is available nutrient formulation for the culture of mixed diatoms it would be necessary to modify the formulation depending on the local species of interest.

For the unfertilized system, the diatom cultures are concentrated and washed by the use of a fine sand filter. Algal flocculation has also been done for Chaetoceros, Tetraselmis, Isochrysis and Skeletonema (Millamena & Jereos, 1978).

Brachionus may be mass produced using <u>Chlorella</u>, <u>Tetraselmis</u> or bread yeast as feed. Frozen <u>Tetraselmis</u> has also been found to be an effective feed for Brachionus.

## 7. Larval Rearing

Feeding

A significant development is the study on the effectivity of feeding frozen Brachionus and frozen brine shrimp to mysis and post-

larvae of P. monodon, respectively. This was tried in 2-ton tanks and gave survival rates comparable with those obtained from feeding with live Brachionus and live brine shrimp (Platon, 1978).

Another importnat experimental result is the effectivity of feeding dried or frozen algae to P. monodon larvae (Millamena & Hereos, 1978). These studies were conducted in 3-liter aquaria using Tetraselmis, Chaetoceros and Isochrysis. These will be tried in 2-ton tanks.

There are some artificial feeds available from Japan, Taiwan and the United States which, finely ground, could be given starting from the mysis stage to postlarvae. In this country, however, larval rearing with the use of these feeds are still limited.

#### Disease Control

To eliminate infective agents that may come with the spawner and which may be carried over into the larval rearing tanks, spawners are first immersed in water treated with formalin (50 ppm) or furanace (3 ppm).

The most common diseases observed in the hatchery are due to the fungi Lagenidium and Sirolpidium. Some diseases are caused by bacteria and protozoans.

The Department's Pathology Section has recently obtained significant results in the screening of potential chemotherapeutants for the control of some of these diseases (Po, et al., 1978).

Penicillin and Streptomycin applied alternately every other day at a concentration of 0.3 and 0.5 ppm, respectively in one-ton larval rearing tanks were found effective in controlling bacterial infection (Motoh, 1977).

## Present Thrusts of the Barangay Sugpo Hatchery

#### Larval Feeding with Preserved Natural Feeds

This would simplify the hatchery operation in that it would eliminate the need to synchronize the mass production of natural feeds with larval rearing operations. Natural feed production may be conducted during the off-culture period of the larvae. Emphasis would be given on the economics and adaptability of the operation by small-scale operators.

Refinements of Site Selection Criteria Using Indicator Organisms

Successful operation of hatcheries by small-scale operators will ultimately depend on the biological quality of the seawater in the hatchery site. The seawater will serve as a continuous source of larval feeds. Small-scale operators may not have the resources and technical expertise to maintain their own algal stock culture.

Economical Water Treatment Systems for Small-Scale Hatcheries

Aside from the desirable algae, there may also be extraneous microorganisms present in the seawater which if carried over to the larval rearing tanks would adversely affect larval rearing operations. Physical and chemical methods of eliminating these contaminants would have to be studied and developed.

Engineering Studies

These would be necessary in seeking alternative low-cost construction materials for larval rearing and algal tanks.

Larval rearing tank design and development would also be conducted to find out more efficient systems.

# PRAWN POND ENGINEERING

Rodolfo T. Tolosa SEAFDEC Aquaculture Department

## PRAWN POND ENGINEERING

## Rodolfo T. Tolosa

Techniques employed in the cultivation of sugpo in ponds is still basically traditional and is in fact patterned after that for bangus culture. Most prawn ponds are converted bangus ponds where they are used for monoculture or polyculture with bangus. The stocking of ponds with sugpo fry depends on the seasonal nature of fry collection. The sugpo fry are collected from known breeding grounds in estuaries and bays during season an are stocked in the ponds until they grow to marketable size.

Engineering concepts and principles have only been recently employed in the design of aquaculture facilities to increase production in both the hatchery and pond culture operations. One has only to examine the culture of prawns in Japan to conclude that applying these concepts is indeed rewarding.

The main operations involved in prawn culture are outlined in Figure 1. The enclosed dotted area in the diagram shows the operations where pond engineering principles may be applied.

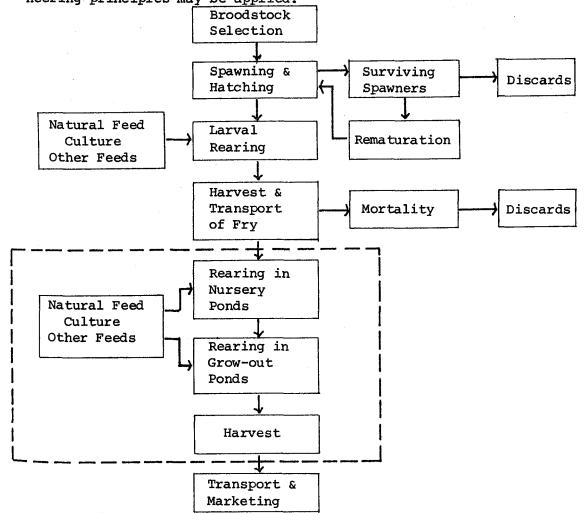


Fig. 1 The Prawn Culture Process

This paper reviews briefly the engineering principles and concepts, materials of construction, design and construction techniques of pond systems adequate for use in the cultivation of prawns.

# Pond System Layout and Design

## 1. Pond Engineering

Pond engineering is principally concerned with water supply, the application and storage of water, the design and construction of pond structures and equipment, and the drainage problems associated with it. It is also concerned with the biological factors involved in the proper cultivation of the cultured species.

## 2. Site Selection

The greater and more detailed knowledge of the pond site there is, the more effectively and efficiently a pond system can be designed and developed. The criteria usually employed in evaluating prospective pond sites are as follows:

Water source (fresh and salt water)
Topography (elevation, soil type, etc.)
Road and market accessibility
Fry source
Availability of electric power
Availability of technical manpower

# 3. Biological Considerations

The biological factors which influence the design and construction of prawn ponds are:

Salinity: 10-20 ppt

Stocking rates

With transfer

Nursery pond: 20-30 sugpo fry/sq m

Grow-out pond:

Monoculture - 5 to 2 sugpo juveniles/sq m

Polyculture - 5 to 1 sugpo juveniles/sq m

.05 to .1 bangus fingerlings/sq m

#### Without transfer

Nursery/grow-out pond:

Monoculture - 1 to 3 sugpo fry/sq m

Polyculture - 1 to 2 sugpo fry/sq m

.04 to .06 bangus fingerlings/sq m

Water depth

Nursery pond: 20-60 cm Grow-out pond: 30-110 cm

pH: 7 to 9

Dissolved oxygen: 5 to 10 ppm

Temperature: 20° to 35°C

Toxic metabolites

Predation and cannibalism

Fertilization

## 4. Layout Considerations

The general engineering considerations which affect the planning and layout of a prawn pond system are:

Water source

Surface water (salt and fresh water)
Ground water (wells and springs)
Precipitation
Floodwater

Interrelationship between the major components of the system for easy access and circulation

Layout types

Conventional type Progressive type Radiating type

Local materials and labor Economics

## 5. Pond System Structures

The development of a pond system consists of the design and construction of several structures, equipment and appurtenances. These structures and equipment may be classified and grouped as follows:

Protection structures: breakers, jetties, barriers
Water measurement structures: orifices, weirs, measuring flumes
Water conveyance structures: canals, flumes, drops, flexible
tubings

Water impounding structures: earth dams, nursery ponds, grow-out ponds, reservoir ponds, sump ponds

Pumps and wells

Other equipment and accessories

# Pond Structures and Equipment in the Philippines

# 1. Protection Structures

Shore protection structures are employed to protect aquaculture facilities along the shore. In a pond system, they usually consist of breakers, jetties and barriers. The sizes and types of the structures vary according to the conditions for which are constructed.

## Engineering analysis

The structures are designed for wave and wind action. The engineering formulas commonly used are the Stevenson formula, the Molitor formula, the Gaillard formula, etc. These formulas are quite outdated and may be used only to establish preliminary designs. The design must be checked and modified properly by applying the more advanced analytical methods and verified by model tests.

## Breakwaters

Breakwaters commonly employed are: (a) rubble-mound breakwater, (b) wooden-type breakwater formed by driving two lines of mangrove piles and filling the space between them with branches of trees, and (c) a buffer zone of mangrove trees.

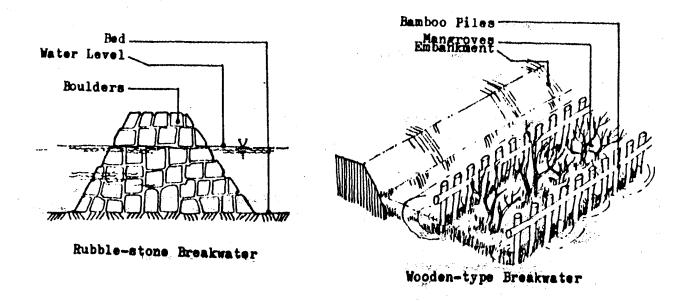


Fig. 2 Breakwaters

## Jetties

Bamboo jetties arranged in a zigzag pattern prevent scouring at river bends. Coconut trunks are also used intead of bamboos. The spaces between the river bank and jetties are filled with twigs and branches.

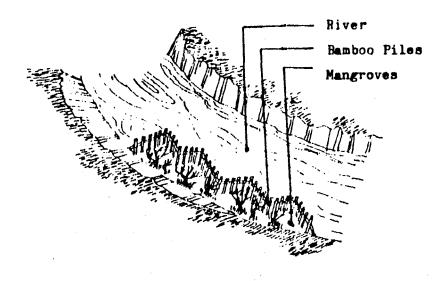


Fig. 3 Bamboo Jetties

# Embankment protection structures

Embankment are protected against internal waves by the following:
(a) bamboo wave breakers, (b) worn-out tires arranged side by side along the embankment, (c) riprapping of embankment, and (d) growing of creeping or close-growing grasses on embankment.

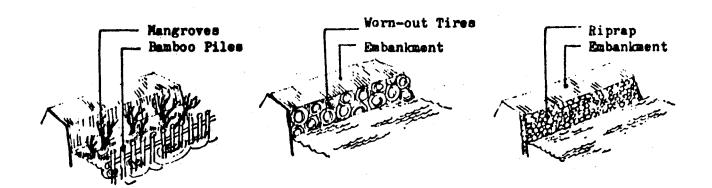
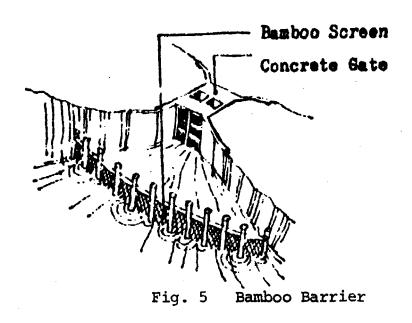


Fig. 4 Embankment Protection Schemes

# Screened barriers

Bamboo or nylon screens are installed at the mouth of the main gates to preven clogging of the gates by floating debris.



## 2. Water Measurement Structures

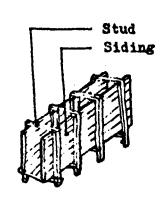
The only type of water measurement structure employed in pond systems is the sluice gate. However, their main function is to admit water to the ponds rather than to measure the flow of water.

# Engineering analysis

The flow through a sluice gate is determined by the following formulas: (a)  $Q = CA\sqrt{2gh}$  if it acts as a submerged orifice, and (b) the Francis formula if it acts as a weir.

## Gates

Water sluice gates are either made of poured concrete, CHB with concrete frame, adobe, stone or lumber. Single, double and triple gates are generally used.



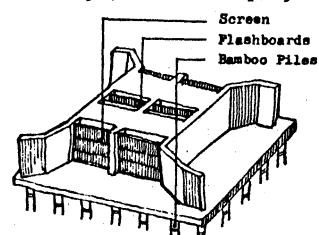


Fig. 6 Gates

## 3. Water Conveyance Structures

Water in rivers and ponds are conveyed either in open or closed conuits. The most common structures employed in the conveyance of water to ponds are canals, flumes and tubes.

Engineering analysis

The formulas used in the analysis and design are the continuity equation, the Bernoulli equation and the Manning formula.

#### Canals

The most common type of conveyance channel used is the earth canal. The sides of the canals have slopes varying from 1:3 to 1:1. To overcome seepage losses, low velocities and erosion, the canals are lined either at the sides, at the beds or both. The materials used for lining are concrete, rock masonry, brick and natural clay of low permeability.

## Flumes

Flumes are used for crossing natural depressions or for conveying water above dike level. They are constructed either of wood, metal or concrete.

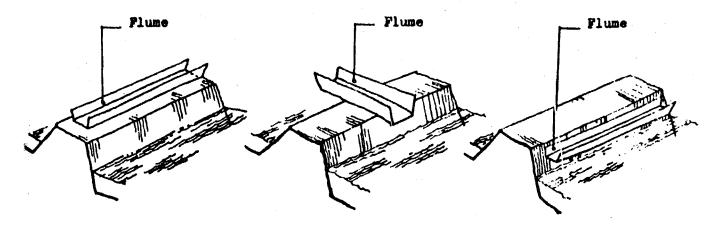


Fig. 7 Some Applications of Flumes

# Flexible tubings

Tubing made of rubber or plastic is also used to convey water. The tubing is generally flexible so that it will lie flat when no water is in the rope.

## 4. Water Impounding Structure

The water impounding structures generally used in a prawn pond system are the earth dams, nursery ponds, grow-out ponds, reservoir ponds, sump ponds.

Engineering analysis

The design of impounding structures is essentially the design of embankments or levees. The procedure consists of determining the height of the embankment, its slopes, its stability and the seepage flow associated with the design.

Construction of embankments

Three methods are employed in the construction of embankments - the line system, the sliding system and the raft system.

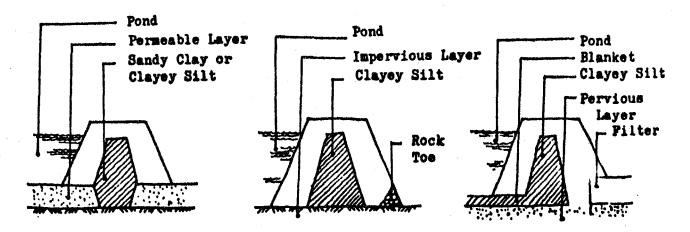


Fig. 8 Embankment Sections\*

Nursery ponds

The usual shape of nursery ponds are rectangular and square. The compartment size ranges from 500 to 1500 sq m. Its orientation depends on the prevailing wind direction. The depth is usually 60 cm. It is provided with an aeration system and provisions for easy drainage are made.

<sup>\*</sup>Diagrams taken from R.G. Hechanova's paper entitled, Practical Applications of the Basic Principles of Hydraulic and Soil Mechanics in Aquaculture Engineering.

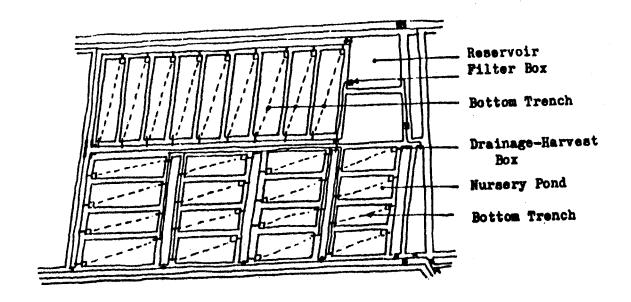
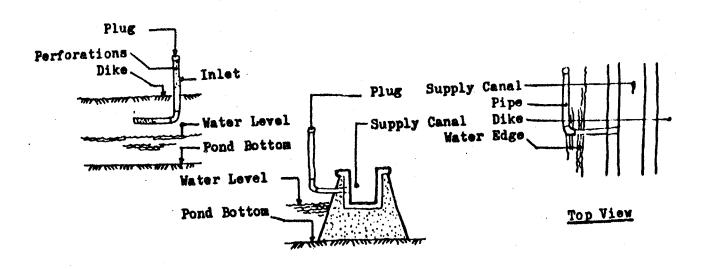


Fig. 9 A Nursery Pond System\*



# Vertical Position\*

Fig. 10 Inlet Pipe

<sup>\*</sup>Diagrams taken from paper by F.D. Apud and M.A. Sheik entitled, Design and Construction of a Prawn Nursery Pond System.

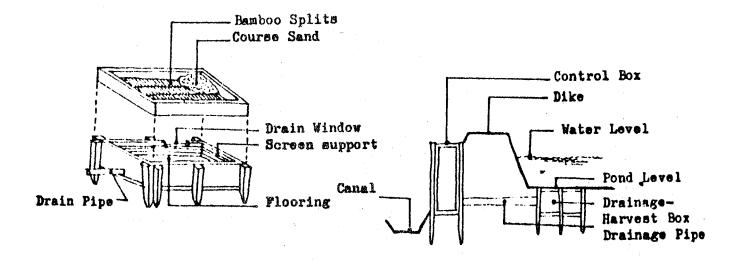


Fig. 11 Drainage-Harvest Box\*

Grow-out ponds

The common size for grow-out ponds is 1 hectare. The shape is rectangular and the depth is usually 1.20 m. Other features are similar to that of the nursery ponds.

## Reservoir ponds

Reservoir ponds are rectangular in shpae. Their sizes are deterdmined to supply approximately three days replenishment of nursery and grow-out ponds. Water depth ranges from 1.6 to 1.8 m. The base is usually 6 m and the crown width is 2 m. The bottom of the pond is at least 10 cm above the highest bottom elevation of nursery and grow-out ponds. Reservoir ponds for the nursery ponds are equipped with filters.

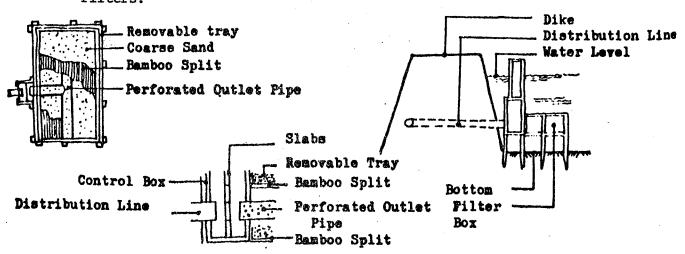


Fig. 12 Filtration Box\*

<sup>\*</sup>Diagram taken from paper by F.D. Apud and M.A. Sheik entitled, Design and Construction of a Prawn Nursery Pond System.

Sump ponds

Sump ponds are reservoir ponds for drainage wayer to be deposited prior to their being released to their points of disposal. Sump ponds are also utilized as harvesting ponds.

# 5. Pumps and Wells

Wells

Two types of wells commongly used are the shallow well and the deep well. Deep wells are usually preferred because of lesser danger of contamination. The formulas used in determining discharges of wells are the Darcy formula for confined wells and the Dupuit formula for unconfined wells.

# Pumps

Four basic designs of pumps are generally used. These are (a) radial type (b) Francis type (c) mixed flow type and (d) axial flow type. The characteristics of these pumps are shown in Fig. 13. Typical pump installation are shown in Figs. 14 to 16.

Specific speed No = rpm qpm		Cross section	Type of pump	Head-discharge characteristics
(a)	H <sup>3/4</sup> 500		Centrifugal (Radial flow)	High head Small discharge
(b)	1000			
(c)	2000		Francis	Intermediate head and discharge
(d)	3000	dp		
(8)	5000		Mixed flow	
(1)	10000		Propeller flow (axial flow)	Low head Lorge discharge

Fig. 13 Pump Characteristics\*

<sup>\*</sup>Chart taken from Irrigation Principles and Practices by W.O. Israelsen and V.E. Hansen.

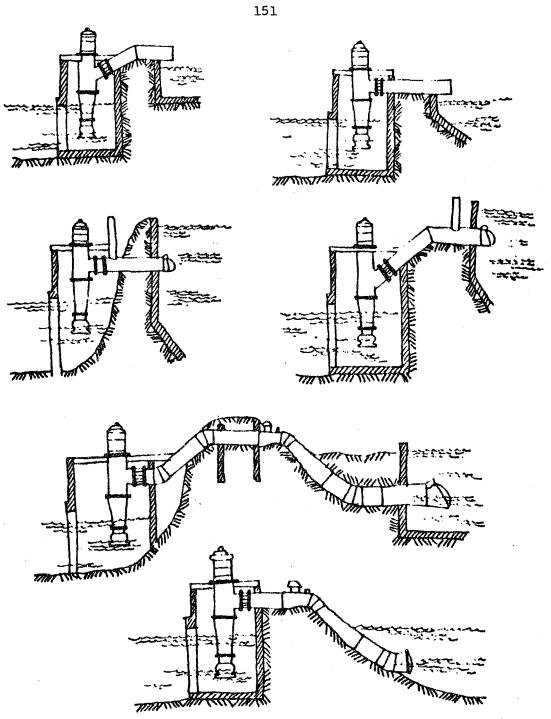


Fig. 14 Pump Installations\*

<sup>\*</sup>Diagrams taken from T.J. Jamandre's paper entitled, Pumps for Brackishwater Aquaculture.

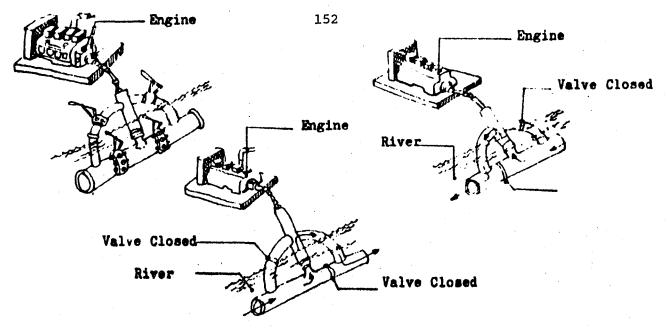
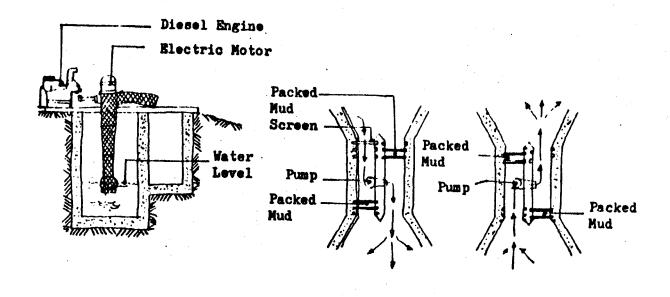


Fig. 15 Watering and Dewatering Ponds\*



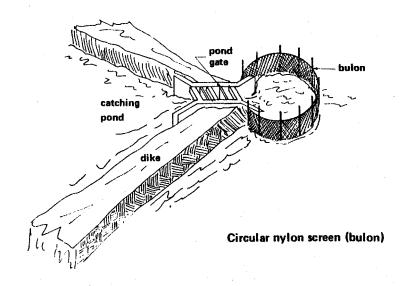
.Fig. 16 Main Tidal Gate Pump Installation\*

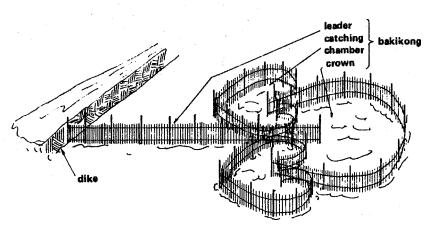
<sup>\*</sup>Diagrams Taken from T.J. Jamandre's paper entitled, Pumps for Brackishwater Aquaculture.

# 6. Other Equipment and Accessories

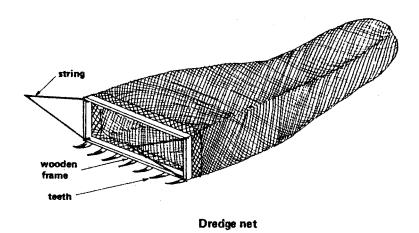
Tidal gauges
Aerators
Electric motors and diesel engines
Trapping gears

The commonly employed trapping and catching devices for prawns are the following: (a) bulon or nylon screen trap for use in draining ponds, (b) bakikong, lumpot and bagnet for harvesting juveniles and full-grown prawns, (c) shrimp cage and suspension net for carrying prawns, and (d) seine, scissor and dredge nets for catching remaining prawns in ponds.





Bamboo shrimp trap (bakikong)



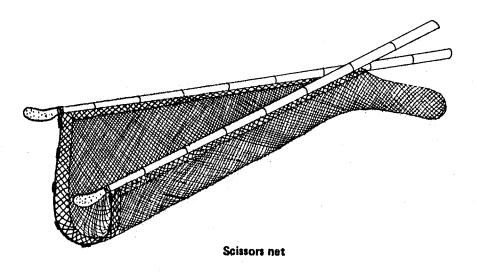
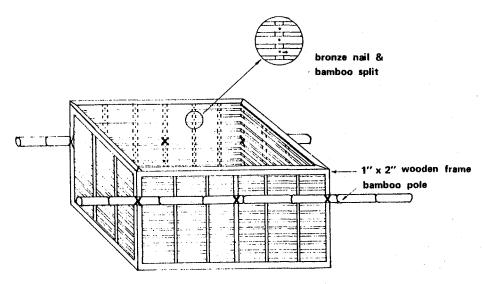
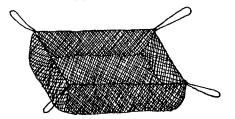


Fig. 17 Commonly Used Trapping Devices\*

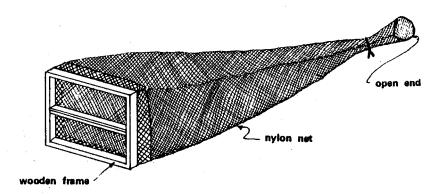
<sup>\*</sup>Diagrams taken from Manual of Pond Operations: Sugpo Pond Culture, by J. H. Primavera and F. D. Apud.



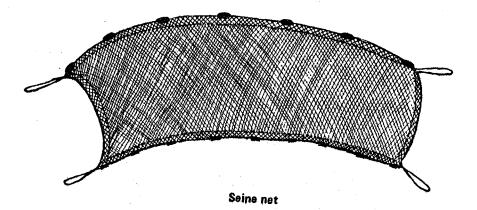
Bamboo cage for transport of juvenile or adult sugpo.



Suspension net (bitinan)



Bagnet (lumpot) attached to wooden frame



## Conclusion and Recommendations

## Conclusion

The subjects of water flow, levees and embankments, foundations, and hydraulic structures are well advanced in the field of hydraulics, soil mechanics and foundation engineering. However, these developments have not been fully applied in pond layout, design and construction. One reason is the fact that these topics are highly complex and technical. There is a need for translating these concepts and principles into more simplified forms. There is also a need to develop low-cost pond structures using indigenous materials which are appropriate for use in the rural areas.

## Recommendations

Preparation of a handbook on pond layout, design and construction for laymen with engineering principles and concepts presented in the simplest forms.

Use of water measurement structures such as the parshall and trapezoidal flumes.

Design, development and fabrication of cheap, durable and portable gates and flumes.

Improved methods of embankment stabilization using low-cost materials such as clay, soil-cement, bamboos, etc.

Improved drainage methods for pond systems.

#### References

- Apud, F. D. and M. A. Sheik, Design and Construction of a Prawn Nursery Pond System. Readings on Pond Construction and Management, SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines, May 1978.
- Denila, L., Layout, Design, Construction and Levelling of Fishponds.

  Readings on Pond Construction and Management, SEAFDEC Aquaculture
  Department, Tigbauan, Iloilo, Philippines, May 1978.
- Esguerra, R. S., Layout, Construction and Management of Brackishwater Fishponds in the Philippines, SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines, May 1978.
- Hechanova, R. G., Practical Applications of the Basic Principles of Hydraulics and Soil Mechanics in Aquaculture Engineering, Paper read at Joint SCSP/SEAFDEC Workshop on Aquaculture Engineering held at SEAFDEC Aquaculture Department facilities, Philippines, 27 November 3 December 1977.
- Israelsen, O. W. and V. E. Hansen, Irrigation Principles and Practices, John Wiley and Sons, Inc., 1962.
- Jamandre, T. J., Pumps for Brackishwater Aquaculture, Paper read at
  Joint SCSP/SEAFDEC Workshop on Aquaculture Engineering held at
  SEAFDEC Aquaculture Department facilities, Philippines, 27 November 3 December 1977.
- Katoh, J., Guide to Design and Construction of Coastal Aquaculture Pond, Japan International Cooperation Agency, Tokyo. April 1975.
- Merriman, T. and T. H. Wiggin, et al, eds., American Civil Engineers
  Handbook, John Willey and Sons, Inc., May 1948.
- Pillay, T.V.R. ed., Costal Aquaculture in the Indo-Pacific Region, Whitefriars Press Ltd., 1972.
- Platon, R. R., Design, Operation and Economics of a Small-Scale Hatchery for the Larval Rearing of Sugpo, <u>Penaeus monodon</u> Fab., Aquaculture Extension Manual No. 1, SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines, July 1978.
- Primavera, J. H. and F. D. Apud, Manual of Operations: Sugpo Pond Culture, Extension Manual No. 2, SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines, September 1977.

- Shigeno, K., Shrimp Culture in Japan, Association for International Technical Promotion, Tokyo, Japan, March 1975.
- Tenedero, R. A., Water and Water Quality in Brackishwater Ponds.

  Readings on Pond Construction and Management, SEAFDEC Aquaculture

  Department, Tigbauan, Iloilo, Philippines, May 1978.
- Tschebotarioff, G., Soil Mechanics, Foundations and Earth Structures, McGraw-Hill Book Co., Inc., 1951.

# NUTRITION AND FEEDING OF $\underline{P}$ . MONODON IN THE PHILIPPINES

Chhorn Lim and F.P. Pascual SEAFDEC Aquaculture Department

# NUTRITION AND FEEDING OF P. MONODON IN THE PHILIPPINES

## Chhorn Lim and F.P. Pascual

The culture of Penaeus monodon in the Philippines is still in its early stage of development. Previously, shrimps were stocked in milkfish ponds, given no special care, and harvested as an extra crop. Due to the high market price, high consumer demand and availability of the seeds through artificial propagation, intensive monoculture of P. monodon has been developed in recent years. In this type of farming, the contribution of natural fish food organisms, grown in the culture environment, to the dietary requirements of the shrimp becomes insignificant. Consequently, an external food source must be provided to achieve higher production. Traditionally, supplementary feeding with trash fish, mussel meat, african snails, frog meat, chicken entrails, carabao hide, etc., has been applied in the Philippines. Considering the difficulty in procuring, storing and transporting the product, controlling water quality of the rearing environment, and time and labor involved in feed preparation and feeding, this practice is uneconomical and impractical. Thus, it is desirable to develop acceptable and nutritionally adequate artificial diets at the least cost to replace the unpredictable and/or unavailable fresh or frozen foods which have been traditionally used.

The objective of this paper is to review briefly the available information on nutrition and feeding of Penaeus monodon in the Philippines.

# Nutrient Requirements

## Protein Quality

The nutritional values of several animal and plant proteins as potential feed ingredients for P. monodon have been evaluated. Results indicate that squid meal was better utilized by P. monodon mysis than shrimp head meal, fish meal, ipil-ipil leaf meal or copra meal. In another study, postlarvae were fed with fresh brown mussel meat and artificial diets containing squid meal, shrimp meal spirulina and casein as protein sources. Results indicate that squid meal and shrimp meal were good protein sources for P. monodon followed by fresh brown mussel meat, casein and spirulina.

Ipil-ipil leaf, seed meals and copra meal are not good protein sources for P. monodon when used solely as major protein sources. Ipil-ipil meals have been identified to contain a lysine derivative, mimosine, whic is toxic to the shrimp. However, mimosine content is reduced by

soaking the leaves for 24 hours in fresh water. When used in combination with fish meal and shrimp head meal, soaked ipil-ipil leaf meals can be incorporated up to one-third of the total protein content in the diet without any apparent harmful effect.

Studies on the optimum inclusion rate of fish meal and shrimp head meal have been conducted in the laboratory and then verified under actual pond conditions. Results indicate that the diets in which three-fourths of the total protein was supplied by the combination of fish meal and shrimp head meal provided better growth than those in which the animal protein was supplied either by fish meal or shrimp head meal alone. The combination in which two-thirds of the animal protein came from fish meal and one-third from shrimp head meal was the most efficient for the growth of P. monodon.

The effect of various feeding regimes (artificial diet, fresh brown mussel meat, fresh brown mussel meat + artificial diet and artificial diet + fresh squid) on the maturation and fecundity of P. monodon spawner has been evaluated. Results indicate the superiority of fresh brown mussel meat over artificial diet and artificial diet + fresh squid. However, the combination of artificial diet and fresh brown mussel meat was found to be better than any feeding regime.

## Protein levels

The optimum levels of crude protein requirements for P. monodon have been reported to be from 40 to 50 percent of the dry ration. Similarly, the data obtained from our study using isocaloric purified diet containing graded levels of protein in the form of casein show that dietary level of 40 to 45 percent crude protein in the diet was necessary for good growth survival and best feed conversion.

## Lipids

Lipids or fats, due to its caloric value contribute significantly to the energy levels of the diets even when present in low quantities. Besides being concentrated energy sources, lipids furnish the essential fatty acids and the fat-soluble vitamins necessary for the growth of the animals.

A study was conducted at the SEAFDEC Aquaculture Department to determine the effect of corn oil, copra oil, soybean oil, beef tallow, pork lard and fish oil on the growth of P. monodon juvenile. Results show that beef tallow is a good lipid source for P. monodon when based on the growth. However, based on the feed conversion values and survival rates, fish oil is preferable to beef tallow. It can be concluded that fish oil is best followed by beef tallow, soybean oil, copra oil, corn oil and pork lard.

# Feeding Practices

The optimum feeding rate for P. monodon juvenile in a controlled environment has been studied. With a diet containing 30 percent protein and about 3,000 kcal of ME/kg, a daily feed allowance of 12 percent of the biomass provided highest weight gain and best feed conversion. However, if shrimps are to be raised in environments where natural foods are available the daily feeding rate should be lower than 12 percent of the biomass.

The effect of the time and frequency of feeding on the growth of P. monodon was studied. Shrimps were fed at a rate of 10 percent of the body weight daily with 30 percent protein diet. When fed once daily, shrimp fed in the morning (0900 hours) had higher weight gain and survival rate than those fed at 1300 hours or 1700 hours. With the same quantity of feed given, shrimp fed 3 times daily out-performed those fed one two or four times per day.

# Diet Preparation

One improtant physical characteristic of the shrimp ration is water stability. Feed pellets must remain intact in the water for a sufficient period because shrimps are slow eaters. A wide variety of various carbohydrate sources available locally have been tested for their binding capacity. Sago palm starch or agar incorporated at 5 percent level in combination with 15 percent wheat flour gave adequate water stability up to 12 hours. Gelatinizing sago palm starch or dissolving agar prior to mixing with other feed ingredients was found necessary. Different qualitities of sago palm starch (crude, semi-purified and purified) were evaluated for their suitability as binder. The semipurified sago starch was preferable than the crude or purified sago starch in terms of binding capacity and cost, results show.

Researches were also conducted to determine suitable techniques of diet preparation. Extruding the pellet through the die with a smaller diameter hole provided a more compact pellet due to higher pressure exerted by the meat grinder during the extrusion process. Likewise, grinding the ingredients to a fine consistency significantly improved the durability of the pellet. Steaming the moist extruded pellet for 5 minutes prior to the drying process increases pellet stability.

In addition to water stability the diet must be attractive and palatable to the shrimp. Plain water, shrimp, mussel, squid and fish extracts were incorporated into purified diets for evaluation of their attractiveness to P. monodon postlarvae. Prawns were readily attracted to diets containing shrimp and mussel extracts. These were followed by fish and squid extracts. Diet prepared with plain water was the least preferred.

# SUGPO CAGE FARMING IN FRESH WATER

J. B. Pantastico
Freshwater Fisheries Station
SEAFDEC

#### SUGPO CAGE FARMING IN FRESH WATER

## J. B. Pantastico

The emerging technology of prawn farming in Laguna Lake has been recently developed at the Freshwater Fisheries Station of SEAFDEC. The efforts complement those at the main station of SEAFDEC at Tigbauan, Iloilo. The outcome has been most rewarding in terms of optimizing the use of inland water resources and the prospect of establishing a new industry in Laguna Lake.

## Research Base

The major research findings that catalyzed the development of this new technology are the successful acclimation of postlarvae to fresh water; development of a stable compound feed utilizing indigenous resources; and finding different types of supplemental feeds suitable for prawn under lake conditions. They are described below:

Acclimation of Penaeus monodon postlarvae to fresh water

Gradual acclimation of postlarvae to fresh water was conducted in aquaria and marine plywood tanks over a one-day, two-day, and three-day period. Different ages of postlarvae were tested for their hardiness. P35 postlarvae gave high percent survival of 98-99 percent while lower values were obtained for P20 and P90.

A three-day acclimation period was optimum for all ages of post-larvae. Shorter duration of acclimation produced survival values as low as 20 percent. This stress effect was apparent with  $P_{20}$  and  $P_{90}$  but not with  $P_{35}$  which showed high survival regardless of the duration of acclimation.

Preliminary studies on the development of compounded algal diet for Penaeus monodon

SEAFDEC FFS Algae Cake was developed for the lake farming of acclimated P. monodon in Laguna de Bay. The formulated feed was prepared in three different forms: wet and dried algae cake, and dried algae pretzel. The dried algae cake was most stable lasting up to 56 and 36 hours under laboratory and lake conditions, respectively. Attractability and acceptability tests were also conducted.

The desirable characteristics of the newly developed feed in the light of establishing a prawn industry in fresh water were also discussed.

Effect of supplemental feeds at varying feeding rates on growth and survival of Penaeus monodon reared in the lake

Acclimated postlarvae ( $P_{20}-P_{30}$ ) were stocked at  $20/m^2$  in cages in the lake and given three types of supplemental feeds: (1) Feed 1 - FFS Algae Cake (2) Feed 2 - trash shrimps and clams (1:1) and (3) algae cake + trash shrimps. Feeding rates varied at 5, 10 and 15 percent of the body weight.

The analysis of variance showed significant to highly significant main effects of type of feed and feeding rates. The effect of a given type of feed is the same whether the feeding rate is 15, 10, and 15 percent. Similarly, the effect of a given feeding rate is the same regardless of the type of feed. Peak periods of growth of P. monodon given supplemental feeds were attained during the 3rd and 4th months of culture (April and May, 1978). P. monodon given trash shrimps and algae cake (1:1) grew better compared to those given clams and trash shrimps (1:1) and algae cake alone at the end of the 6th month. Highest survival was attained in lots given clams and trash shrimps.

# Initial Packaging

Based on these production-oriented researches and the results of experiments in progress, the research staff of the Station evolved a systematic procedures on "Prawn Cage Farming in Laguna de Bay." This may be considered an initial step towards packaging the new technology. The procedure is described below:

Transport and Handling of Sugpo Fry

Obtain fry from hatcheries or from the wild. Fry should be about 35 days old (P35) or about 30-40 mm long. Put fry in oxygenated polyethylene bags at 1,000 fry in 8 liters brackishwater. Add seaweeds or eel grass as substrate. Place bags in an inverted position in buri baskets for transport to short distances or in styrofoam boxes with ice for long distance transport. Amount of ice to be added should be regulated to maintain the temperature at about 21°C.

#### Acclimation to Fresh Water

Upon arrival, check the salinity of the water in polyethylene bags. Allow the fry to rest in brackishwater with the same salinity (usually 12 to 18 ppt) for 1 to 2 days in marine plywood tanks. Stock at 20/liter. Aerate moderately and feed once daily with FFS algae cake (50% protein at 10 percent of body weight).

## Lake Farming

- 1. Consider the following major criteria in selecting sites in Laguna Lake for prawn farming:
  - a) It should not be exposed to strong waves
  - b) The lake bottom should be silt-loam or clay-loam
  - c) The depth of water should be at least 2 m
  - d) The area should be relatively pollution-free

Based on preliminary findings of the eco-monitoring team using the above criteria, the following sites in Laguna Lake may be recommended: Talim Island (Binangonan side), Cardona, Los Baños, Pila, and Pililia.

2. From the acclimation tanks containing one-half lake water and one-half tap water, transfer fry to hapa nets (10 x 10 x 4 1/2 m) in the lake. Stock at  $40/m^2$ . During the first month, no supplemental feeding is necessary. On the second month, feed with a combination of FFS algae cake (starter feed, 50% protein) and trash shrimp at 5 percent of the body weight. Give one-third of the ration in the morning and two-thirds in the afternoon. Continue feeding for two months. Transfer to B-net cages when juveniles reach 80-120 mm long. At this size and age, post-larvae cannot pass through B-nets (mesh size, 55 mm). Note: Hapa nets should touch the lake bottom for better growth of prawn.

A module is presented as the most efficient way of setting up cages in the lake. This takes into account proper water circulation for all the cages.

3. Transfer fry from hapa nets to B-nets (10 x 10 x 4 1/2 m) as mentioned above. Cover cages for security and install them with the bottom submerged in the muddy substrate.

Reduce stocking density to  $30/m^2$ . On the fourth month, feed with a combination of FFS algae cake (grower feed, 40% protein) and trash shrimp at 5% of the body weight. During the fifth month, feed with a combination of FFS algae cake (finisher feed, 30% protein) and trash shrimp at the same feeding rate as above.

4. Harvest after five months when prawn attains marketable size which is approximately 40 grams.

Reproducible results were obtained following the above procedure. This lends viability to the new technology. Thus, a proposal has been prepared establishing a one-hectare module/demonstration farm for pilot testing. Should this be implemented, the pilot operations shall be closely monitored to determine the problems in the large-scale application of experimental results.

## Research Thrust

While there is enough baseline date for initial implementation, there are still many problems areas that must be worked out to achieve success. These gaps have been identified and given top priority in the research activities of the Station for 1979. Broadly, the areas of investigation involve the more applied aspects of nutrition and fish culture. The identified problems include the following:

- 1. Improved techniques of transport and handling of postlarvae
- 2. Modification of the acclimation technique
- 3. Finding more varied and economical sources of supplemental feeds
- 4. Determination of the optimum feeding rates as well as the protein requirement at different stages of development
- 5. Finding suitable management techniques for prawn cage farming, e.g., stocking density, substrate preference

# Summary and Conclusion

The new technology on prawn farming in fresh water was evolved through vigorous research at the Freshwater Fisheries Station, SEAFDEC. Pilot testing is proposed as a most important step towards demonstrating the viability of a developing industry. A continuous flow of research to tie the loose ends and strengthen application of the new technology is strongly recommended.

DISEASES OF PRAWNS
(Pests & Diseases of Sugpo)

Rogelio Q. Gacutan SEAFDEC Aquaculture Department

#### DISEASES OF PRAWNS

# Rogelio Q. Gacutan

# Fungal Diseases

phycomycetous fungi belonging to the genera <u>Lagenidium</u>, <u>Sirolpidium</u> and <u>Haliphthoros</u>. <u>Lagenidium callinectes</u> Couch is the most pathogenic and virulent of the three. In 1976, 35 of 51 hatchery production runs were affected by fungal infections, 22 of these were severely hit and therefore discarded. In 1978, due to safeguards instituted against infection, only 9 of 43 experimental runs were affected. Production increased from 2.6 M P<sub>5</sub>s in 1976 to more than 8 M in 1978.

# L. callinectes, its occurrence

Since its isolation from diseased crab eggs (Couch, 1942) it has been reported to affect (be transmitted, harbored by) a variety of marine animals including 4 species of penaeids, 5 species of crabs and a species each of lobster, barnacle and red alga. These are Penaeus aztecus Yves (Cook, 1971); P. setiferus (Lightner and Fontaine, 1973); dungeness crab Cancer magister Dana (Rogers-Talbert, 1948; Armstrong et al., 1976); blue crab Callinectes sapidus Rathbun (Couch, 1942; Sandoz et al., 1944; Bland and Amerson, 1973); American lobster Homarus americanus (Nilson et al., 1976); P. merguiensis de Man (AQUACOP, 1975); P. monodon Fabricius (SWUSVOP, 1977; Baticados, et al., 1978); barnacle Chelonibia patula Ranzani (Johnson and Bonner, 1960); oyster crab Pinnotheres ostreum (Rogers-Talbert, 1948); mud crab Neopanope texana (Rogers-Talbert, 1948) and the alga Ectocarpus (Fuller et al., 1964).

## Morphology, Zoosporogenesis and Pathogenecity

Despite wide variations in sizes of the vegetative and reproductive structures, the fungus may be recognized on the basis of the characteristic hyphal system, the discharge vesicles formed, and the manner of sporulation. Isolates from P. monodon zoea (Baticados et al., 1978) produced (a) a mycelial system wherein the hyphae measured 2.5-6.25 u wide (b) discharge vesicles ranging from 14.4 to 25 u in diameter, the latter containing from 14 to 32 spores, 3.75 to 6.25 u wide and 5-6.25 u long.

Larvae infected <u>callinectes</u> in <u>P. monodon</u> replaces the larval tissues with an expensive hyphal system and produces extramatrical germ tubes. These would develop terminal discharge vesicles from which zoospores develop. The zoospores are released into the water after the vesicle collapses.

The time factor is short and may end in less than 30 minutes. A discharge vesicle is formed when the cytoplasm of the hypha flows into the extramatrical tube. This occurs in 5 to 10 minutes. Spore formation then proceeds for 10 to 20 minutes after which the spores are seen continuously moving inside the vesicle. The spores then become active and are released 10 to 15 minutes later.

## Approaches to the control of the pathogen

Physiological experiments show that the <u>P. monodon</u> isolate has a wide range of tolerance for water temperature, pH, and salinity so that its life cycle may not easily be disrupted by these parameters. In fact, growth and sporulation are known to approach or coincide with the optima for larval rearing. Ultraviolet irradiation has been shown to be ineffective against isolates.

Being phycomycetous, the pathogen may either be air-, water- or soil-borne. One would therefore expect the zoospores or the hyphal system to gain entry via (a) water or (b) spawners, and, judging from long history of infections in some of the tanks used, to have been established deeply in the tank crevices. It was therefore necessary on account of a to have an efficient water filtration system and as a matter of protocol to subject the tanks to chemical treatment with a suitable disinfectant and to drying before and after an experimental run.

## The search for a suitable chemotherapeutic

That much effort is spent for screening for a suitable chemotherapeutic does not come as a surprise. Bland et al., (1976) did in vitro toxicity studies against 2 L. callinectes isolates from P. setiferus and C. sapidus using 12 compounds. He identified two -- malachite green and DS 9073 (Experimental bactericide/fungicide, ICI America, Inc. -- to be particularly effective. At the same time Armstrong et al., (1976) came up with two, namely, Trifluralin (L,L,L-trifluoro-2, 6-dinitro-N, N-dipropyl-p-toluidine) and Benomyl ("Benlate", methyl-1-(butylcarbamoyl)-2-benzimidazolecarbamate) which were effective against L. callinectes from C. magister. In SEAFDEC, Po et al., (1978) screened 34 antimycotic compounds against L. callinectes isolates from P. monodon and Scylla serrata. Based on the results, six loomed as potential chemotherapeutants. These are clotrimazole, crystal violet, econazole nitrate ("Pevaryl," 1/2-(2,4-dichlorophenyll-2(4-chlorobenzyloxyl)-ethyl/-inidazole nitrate), malachite green, trifluralin and Treflan R (23.1% Trifluralin).

## Animal toxicity tests

The ideal chemotherapeutic in aquaculture situations is one which should inhibit the growth of the fungus and causes no harm to the crustacean larva. Whether or not a chemical is suitable may be borne out by results of bioassay experiments.

Results of experiments by Bland et al., (1976) shows that malachite green at concentrations of 0.006-0.012 ppm added for 24 hr had very little effect on larval survival for either P. californiensis, P. stylirostro or P. vannamei. Toxic effects were in fact not evident until a treatment of more than 0.06 ppm was used. P. stylirostris zoea were most sensitive. Similar bio-assays by Po et al., (1978) on P. monodon reveal that treatment level of 0.006 may be applied only in mysis stages. The other compound Bland et al., (1976) found effective, DS 9073, was not subjected to a bioassay but believed to be potentially suitable as it rapidly incapacitate zoospores even at concentrations lower than the toxic level.

Armstrong et al., (1976) considered trifluralin to hold promise for fungal control on the basis of a low effective concentration of 0.0015 mg/L. Furthermore it was toxic to Cancer magistrate larvae at a concentration 100 times larger for a selectivity ratio of 117.1 over 96 hrs.\* Benomyl had an SR of 100 after 48 hrs and may be used over that time duration and not beyond.

Of the chemicals screened by Po et al., (1978) only malachite green and Treflan R were bioassayed. Results indicate the possibility for use of malachite green only in mysis. Treflan R (Gacutan, 1978; unpublished observations) concentrations higher than 0.1 mg/L were well-tolerated by M<sub>1</sub> for 96 hrs.

## Lessons from other hatcheries

Chemotherapeutics in larval rearing should be used in conjunction with physical methods of excluding the propagule or agent of infection from the water such as filtration and/or sterilization of all seawater used during the rearing. Bland et al., (1978) believed that these methods entail considerable expense. Moreover, Fischer et al., (1975) used a malachite green dip in combination with ultraviolet irradiation in successfully preventing Lagenidium infection in Homarus americanus larvae. In one of the more successful P. monodon larval rearing facility in the tropics, Tahiti, AQUACOP (1978) uses as a routine protocol chlorinated water and a preventive antibiotic at 2 ppm and the antifungal Treflan EC\*\*at 0.01 ppm, the latter dispensed from a dilute solution in a bottle continuously for 6 hours. It is claimed that this procedure assures an 80 percent survival to P4 from N1 at 28°C.

Arguments against addition of a phophylactic chemical

The exact or even appropriate time when infection starts is not commonly known. The experience in this laboratory indicates that histopathology in hosts and signs of the pathogen are apparent only when the disease is already widespread. This has also been observed in Tahiti (AQUACOP, 1977). Armstrong et al., (1976) observed that it was often

<sup>\*</sup>SR =  $EC_{50}$ larvae/Cone Toxic to fungus.

<sup>\*\*</sup>Effective component is Trifluralin.

too late to save the portion of the larvae due to the endobiotic nature of the fungus. Everything thus points to a preventive approach.

The Tahiti group (AQUACOP, 1977) observed that fungal spores are attracted to dead eggs or dead larvae where they (spores) settle, germinate and reproduce rapidly. It was observed earlier (Bland and Amerson, 1973) that zoospores swim readily toward Callinectes sapidus eggs when placed in a glass slide. The same mechanism is believed to occur in penaeids. In addition, researchers postulate a naturally-occurring source of zoospore like the gills of the spawner which release the zoospores precisely for a collision between the two bodies (Bland, 1978 as cited by Lightner, 1978 on a visit to SEAFDEC) leading to infection.

## The SEAFDEC Experience

The above postulates of Bland led us to try a different approach to <u>Lagenidium</u>. In numerous instances over the past 3 years, unhatched eggs were observed to have been infected when the larvae have already metamorphosed to the naupliar (N<sub>6</sub>) and zoeal stages (Z<sub>1</sub>). This convinced us to disinfect spawners with very high concentrations of Treflan R for an hour after an equal duration of thorough washing. None of the 28 experimental runs conducted showed signs of either <u>Lagenidium</u> or Sirolpidium infections (Gacutan, 1978). Of the 28, twelve (12) runs were successfully reared to the 5th day of the postlarval stages (P<sub>5</sub>) for a total production of more than 6.224 M P<sub>5</sub>'s.

## Future researches on Lagenidium, recommendations

Treflan R is better known as an herbicide. More of this kind of chemical must be tried. Another herbicide, 2,4-D (2,4-dichloro-phenoxy-acetic acid) was subjected to bioassays, and its effect on egg hatching and its ability to arrest epizootics caused by Lagenidium was assessed. It was well tolerated considering that the LD $_{50}$  at 96 hrs was 0.6 mg/L for M1. These values compare favorably to that for Treflan. Furthermore it was shown to be equally effective in arresting epizootics and minimally affected the hatching rate (Gacutan, unpublished data).

## Bacterial Diseases

Locally, studies on this group of pathogens had been relegated in priority on account of the search for temporary solutions to fungal diseases. Lately however two kinds of minor diseases were recognized from a few hatchery runs of  $\underline{P}$ . monodon.

#### Necrosis of appendages

The earliest symptoms ("browning" in the exoskeleton, pleopods, pereiopods, or telson/uropods were noticed as early as the  $\mathbf{Z}_1$ . The browning spread progressively towards the base of the extremities leading

to necrosis and finally to erosion of the affected areas. Deaths have been attributed to invasion by secondary/opportunistic organisms after considerable cuticular injury and breakdown, or to the inability of the larvae to molt, as the old carapace is still adpressed to the musculature. The disease is seldom lethal but it could be serious if it starts early in the larval stages.

The etiology of the disease in P. monodon has not yet been worked out. However, shell diseases of this nature as in other penaeids were shown to have been caused by three genera of bacteria namely, the Chitinoclastic, Beneckea, Vibrio and Psuedomonas (Cook and Lofton, 1973).

Locally, the disease plays a minor role in hatchery mortalities presumably due to the ability of the larvae to tolerate the lesions. In Tahiti (AQUACOP 1977) where the disease is reportedly rampant, control is brought about by the application of an antibiotic mixture consisting of streptomycin-bipenicillin (2 ppm of the active product (AP), 2 IU/ml), erythromycin phosphate (1 ppm AP), tetracycline chlorhydrate (1 ppm AP), sulfamethazine (3 ppm AP), and furanace (0.1 ppm AP). At present only erythromycin phosphate at 1 ppm is being used for prevention to preclude possible toxic effects of the other antibiotics. Right after application the larvae react to the treatment; their feeding activities are resumed. Recovery is quick, and no trace of the necrosis is left after metamorphosis.

Frequent renewal of the rearing water, chlorination, or ultraviolet treatment of the water were ineffective as control measures. Filamentous bacteria, Leucothrix mucoz.

This is an ectocommensal bacterium which affects penaeids particularly those held in crowded volumes of water rich in organic and inorganic substrates such as phosphates and nitrates (Fisher, 1976) and with optimum temperature. It has been shown to be widespread, epiphytic in many marine animals (Overstreet, 1973; Johnson et al., 1971; Nilson et al., 1975; Steenbergen and Schapiro, 1976; Fischer and Nelson, 1977).

In P. monodon, L. mucoz has so far exhibited a distinct seasonality, affecting cultures towards the months of October to December. Its primary effect upon the host lies obviously on asphyxiation when attached to the gills, or on impairment of the molting process as the setae may be entangled by the filaments. The animal can cast off the infestation by molting.

Morphologically, the filaments are unbranched, attached singly to the cuticle, have a basal diameter of 2 mu and consist of septage chains of almost square-shaped bacteria (Couch, 1978). The bacterium lacks a differentiated holdfast; it does not penetrate the epicuticle and is apparently secured by an electron opaque mucouslike substance presumably secreted by the bacterium.

The use of antibiotics to prevent and treat the disease is a very popular alternative. The Tahiti group (AQUACOP, 1977) routinely uses an antibiotic mixture to control the disease. Cultures are treated every 3 days as preventive measure and with twice the dosage for treatment. Leucothrix in rock crab eggs and larvae responded to 4 mg/L streptomycin (Johnson et al., 1971); those in H. americanus to 10 mg/L neomycin (Steenbergen and Schapiro, 1976); those in C. sapidus eggs to 1 mg/L streptomycin and 1 mg/L penicillin (Fisher, 1976); and C. sapidus larvae to 100 mg/L each of streptomycin and penicillin (Fisher and Nelson, 1977).

## Sudden mortalities; Vibrio/Aeromonas

Isolation studies from moribund shrimps in the SEAFDEC laboratory point to the prevalence of <u>Vibrio-caused</u> mortality. This genus and Aeromonas are widely known to cause many diseases in fishes.

The role that <u>Vibrio</u> plays in shrimp health is not clear. Vanderzant et al., 1970 for example isolated <u>V. parahaemolyticus</u> from white shrimp from the Gulf of Mexico. The pathogenicity of the organism on shrimp is not established although it is known to cause human gastroenteritis in Japan and, possibly, in the United States (Krantz et al., 1969).

Natural waters especially those located in inshore regions are veritable depositories of bacteria or "gram-negative bacterial soups" (Couch, 1978) and therefore <u>Vibrio</u> and <u>Aeromonas</u> are expected to abound. <u>Vibrio</u> parahaemolyticus isolated from water have very short generation times (12-14 min) at high temperatures (39°C). It is believed that warm environments such as ponds might enhance the pathogenecity of bacteria to shrimps (Ulitzur, 1974).

## Diseases Caused by Protozoans, Algae

Extensive daily monitoring of all hatchery runs of P. monodon larvae was carried out for 3 years. The most common protozoans encountered are the ciliates Zoothamnium, Vorticella and Espistylis. A gregarine, presumably Gregarina, and a green alga, Licmophora abbreviata Agardh are the other common pathogens. A suctorian, Ephelota gemmipara, a very powerful pathogen wrought havoc on cultures from March through June, 1976 and has not occurred thereafter.

Ciliates are observed to foul up the external surfaces of P. monodon by egg membranes or larval gills as was observed by Johnson (1974a) and Nilson et al., (1975) in C. magister and H. americanus. They are much more harmful to the larval stages as they can become entangled with the setae and may prevent ecdysis. In many instances the infestation were cast off by successful molt, but the hosts were reinfected, probably by contact with animals or exuviae.

These being not really lethal in local P. monodon hatchery operations, no control measures have so far been adapted. However, Johnson (1976) screened and found quinacrine hydrochloride (0.6 mg/L) to be most effective against Epistylis in juvenile P. setiferus. Three other chemicals -- chloramine T, quinine bisulfate, and quinine sulfate were also therapeutic.

More often than not, the type and extent of microbial fouling results from prior water quality (high nutrient load, high siltation, turbidity, low  $O_2$  tension) rather than from activity of a specific microbial pathogen. Fisher (1977) went to the extent of suggesting the use of activated charcoal if only to reduce the nutrient load so as to limit microbial growth and avoid heavy epibiotic fouling.

#### Recapitulation

There are a few aspects that need to be dealth with especially now that there is a headway in the control of <u>Lagenidium callinectes</u>. Firstly, nothing much is known of diseases and causes of mortality the moment the P5's are stocked into ponds. Secondly, the spawners should be viewed as a potential source of infection. These two areas of researches have to be explored further.

#### Literature Cited

- AQUACOP. 1975. First observation on the diseases of penaeidae raised in a tropical environment. Unpubl. report. CNEXO, Tahiti, 4 pp.
- AQUACOP. 1977. Proc. World Mar. Soc. 8:685-697.
- Armstrong, D.A., Bucahanan, D. V. and Caldwell, R.S. 1976. J. Invertebr. Pathol., 28:329-336.
- Baticados, M. C., Gacutan, R. Q., Po, G. L. and Lavilla, C. R. 1979. Fish. Res. J. Phil. 3 (In press).
- Bland, C. E. and Amerson, H. V. 1973. Mycologia 65:310-320.
- Cook, H. L. 1971. FAO Aquacult. Bull., 3:13.
- Cook, E. W. and Lofton, S. R. 1973. J. Wildl. Dis. 9:154-159.
- Couch, J. N. 1942. J. Elisha Mitchell Sci. Soc., 58:158-164.
- Couch, J. N. 1978. Fish. Bull. 76:1-44.
- Fisher, W. S. 1976. J. Fish. Res. Board Can., 33:2849-2853.
- Fisher, W. S. 1978. Proc. World Mar. Soc. 8:
- Fisher, W. S. and Nelson, R. T. 1977. J. Fish. Res. Board Can., 34:432-436.
- Fuller, M. S., Fowles, B. E. and Mclanghlin, D. J. 1964. Mycologia, 56:745-756.
- Johnson, P. W., Sieburth, J. McN., Sastry, A., Arnold, C. R. and Doty, M. S. 1971. Limnol. Oceanogr. 16:962-969.
- Johnson, S. K. 1974. Ectocommensals and parasites of shrimp from Texas rearing ponds. Texas A & M Spl. Publ., TAMU-SG-74-207, 20 pp.
- Krantz, G. E., Colwell, R. R. and Lovelace, E. 1969. Science 164: 1286-1287.
- Lightner, D. V. and Fontaine, C. T. 1973. J. Invertebr. Pathol. 22:94-99.
- Nilson, E. H., Fisher, W. S. and Shlesser, R. A. 1975. Proc. World Mar. Soc., 6:367-375.

- Nilson, E. H., Fisher, W. S. and Shlesser, R. A. 1976. J. Invertebr. Pathol. 27:177-183.
- Po, G. L., Lavilla, C. R. and Llobrera, A. T. 1978. Kalikasan, Philipp. J. Biol. 7 (in press).
- Po, G. L., Sanvictores, E., Baticados, C. and Lavilla, C. R. 1978. SEAFDEC Report. 19 pp.

Overstreet, R. M. 1973. Aquaculture 2:10-5-140.

Rogers-Talbert, R. 1948. Biol. Bull. 95:214-228.

Steenbergen, J. F. and Shapiro, H.C. 1976. Am. Zool. 15:816.

Ulitzur, S. 1974. Microb. Ecol. 1:127-135.

## POST HARVEST HANDLING OF SUGPO

Katherine M. Apolinario National Institute of Science & Technology

#### POST HARVEST HANDLING OF SUGPO

## Katherine M. Apolinario

A remarkable development in fish production and processing has been achieved within the last decade in this country. This is due primarily to the tremendous growth of export in marine products. Prawn has the highest market value among the fishery products.

Buyers collect prawn by going around small sea farms. They bring the produce to a town where they are iced before being transported in a cargo truck to a processing plant or market. The original freshness of the prawn is lost due to the series of handling without the benefit of ice. In places where there are ice plants near the source, the quality of the product is maintained better. A few prawn producers/traders airlift their product to Manila; the freshness of the prawn is retained to fetch a higher price.

There are few available published studies in the handling, transport and freezing of prawn in our country. In advanced countries, a well developed system is being implemented by fish producers. The application of their technology however is not economical under our existing conditons.

The Food Processing Department (FPD) of the Food Terminal, Inc. (FTI) has standardized the handling, transport, freezing and storage procedures for Penaeus monodon.

Sugpo investigated was obtained from Guiñangan, Quezon. Prechilling of prawns to 4°C prior to packing for transport preserves the quality of the prawns.

Polybox (polystyrene) with wooden frame was found to be the best constainer among four containers examined (wooden box, big kaing, small kaing and polybox) for hauling prawns from farm to market. Its high cost over other types of containers is offset by the better quality, less rejects and less loss in weight on arrival of the products at the FTI.

Blast freezing at minus 40°C reduces bacterial load to a count within the FDA limit for frozen products. Further storage at minus 23°C reduces aerobic or coliform organisms. E. coli is reduced but not totally eliminated in one year storage, Salmonella was not present in prawn that were investigated.

Sizing and quality standard should be applied in the trade to get a maximum return from the harvest.

BFAR conducted studies on the effect of bisulfite in icing and freezing of shrimps. Results have shown that sodium bisulfite (food grade) is effective in delaying the onset of blackening in shrimps. Dipping for 20 minutes in calamansi mixture (1 part calamansi to 20 parts water) is recommended for preventing black spot formation.

## Complete Researches on Prawn Processing

- Standardization of Handling, Transport and Freezing of Sugpo (Penaeus monodon) (FTI)
- 2. Preparation of Kroepeck from shrimp (CLSU, UPCF, BFAR)
- 3. The effect of edible coating CMC (Carboxyl methyl cellulose) on the dehydration quality of shrimp (preliminary studies) (UPCF)
- 4. Canning of shrimps (Penaeus indicus) in shrimp head extract (UPHE)
- 5. Canning of shrimps (Penaeus merguiensis) in buffered brine (UPHE)

## On-going Researches

- 1. Standardization of canning procedures for shrimp products (NIST)
- 2. Studies on the effect of bisulfites in icing and freezing of shrimps (Penaeus merguiensis) (BFAR)

#### References

- Dolendo, A., E. Tongco, R. Roncal and Ma. Alameda, 1978. Standardization of handling, transport and freezing of sugpo (Penaeus monodon). Published by NSDB, Mla.
- 2. Guevara, G., F. Abella, & S. Canonizado. 1978. Studies on the effect of the use of bisulfites in icing and freezing of shrimps (Penaeus merguiensis). Unpublished.
- 3. Legaspi, A. 1979. Personal communication.

PRESENT STATUS OF PRAWN FARMING IN THE PHILIPPINES

Rolando R. Platon
SEAFDEC Aquaculture Department

## PRESENT STATUS OF PRAWN FARMING IN THE PHILIPPINES

#### Rolando R. Platon

Prawn culture in the Philippines is still mainly traditional. Except for the few who can secure hatchery-produced fry, almost all fishpond operators involved in prawn culture still depend on the wild catch to stock their ponds. Rearing techniques in ponds are generally based on culture methods used for milkfish.

This paper summarizes the usual practices and recent developments in prawn culture in the Philippines.

## Seed Production and Larval Rearing

#### a. Broodstock Development

The successful spawning of cultured P. monodon after eyestalk ablation, stocked in pens under fully marine conditions for gonadal maturation, (Santiago, 1977) has been a significant development in the effort to overcome inadequate and unreliable supply of spawners. Before this, spawner supply mainly depended on the catch from the wild.

Gonadal development in P. monodon since then, has been further studied in more closely controlled environment. With a flow-through system in land-based ferro-cement tanks (Tolosa, 1978) using full-strength marine water, Primavera (1978) observed a minimum of one week and an average of three weeks from ablation to full gonadal maturation on P. monodon. A minimum period of 3 to 5 days for a subsequent spawning after the preceding one was also observed.

The percentage of the original stock which rematures decreases with subsequent rematurations.

The broodstock may be from ponds or from the wild. Desirable weights are 90 g for females and 50 g for males. Those obtained from ponds should be at least one year old (Primavera, 1978).

Since harvest of marketable sized prawns from ponds is 4-6 months from stocking, it would be necessary to provide for a broodstock pond where the marketable sized prawns may be stocked until these would be at least one year old and ready for ablation.

From the source, the prawns may be transported in continuously aerated plastic or canvas tanks. Acclimation should be done over a period of 1-3 days depending on the difference in water conditions of the source and that in the tank or in the pen.

Ablation should be done only when the prawns are hard-shelled. Only the females are ablated and it may either be the left or the right eye. At present, feeds for the broodstock mainly consist of mussel meat but studies are being done on the nutritional requirement and development of artificial diets (Primavera & Lim, 1978).

Fecundity of ablated P. monodon is less than that of the wild. Eggs from one ablated spawner number between 20,000 to 500,000 while eggs from one wild spawner ranged from 50,000 to 1,000,000.

There is no significant difference in the hatching rates of eggs from wild or ablated spawners. Hatching rates range from 0 to 98 percent with 40-50 percent as the average.

## b. Small-scale Prawn Hatchery

Prawn hatchery systems developed earlier in other countries like Japan (Shigueno, 1972) and the United States (Cook & Murphy, 1966, Mock & Neal, 1974), have to be modified to suit our local environmental and economic conditions.

There are two general types of hatchery systems (Mock & Neal, 1974) used for the larval rearing of prawns. These are the fertilized and the unfertilized systems.

The fertilized system involves the production of natural feeds in the same tank used for larval rearing. The plankton bloom in the rearing tank is induced by adding fertilizers. The type of plankton bloom is influenced by the biological population in the seawater pumped into the rearing tanks, thus this system is highly site-specific. Larval rearing tanks range in size from 10 to 200 tons. The dependability and larval survival for this system are generally low. The stocking density is normally low at 30-50 larvae per liter with survival rates averaging about 20 percent from nauplius to postlarvae.

The unfertilized system is more sophisticated and involves the mass production of uni-algal cultures which have been found as effective feeds for the larvae, e.g., Skeletonema, Isochrysis, Chaetoceros, Tetraselmis, etc.

The unfertilized system has a higher efficiency but requires a higher initial investment cost and a higher production level for an economically viable operation. The efficiency of the fertilized system is lower but requires a lower investment cost and a lower production level for an economically viable operation.

For a small scale hatchery using the fertilized system, as the hatchery capacity increases and goes beyond a certain production level it would be cheaper to shift to the unfertilized system.

The Barangay sugpo hatchery project of the SEAFDEC Aquaculture Department, organized in January 1977, has the function of developing a small-scale compact hatchery system for P. monodon to serve as a model for fish farmers in adopting the prawn hatchery technology within their economic and technical capabilities. It would also serve as a training facility for interested parties.

The guidelines on the design and operations of a small-scale hatchery system was already prepared and published as an Aquaculture Extension Manual of the Department. It is basically patterned after the unfertilized system but not as sophisticated. At the moment when there is still no comprehensive survey to pinpoint which areas in the country are suitable for the fertilized system and which areas are for unfertilized system, a model of a hatchery system based on the unfertilized system is deemed appropriate. The unfertilized system, being not dependent on the biological population of the seawater in a specific location, can be adopted in a wide range of environmental conditions. Algal stock cultures need not be maintained by small-scale operators as these can be obtained from the SEAFDEC Aquaculture Department's Phycology Laboratory at Tigbauan. After a period of hatchery operations when it will have been observed that a specific site is appropriate for the fertilized system, the Barangay hatchery system can be modified and may be operated as a fertilized system.

Barangay hatchery runs in Tigbauan using 2-ton conical-bottom tanks gave an average larval survival rate of about 30 percent from nauplii to P<sub>5</sub> with a normal initial stocking of 100,000 nauplii. The highest production of 70,000 P<sub>5</sub> in one tank with a survival rate of about 60 percent was obtained.

At the SEAFDEC substation in Batan, Aklan, hatchery runs gave a highest survival rate of more than 90 percent from nauplius to P<sub>5</sub> with an average of about 50 percent.

Barangay hatchery operations, developed mainly for P. monodon, were also found effective for the larval rearing of other penaeid species like P. japonicus, P. indicus, P. merguiensis and M. ensis.

#### c. Natural Feed Production

Algal Culture

The bulk of the problem in hatchery operation is the production of natural feeds.

In the fertilized system, the larval feeds consist of a highly diverse plankton population in the rearing tank, predominantly diatoms such as Skeletonema, Chaetoceros, Nitzchia, Rhizosolenia, Thalasiosira, etc. The natural bloom in the rearing tank is induced by adding mainly potassium nitrate (1-2 ppm) and potassium phosphate (0.1-0.2 ppm).

In the unfertilized system, mass production of uni-algal cultures is conducted. The SEAFDEC Phycology Laboratory has already standardized the culture techniques for the mass propagation of Chaetoceros, Skeletonema, Tetraselmis and Isochrysis. Mass propagation involves a series of culture volumes from a one-liter dextrose bottle to 3-liter jar, 200-liter tank, 1-ton tank and finally to 40-ton rectangular concrete tank. While the 1-liter, 3-liter and 200-liter cultures are continuously lighted by flourescent lamps the 1-ton and 40-ton cultures are located outdoors and depend on the sun as the light source.

For small-scale systems the maximum culture volume may only be up to 1 ton. The algal culture is concentrated and washed by the use of a fine sand filter before feeding into the rearing tank.

Even with uni-algal cultures, synchronizing natural feed production with larval rearing operation is sometimes met with difficulties, e.g. the expected bloom does not occur due to contamination.

The feeds for the zoea stage mainly consist of algae. At the mysis stage, the larvae feed on rotifers (Brachionus) or brine shrimp in addition to the algae. In the postlarval stage, the diet mainly consists of brine shrimp or blended mussel meat or shrimp meat.

#### Brachionus Culture

The culture technique for the mass production of <u>Brachionus</u> fed with <u>Chlorella</u> or <u>Tetraselmis</u> has already been standardized and is one important component of the hatchery operation. <u>Brachionus</u> culture is harvested by draining onto a fine (mesh no. 200) nylon net.

#### Brine Shrimp Culture

The nauplius of <u>Artemia</u> is the primary food of the mysis and the postlarvae in penaeid hatcheries and also of aquarium fishes. Brine shrimp is normally available in the form of cysts or eggs contained in cans which could remain viable for years. These cysts are collected in large quantities from their hypersaline environment, e.g. Salt Lake in Utah, or San Francisco Bay. When placed in ordinary seawater, the cysts hatch in about one day.

The biology of brine shrimp has been significantly studied (Sorgeloos, 1973; Nimura, 1967). At this stage basic research data are being applied into aquaculture systems for the mass production of this species.

The life cycle of <u>Artemia</u> is about 2-3 weeks in ordinary seawater (32-36 ppt), at a temperature range of 27°-32°C. Subjecting them to salinity stress by increasing from 32 to about 60 ppt, gravid females give off their eggs (Villacarlos, 1975).

Experiments on feeding for brine shrimp at SEAFDEC showed that Chlorella (Villacarlos and Villegas, 1976) and fine rice bran (less than 60 microns in diameter) (Bernardino & Laviña, 1978) are each effective feeds for mass rearing in tanks.

The first successful mass rearing of brine shrimp in the Philippines; using earthen ponds (de los Santos, 1978, personal communication), is now capable of producing 500-1000 grams of cysts per hectare per day.

Screening of Artemia strains for local culture is going on at SEAFDEC.

#### d. Artificial Feed Formulation

The use of artificial diets in the larval rearing of prawns in the Philippines is not as common as it is in Japan, the United States, Taiwan and Panama. Most of these feeds are manufactured by companies which also own the hatcheries; these feeds are for their own use. These artificial feeds, after having been finely ground and passed through Mesh No. 60, may be given starting at the mysis stage.

For the postlarval stages of P. monodon, Lim (1978) developed different artificial diets containing different protein sources such as casein, shrimp meal, squid meal and Spirulina. Results showed that squid meal and shrimp meal are good protein sources for P. monodon postlarvae.

Much has to be done regarding nutritional requirements of the different larval and postlarval stages of the prawn and the eventual development of artificial diets.

Development of micro-capsulated artificial diets for the larval stages is being done in Japan and Europe. Efforts on these are mostly experimental at the experimental stage.

#### e. Diseases

Diseases in prawn hatcheries are mainly caused by infections from fungus, bacterial and protozoans. <u>lagenidium</u> or <u>Sirolpidium</u> can cause mass mortality at all larval and postlarval stages. Some bacterial infections have been observed to be associated with the collapse of diatoms in the larval rearing tank (Villaluz, et al., 1976) causing reddening and discoloration of body tissues of mysis and postlarvae.

The most effective method of controlling these diseases is to eliminate the possible sources of infection. Chlorination of water after fertilization and neutralization 12 hours later with sodium thiosulfate is helpful (Cook, 1976).

Disinfection of spawners before these are placed in spawning tanks using formalin (50 ppm) or furanace (3 ppm) is a standard practice in Barangay hatchery operations. The spawning debris should be removed and the eggs may be treated with malachite green (5 ppm). In transferring nauplii from the hatching tank to the larval rearing tank, unhatched eggs should be settled first and scooping of the nauplii should be done with care not to scour the sediments. Gacutan (1978) also pointed out Treflan (0.1 ppm) and 2, 4-D (0.01 ppm) to be suitable for disinfection of spawners.

#### f. Rearing in Nursery Ponds

Harvest in the hatchery is done at  $P_5$ . From the hatchery the postlarvae are transported to the nursery ponds using continuously aerated transport tanks (for hundreds of thousand  $P_5$ ) or in oxygenated plastic bags contained in styrofoam boxes (for 10,000 to 20,000  $P_5$  per bag). Transport should be done in the early morning or late afternoon or on such time that after acclimation at the pond site, stocking could be done when the sun is not so bright (earlier than 0900 hrs or later than 1700 hrs).

The period of acclimation varies depending on the difference in water conditions in the pond and in the container. Normally, three hours is sufficient.

Pond culture of prawns in the Philippines is basically an adaptation of the culture system for milkfish. Since prawn and milkfish have entirely different biological requirements, an attempt to intensify prawn culture would require modifications of existing milkfish culture systems or development of systems more appropriate for prawns.

Apud (1977) has developed an effective nursery pond system for prawns. The important features of the system are:

- a daily replenishment of about 10 percent of the pond water volume
- 2. water depth of 50-75 cm
- 3. sand filtration of water flowing through the nursery pond
- 4. introduction of water to the ponds by sprinkling through perforated pipes, increasing dissolved oxygen in the water
- 5. diamond-shape ponds with the two acute corners positioned along the prevailing wind directions
- 6. a horizontal gravel and sand filter box through which water from the pond is drained and is located on one of the two acute corners
  - 7. diagonal trench canal extending along the two acute corners

Pond areas ranging from 500 to 1,500 sq m per compartment are practical and easily manageable.

The nursery pond is prepared and fertilized in a similar manner as for milkfish although the benefits of fertilization for prawn culture are indirect (Cook, 1976). Fertilizers induce phytoplankton bloom upon which various microorganisms feed; prawns feed on the microorganisms.

Without supplementary feeding, nursery ponds may be stocked at densities ranging from 50 to 100 P<sub>5</sub> per sq m. With supplementary feeding (trash fish, mussel meat, or formulated feeds) stocking densities may be as high as 150 P<sub>5</sub> per sq m.

Optimum water salinity is 20-25 ppt. Survival rates from P5 to P35 range from 40 to 80 percent with an average of about 60 percent.

The use of raceways as nurseries is practical in areas where electric power needed to drive a blower or compressor is dependable. Feeding for this system is mainly introduced.

When juveniles or P35, about 1-2 gm sizes are harvested, the filter tray at the draining end of the pond is removed. The box which holds the filter tray in place also serves as a collecting pool. A bagnet fitted to the monk gate at the discharge end collects juveniles that have escaped from the collecting box. Juveniles inside the box are scooped and transferred into pails or tank containing enough water. Those left in the pond bottom or in the diagonal trench canal are flushed into the collecting box.

#### g. Transport of juveniles

Juveniles may be transported by either using a continuously aerated transport tank (cylindrical and lying on its side with an opening at the top) or oxygenated plastic bags.

A continuously aerated tank was used in transporting P25 from SEAFDEC's Leganes ponds to its Freshwater Fisheries Station in Binangonan, Rizal. For a stocking denisty of 500,000 per ton of water, the mortality rate was about 20 percent. The tank was transported by ship and the total time of transport and handling from Leganes to Binangonan was about 30 hours.

When transporting with the use of oxygenated plastic bags, the juveniles are transferred into a tank containing water which should at least be sand-filtered. The water temperature is then reduced gradually to about 20°C using frozen sea water. The juveniles are then packed in plastic bags containing 8-10 liters of water and inflated with about 16 liters of oxygen. The bags are placed singly or doubly in styrofoam boxes, each box provided with an ice pack firmly placed on top of the plastic bag.

Yap, et al., (1978) established the range of transport mortality rates for juveniles (P22) transported in oxygenated plastic bags, at different packing densities for a period of 12 hours of transport and handling. Five density levels were 1,000, 2,000, 3,000, 4,000 and 5,000 juveniles per bag. A pack of 300 g of ice was used in each box. It was found that prawns of 40 mg size can be packed as high as 3,000 per bag. Packing densities above 3,000 per bag containing 8 liters of sea water and 16 liters of oxygen can be used only for short transport periods.

## Culture in Grow-out Ponds

#### a. Layout and Construction

Pond culture of prawns is still in great need of basic standards of pond layout and construction. There have been significant results from basic researches during the last decade which can be made as the basis for the development of an aquaculture system for prawns.

## Pond Layout

In extensive systems where prawns mainly subsist on natural feeds propagated by fertilization of ponds, Santiago, et al, (1974) observed that growth rate of P. monodon decreased after about two months of culture in ponds. This observation is confirmed by some fishfarmers who have tried mono-culture of prawns.

It would probably be desirable to develop a progressive method of culture wherein the stock may be transferred from one pond to another depending on the size of the stock. The lay-out of ponds can thus be arranged to enable a series of transfer from nursery pond (NP), to the transition pond (TP) and finally to the rearing pond (RP). The ponds should be adjacent to enable the prawns to move with the water during transfer.

For intensive systems, it would be sufficient to have nursery ponds (NP) and rearing ponds (RP). Since feeding would mainly consist of feed introduced into the pond, a flow-through system would be advisable to maintain water quality in the ponds.

#### Dike Construction

Before the construction of dikes, design criteria (Denila, 1976) should include:

- 1. tidal fluctuations
- observations of flood waters
- 3. weather conditions
- 4. availability of local labor
- 5. type of soil
- 6. water source

The decision on whether to use tidal fluctuation or pumping to supply water into the ponds is greatly influenced by the economics of construction and the dependability of electric power. The desirable effective depth of water in the pond is 1 m.

## Water Distribution System

It is desirable to have separate intake and discharge canals. This would minimize the spread of disease from one pond to another. This would also enable better exchange of water unlike in a one-canal system where water at the far end is not likely to be flushed out unless the pond is completely drained. With this system, a flow-through condition may be employed which is essential for intensive culture.

## Water Control Gates

Design of gates should consider the following:

- 1. water requirement in the ponds per unit of time and the amount to be drained per unit of time
- 2. a provision for water to be taken in and discharged from the bottom
- 3. the bottom should allow complete drainage of water from the pond
- 4. provision for screens to serve both as a predator control and to prevent escape of prawns from the pond
- 5. provision for installing a net for harvesting
- 6. when using boards, these should be interchangeable
- b. Liming and fertilization

Pond soil should have a pH of at least 6.5 Acidic soils normally result to lower growth rate. Liming may be used to reduce or eliminate soil acidity. The amount of lime to be applied into an acidic pond depends on the pH. For pond conditioning in acidic ponds, Primavera and Apud (1977) recommend a lime dosage of 1,000-2,000 kg/ha.

Since the composition of soil and sea water varies with location, the desired fertilizer dosage for different ponds would also vary. It is suggested that every pond operator develop a fertilization method appropriate for his own ponds. Soil and water analysis should be made to determine the amount of nitrogen and phosphorus that should be added. With a certain starting dose, the rate of application may be increased or decreased while the corresponding type of phytoplankton blocm is observed. The optimum level of fertilization could be established after a number of trials.

Diatoms in prawn ponds is more desirable than other types of algae (Cook, 1976). A bloom of diatoms in ponds is characterized by a yellowish brown color while other types give a bright green color. The nitrogen to phosphorus ratio of 30:1 has been found most suitable for diatoms.

It has been a common practise among fishfarmers to use both organic and inorganic fertilizers.

#### c. Pests and Predator Control

Fish, crabs and birds are the main predators in prawn ponds.

The entry into the pond of unwanted fish may be prevented by the use of screens installed in the gates. However, those which are able to gain entry may be eliminated with the use of Saponin applied at the rates of 10-25 ppm (Cook, 1976). This effects the fish but not the prawn. Rotenone is also effective in eliminating fish predators but care must be taken when using it because the difference in lethal limit for fish and prawns is small. Thorough drying of ponds during pond preparation is effective in eliminating unwanted fish.

Crabs are one of the causes of leakage in dikes. Traps may be used to catch them.

Birds can eat a significant portion of the cultured prawns. They may be driven away by bird-scaring devices (Cook, 1976). Stumps extending beyond the water level in ponds may encourage flocking of birds as these stumps provide resting places. These stumps should be removed.

Snails compete for the natural food. These may be eliminated by applying commercial nicotine at 12-15 kg/ha or tobacco waste at 200-400 kg (Primavera and Apud, 1977) during pond preparation.

#### d. Natural Food in Ponds

The natural feeds growing in ponds consist of lablab, lumut, phytoplankton and benthic animals.

Lablab is mainly composed of benthic blue-green algae and diatoms. Many other forms of plants and animals are associated with it. Lablab grows well at a salinity level of about 20 ppt.

Lumut is composed of filamentous green-algae. Other organisms associated with it contribute to its nutritive value.

Phytoplanktons are microscopic plants which float in the water. Other organisms eat phytoplanktons; prawns feed on these other organisms.

Benthic organisms are those which remain at the bottom of the ponds and feed on detritus or settled decomposing substances.

#### e. Nutrition and Feed Formulation

In extensive traditional ponds, feeding is mainly supplementary to the natural productivity of ponds. The common feeds that are given are rice bran, mussel meat, trash fish, corn or carabao skin, toads and snails.

Apud (1978) conducted a study on the monoculture of P. monodon using a flow-through water management scheme with supplementary feeding at various stocking densities in ponds. Over a period of 3.5 months, with stocking densities of 2.5, 5.0, 10 and 20 juveniles (0.45 g) per sq m, the average weight at harvest was least (7.24 gm) at 20 per sq m density. It consistently increased with decrease in stocking density. Total production per hectare increased consistently with increase in stocking density; 583.84 and 1264.43 kg at 2.5 and 20 per sq m density, respectively.

Mangalik and Lim (1978) studied the effect of various lipid sources on the growth and survival rates of P. monodon juveniles in a controlled environment. Results of the study indicated that beef tallow is a good lipid source for P. monodon when based on growth rates. However, based on feed conversion values and survival rates, fish oil is better utilized by shrimp than beef tallow. Pork lard, coconut oil and corn oil are not good lipid sources for P. monodon.

## f. Monoculture/Polyculture

In the Philippines, the bulk of pond-harvested prawns is cultured with milkfish. Only a few are involved in monoculture of prawns. Among fishpond operators in Iloilo Province who were involved in SEAFDEC's Cooperators' Program, 77 percent had dual culture of sugpo and milkfish while only 23 percent had monoculture (SEAFDEC, 1977). The percentage of those involved in monoculture for Iloilo is most likely to be the highest among all regions in the country due to the presence of the SEAFDEC hatchery in Iloilo which could provide large quantities of fry at a given time.

By comparing the economics of the two culture systems, the returns from monoculture is significantly higher than that from polyculture with milkfish. (Apud, personal communication, 1978).

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Economics of Mono- and Poly-Culture

	Monoculture	Polyculture with Milkfish
Stock requirement/ha/yr (2 operations/yr)		
a) P. monodon juveniles (40,000 and 10,000 at \$\mathbb{P}0.35)	14,000.00	3,500.00
b) Milkfish fingerlings (6,000 at \$\mathbb{P}0.30)		1,800.00
Total Production Cost*	36,000.00	16,500.00
Gross Income:		
a) 40,000 x 60% x \$\frac{40.00}{20}\$ pcs/kg x \$\frac{40.00}{kg}\$	48,000.00	
b) 10,000 x 60% x 1/40.00/kg		12,000.00
$\frac{6,000 \times 90\%}{3 \text{ pcs/kg}} \times \cancel{F}5.00/\text{kg}$		9,000.00
Net Income	12,000.00	4,500.00

<sup>\*</sup>Does not include land acquisition cost

The development of an intensive monoculture system depends on the dependable supply of fry from hatcheries and the development of suitable formulated diets.

## g. Stocking rates

For polyculture systems with milkfish, stocking per hectare of 5,000-10,000 for prawns and 500-1,000 for milkfish is recommended by Primavera and Apud (1977). At higher stocking densities of prawn, supplementary feeds are introduced.

For monoculture systems, stocking densities for prawn range from 5,000 to 30,000 per hectare for extensive systems and 100,000 to 200,000 for intensive systems.

#### h. Parasites and diseases

Since the prevailing method of prawn culture at the moment is still the extensive one, few cases of disease from ponds have been reported. Among those observed is "black gill" disease. This can be caused by fungus, bacteria or detritus.

Another condition observed is the papery exoskeletons and soft flesh of prawns. This may be caused by poor nutrition and poor pond conditions.

Some shrimp diseases observed in other countries are muscle necrosis (Rigdon and Baxter, 1970), cotton shrimp (Sinderman, 1974), Virio (Shigueno, 1974), white shell disease and viral disease.

In the control of diseases, it would be worthwhile to consider the environmental conditions and nutrition of the infected stock. Mere addition of chemicals is not sufficient.

#### i. Harvesting

After a rearing period of 4 to 6 months in ponds with 10-25 ppt salinity, the size of the stock may range from 30 to 60 grams each (Primavera and Apud, 1977). Growth is slower at higher salinities.

Harvesting may be done partially or totally. Partial harvesting may be done with nets, or traps. If nets are used, it would be effective to attract the prawns and getting them to concentrate in a certain area by introducing food or, if harvest is done at night, by the use of lights.

Total harvest may be done with the use of bagnet in sluice gate, partial draining of water or with a trap in the outlet canal.

With the bagnet in the sluice gate, harvest is done by draining the pond and catching the prawns as they move with the outflowing water.

By partially draining the water the prawns move to the deeper canals. These are then caught by dragging a net along the canal or with the use of scoop nets.

Traps may be installed in the water outlet canal. As the pond is drained, the prawns moving with the outflowing water are caught in the traps.

## Sugpo culture in cages in freshwater

Successful grow-out culture of P. monodon in freshwater using cages was achieved at the SEAFDEC Freshwater Fisheries Station in Laguna de Bay.

Juveniles (1 gram size) from the SEAFDEC ponds in Leganes which were earlier stocked as postlarvae from the Tigbauan hatchery were transported to the Freshwater Fisheries Station in Laguna de Bay. After acclimation for a period of about three days these were stocked in cages and placed in the lake. Supplementary formulated feed was given.

## Post-harvest handling, processing and marketing

After harvest, dirt and debris are removed. The prawns are placed in baskets or any suitable container with crushed ice poured on top of the prawns. A container of 15-20 kilos capacity is convenient for handling and transporting (Tan, n.d.). Handling should be done carefully as bruised prawns deteriorate fast. For local markets, the prawns may be brought to the market in this condition. It is important that before the product finally reaches the consumers, it should be kept at a low temperature.

If the prawns are to be exported, further processing is necessary. From the ponds, the iced prawns are brought to the processing plant. The heads are then removed to help cut down on transport cost and minimize deterioration in transit. The head contains about 75% of bacteria on prawns (Legaspi, 1975). The prawns are then washed with cold water and sorted as to size. Prawns of same sizes are placed in 2 kg capacity trays (Tan, n.d.). These trays holding the headless prawns are subjected to quick freezing at -30 to 40°C for one hour.

The trays are then removed and chilled water is poured over the prawns to a level that all are immpersed. The trays are again quick-frozen for another hour. The headless prawns are finally encased in small blocks of ice which are removed from trays by immersing in ordinary tap water. The blocks are then placed individually inside plastic bags and packed in bigger boxes (cartons), each box containing 10 blocks.

The boxes are sealed and stored at -15 to 20°C. These are shipped with the use of a refrigerating unit.

## Economics of prawn culture

## Assumptions:

- a. 30% of ablated females will spawn
- b. each spawner has 200,000 eggs
- c. hatching rate of eggs is 50%
- d. survival rate in the hatchery is 30%
- e. each hatchery tank is stocked with 100,000 nauplii
- f. stocking density in nursery ponds is 100 postlarvae per sq m
- g. survival rate in nursery ponds is 50%
- h. stocking density in grow-out ponds is 10 juveniles per sq m
- i. survival rate in grow-out ponds is 70%
- j. at the time of harvest, size of stock is 50 grams each or 20 pieces in 1 kg
- k. the price of prawn is \$\mathbb{P}40.00 per kg

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Economics of an Integrated Prawn Project

		Area	Initial No. of runs	Operating	Seed/Stock		Income	
		Requirement	Investment	or crops/yr	Expenses	Requirement	Production	P.A.
Broodstock	2	4-m dia. tanks (50 aq m)	<b>≱</b> 280,000	9	₹ 90,000	800 broodstock/ year 400 males; 400 females	120 spawners/y	
Hatchery	10	2-ton tanks (250 sq m)		12		120 spawners/yr 24 M eggs/yr 12 M naup/yr 1 M naup/run	3.6 P5/yr 300,000 P5/ru	ın
Nursery	20	600 sq m ponds	336,000	6	60,000	3.6 M P5/yr	1.8 M P35/yr	
Grow-out (Lemo.)	30	5,000 sq m ponds	1,500,000	2	400,000	1.8 M P <sub>35</sub> /yr	1.26 M pcs/yr 63,000 kg/yr	\$2.52 M at \$40/k
		<del></del>	¥2,116,000		<b>≱</b> 550,000			

#### References

- Apud, F. and Shiek, M. 1977. Nursery Ponds for P. monodon. Training on Pond Culture, SEAFDEC Aquaculture Department.
- Apud, F. et al., 1978. Monoculture of P. monodon using flow-through water. Management scheme with supplementary feeding under varying stocking densities in earthen ponds. Annual Report, SEAFDEC Aquaculture Department.
- Bernardino, A. and Laviña, E. 1978. Mass rearing of Artemia from nauplii to adult. Annual Report, SEAFDEC Aquaculture Department.
- Cook, H. L. 1976. Problems in Shrimp Culture in the South China Sea Region. South China Sea Fisheries Development and Coordinating Programme, Manila.
- Cook, H. L. and Murphy, M.A. 1966. Rearing penaeid shrimp from egg to postlarvae. Proc. S East Ass. Game Fish Commns. 19:283-8.
- Gacutan, R. 1978. Effect of triflurclin (Treflan), malachite green and 6-hydroxy-methyl-2-2 (5-nitro-2-furyl) vinyl pyridine as disinfectants of spawners. Annual Report, SEAFDEC Aquaculture Department.
- Legaspi, A. S. 1975. Shrimp processing. Lecture delivered at BFAR-SEAFDEC Prawn Culture Training, Iloilo, Philippines.
- Lim, C. 1978. A preliminary study on the evaluation of casein, shrimp meal and Spirulina as protein sources of P. monodon postlarvae.

  Annual Report, SEAFDEC Aquaculture Department.
- Mangalik, A & Lim, C. 1978. Effects of various lipid sources on the growth and survival of P. monodon from postlarvae to juvenile stage in a controlled environment. Annual Report, SEAFDEC Aquaculture Department.
- Mock, C. R. and Neal, R. A. 1974. Penaeid shrimp hatchery systems. FAO/CARPAS Symposium on Aquaculture in Latin America, Montevideo, Uruguay.
- Nimura, Y. 1967. Biology of the brine shrimp. Review, Bull. Jap. Soc. Sci. Fish. 33:690-702.
- Platon, R. R. 1978. Design operation and economics of a small-scale hatchery for the larval rearing of sugpo, P. monodon. Aquaculture Extension Manual No. 1, SEAFDEC Aquaculture Department.

- Primavera, J. H. 1978. Sugpo (P. monodon) Broodstock, Aquaculture Extension Manual No. 3, SEAFDEC Aquaculture Department.
- Primavera, J. H. and Apud, F. 1977. Manual of Operations: Sugpo pond culture, Aquaculture Extension Manual No. 2, SEAFDEC Aquaculture Department.
- Primavera, J. H. and Lim, C. 1978. Effects of different feeding regimes of fecundity and egg quality of ablated P. monodon. Annual Report, SEAFDEC Aquaculture Department.
- Santiago, A. 1977. The successful spawning of cultured P. monodon.

  Training materials for seminar on Sugpo Culture, SEAFDEC

  Aquaculture Department.
- Shigueno, K. 1972. Problems on prawn culture in Japan. Overseas Technical Cooperation Agency, Tokyo, Japan.
- Tan, S. P. (n.d.). Pre-market treatment and marketing of sugpo.
- Sorgeloos, P. 1973. High density culturing of the brine shrimp, Artemia salina L. Aquaculture 1 (4):385-391.
- Tolosa, R. T. 1978. Notes on the construction of 12 cu m ferrocement tank for prawn broodstock. Journal of Ferrocement: Vol. 8, No. 2.
- Villacarlos, L. T. 1976. The brine shrimp, <u>Artemia salina</u>, Training Materials for seminar on sugpo culture, <u>SEAFDEC Aquaculture</u> Department.
- Villacarlos, L. T. and Villegas, C. 1976. Preliminary works on brine shrimp culture. Training materials for seminar on sugpo culture, SEAFDEC Aquaculture Department.
- Villaluz, A., et al. 1976. Mass production of penaeid fry at the SEAFDEC Aquaculture Department, Tigbauan hatchery. Training materials for seminar on sugpo culture, SEAFDEC Aquaculture Department.
- Yap, W. G., et al. 1978. Mass transport of sugpo, P. monodon, juveniles. SEAFDEC Aquaculture Department.

# THE BRINE SHRIMP (Artemia salina Leach)

Ceferino de los Santos, Jr. President, WVFFP and Member, FIDC

# THE BRINE SHRIMP (Artemia salina Leach)

Ceferino de los Santos, Jr.

The exploitation of naturally occuring artemia cysts was started in San Francisco Bay, California in the 1930's when Seale and Rollefsen identified it as an excellent food for fish fry. Later, artemia cysts were discovered in the Great Salt Lake in Utah and in Lake Champlin, Saskatchewan, Canada. The cysts were collected from the shores of salt lakes, dried and vacuum packed. The cysts remained viable for as long as 15 years (Bowen 1937). Bardach, et al. (1972), and Goodwin (1976) state that newly hatched artemia nauplii constitute not only the best but in most cases the only available source of live food for the earliest stages of most cultured species of fish and crustacean. Botsford (1974) also stated that older larvae and adult brine shrimps still assure the best results for culturing fish and crustaceans. Today, actual demand for artemia cysts has exceeded available supply. Over 50 tons of dry cysts are consumed yearly in aquaculture business (hatcheries), the aquarium industry, and in research program which use artemia as test organisms (Sorgeloos, et al., 1976). This product is not readily available in the Philippines and is a great constraint to hatchery operations which is just beginning in the local aquaculture industry.

The great need for this natural food has compelled the writer to try production on pilot scale in manmade salterns preparatory to commercial scale production.

#### Literature Review

Artemia salina Leach is a lower crustacean of 1-2 cm long which is found in nature in salt lakes and brine ponds. It belongs to the Sub-Class Branchiopoda, Order Anostraca, Family Artemiidae. In 1758, Linneaus made the first scientific description of the animal which he called "Cancer Salinus". In 1910, Daday reclassified the different salt water artemia into one single polytypic species, the Artemia salina (Linneaus 1758) Leach (1812). Today, there are more than 50 known strains found in various places in the world. Sorgeloos, et al., have started to make comparative analysis of the different strains by certain parameters, such as (a) volume of cysts harvested from the natural habitat, (b) fatty acid composition of the cysts, (c) survival of young nauplii at different temperature-salinity combinations, (d) general ecological characteristics of the population, and (e) nutritional value of the first instar or nauplii as food for fish and crustacean larvae. Of the 14 strains so far studied as to chorion thickness of the cysts, the Australian Strain has the thinnest (4.1 u), followed by the San Francisco Bay Strain (4.4 u).

The following table, made after Sorgeelos, et al. show that varying thicknesses of the chorion of the 14 strains.

Source	Thickness
Australia (unknown locality)	4.1 u
San Francisco Bay, California (wild)	4.4 u
Great Salt Lake, Utah	5.1 u
Site, France	5.2 u
Cadiz, Spain	5.3 u
Cadiz, Spain	6.7 u
San Francisco Bay (laboratory produced)	6.8 u
Palko Strain, India	7.5 u
Lake Champlin, Canada	9.4 u
Great Inagua, Bahamas	11.2 u
Tsingtao, People's Republic of China	11.6 u
Araya, Venezuela	12.0 u
Lake Champlin, Canada	13.9 u
Burgos-Pormorije, Bulgaria	15.3 u

This table is made to show the different thicknesses of the 14 strains to serve as guide in the decapsulation procedure which may call for different levels of concentration of the oxidizing agent and for different time frames to dissolve the chorion.

Sorgeloos, et al. state that so far no correlation in the thickness of the chorion to diameter size could be established. Differences in fatty acid contents, except for strains from great Inagua and Australia which were found negative, are more quantitative than qualitative (1975).

## Morphology

The inactive dry cysts or "Daueriern" of Artemia salina remain in diapause as long as they are kept dry or under anaerobic conditions. Upon immersion in seawater, the cysts hydrate or absorb water and expand to spherical form. In the dehydrated state, the cysts appear like dented pingpong balls. Within the shell, metabolism starts. A number of hours later, the outer membrane bursts and the embryo appears (breaking stage) surrounded by the hatching membrane. The only features that may be seen are the nauplius eye (ocellus), a pair of antennae, a pair of antennulae, and an oval shaped body. The embryo gets out of the hatching membrane after a few hours.

Inside the hatching memberane, the newly differentiated antennae and mandible starts moving and, within a short period, the hatching memberane is ruptured and the free swimming nauplius is born. This is the first instar larva, colored brownish orange due to the presence of yolk. It has three pairs of appendages: the antennae which have

locomotory functions, the sensorial antennullae, and the rudimentary mandibles. A single red ocellus is located in the head region between the antennullae. The ventral side of the animal is covered by a large labrum.

The larva grows and differentiates through about 15 molts. The trunk and abdomen elongate; the digestive tract becomes functional; food particles are collected by the setae of the antennae; paired lobular appendages which will become thoracopods are budding in the trunk region; and the lateral complex eyes are developing on both sides of the ocellus.

From the 10th instar, the antennae lose their locomotory function and their long setae, bend forward to the head and undergo sexual differentation. All the eleven pairs of thoracopods had developed. In the males, the antennae develop into hooked graspers while in females, they become sensorial appendages. The thoracopods are now differentiated into three functional parts: the telopodites act as filters; the oarlike endopodites with long setae having locomotory activity; and the membraneous exopodites function as gills.

After 14-15 days from incubation, the 8-10 mm long adult is characterized by stalked lateral complex eyes, the sensorial antennullae, the linear digestive tract, and eleven (ll) pairs of thoracopods. In the male, the antennae develop into musculated graspers with sensorial papilla at the inner sides; in the posterior part of the trunk, a paired penis develop. The female has primitive antennae with sonsorial functions and paired ovaries situated on both sides of the digestive tract behind the thoracopods. The ripe occytes are transported from the ovaries into the unpaired brood pouch or uterus via the two oviducts (Sorgeloos et al., 1975).

## The Reproductive Cycle

Precopulation is started by the male grasping the female with its antennae between the uterus and last pair of thoracopods. In this "riding" position, the couples swim around for 3-4 days. Copulation is a very fast reflex action, the male abdomen bends forward and one penis, which has become elongated to 10 times its original size, is introduced into the uterus opening. Bowen (1937) states that all offsprings in one brood have only one genotype and cross-breeding of different strains is not possible. The reproductive system of the female consists of 2 ovaries, 2 pouchlike oviducts, and a ventral median uterus.

Within the 24-48 hour period, the following happens: the female expels from the uterus the first generation as either virgin eggs or nauplii. The birth process takes from 2-10 hours. They remain there for 1-40 hours, whether copulation occurs or not. They then pass into

the uterus, the process taking less than 30 minutes. The eggs remain in the uterus for 3-5 days whether fertilized or not. The cycle is completed in 4-6 days. It must be noted that the female does not store sperm. Although the adults clasp continuously, fertilization is only effective when the eggs are in the oviducts.

The fertilized eggs develop into either free swimming nauplii which are set free by the mother. Or, when they reach the gastrula stage and dissolved oxygen level in water is low (salinity 90 plus ppt), the eggs are surrounded by a thick shell and deposited as cysts. Production of nauplii or cysts is dependent on oxygen level or when chelated iron (ferric EDTA) is present (Sorgeloos et al., 1975).

Research at Christmas Island shows that more offsprings or cysts are produced when the animals are hatched and grown in tanks at 32 ppt salinity at 26.0 degrees Celsius for 7-10 days, after which salinity is increased to 90 ppt. Newly hatched nauplius weigh 0.026 mg, sexually matured adults 1.3 mg. Adults deliver live nauplii at an average of 40 per day for 6 months. (UNIHI-TR 1973).

## Parameters for Maximal Hatching Efficiency of Cysts

- 1. Hatching rate is extremely dependent on temperature and salinity which must be kept constant (28 degrees C and 28-32 ppt).
- 2. The cysts must be kept in suspension in oxygen-saturated seawater.
- 3. Shortly after hydration, the cysts must be illuminated for a specific time and lux generally one hour by a 40 watt flurescent tube; the immersion of cysts in continuous darkness results in lower hatching efficiency.
- 4. Without decapsulation, the cysts require exposure to light for 5 minutes for the San Francisco strain and 10 minutes for the Utah strain at the start of hydration and with moderate aeration. After exposure to light, the cysts should be covered with dark cloth or immersed in darkness and vigorously aerated. No cysts should sink to the bottom of the hatching cylinder; if some do, it is indicative of weak aeration.
- 5. After hatching and removal of nauplii, check eggs to see if some are still at breaking stage or if the shell is still whole. Continue aerating for another 24 hours, stopping aeration periodically to remove the hatched nauplii with the aid of a light beam. The nauplii are attracted to light and will gather against the light source (Sorgeloof et al., 1975).

## Decapsulation of Cysts with Chemicals

## Decapsulation of Artemia salina Cysts with Chemicals

#### a. General Principles

The efficient hatching of artemia cysts to nauplii for use as live food for fish and crustacean larvae has been a problem due to the high cost of cysts and the differences in chorion thickness. Hatching efficiency and varying hatching time give rise to problems in the use of the material and in the removal and separation of empty shells and hatching membranes.

Dr. P. Sorgeloos and Dr. E. Bruggeman of the University of Ghent, Belgium have recommended a chemical process to remove the chorion of the cysts with the use of sodium hypochlorite as the oxidizing agent.

Test runs were made following the recommended technique and results were very successful and attained hatching percentages of 90-98 percent using the locally produced cysts of the San Francisco strain.

The values to consider are:

Ratio of cysts to active product (NaOC1) - 2 gms cysts to 1 gm active product

Volume of solution (seawater plus hypochlorite) - 200 ml to 15 gms cysts

Sodium hydroxide (NaOH) to be added to the solution - 2.5 ml of 40 percent solution to 100 ml of seawater plus hypochlorite solution (2 gms NaOH/15 gms cysts). (The NaOH solution should be prepared in advance to allow for cooling)

Technical sodium thiosulphate (or Sodium sulphite) to treat decapsulated cysts - 0.5 ml of 1 percent solution per 10 gms cysts. Keep in refrigerator in a dark bottle

#### b. Procedure

- 1. Hydrate the cysts in water (sea or tap) under strong aeration for 1 hour.
- 2. Stop aeration and filter the cysts on a 150-200 micron screen and wash with clean water.

- 3. Resuspend the cysts in a bucket or glass cylinder with measured volume of seawater + hypochlorite solution and add sodium hydroxide at measured volume.
- 4. Stir the suspension continously with a stick to keep the cysts in suspension. Check temperature as it will gradually rise. Add ice if temperature rises higher than 40 degrees Celsius.
- 5. Stir the suspension from 7-15 minutes depending on color change (from brown to light orange). Time lapse difference is due to the purity of the active oxidizing agent.
- 6. When decapsulation is finished, filter the cysts and wash thoroughly to remove the smell of chlorine.
- 7. Resuspend in seawater and add sodium thiosulphate solution at measured volume and agitate the suspension for 2-3 minutes. Decapsulated cysts will sink while lighter materials like membranes, plumes, etc., will float. Remove the foreign materials from the cysts letting water out from the top drain, or siphon cysts from the bottom of the bucket.
- 8. Wash the cysts with clean water and they will be ready for incubation.
- 9. To keep the cysts for later incubation, they should be resuspended in saturated brine (250-300 gms technical salt in 1 liter of distilled water) under a strong aeration for 3-4 hours. Then siphon off the cysts as they will float and keep in saturated brine in dark containers. Do not expose to light.

#### c. Test Run

Decapsulation

The test run was conducted from 22-24 December 1978. The procedures:

The chemicals are prepared and 15 gms cysts are measured. The cysts are washed in freshwater to remove salt; place in a tall glass jar with 1 liter of freshwater under strong aeration for 1 hour. The cysts are then collected in a fine mesh cloth strainer. A plastic 1-gallon container is filled with 200 ml of seawater + hypochlorite solution to which is added 7.5 ml of 40% NaOH solution. The solution is stirred to mix well and the cysts are put in. The suspension is continuously stirred for 10 minutes until the cysts change in color from dark brown to light orange. Temperature is constantly checked and should never rise higher than 35 degrees Celsius.

The cysts are filtered off and washed thoroughly under the tap with running water at a slow rate, with the strainer continuously shaken, until no smell of chlorine is noticed. The cysts are then resuspended in 200 ml seawater to which is added 0.75 ml of 1% Na<sub>2</sub>SO<sub>3</sub>. The suspension is stirred for minutes. The cysts are filtered off and washed with tapwater.

#### Incubation

One teaspoon of decapsulated cysts out the whole batch are suspended in seawater (30 ppt) and aerated vigorously. After 13 hours and 14 minutes, the suspension is checked by taking a drop and mounting it on a slide to be examined under low magnification. Some nauplii would be seen swimming and most of the cysts would have broken out of the thin membrane, looking like teardrops. Aeration is resumed, and 5 hours later, the second microscopic check would show about 50 percent hatchouts and free swimming nauplii, while the rest of the embryos would be inside their hatching membranes. In my trial, about 2 percent of the cysts did not hatch, most of which had portions of the chorion undissolved.

Eighteen hours and 12 minutes from start of the incubation, the nauplii are siphoned off the separate them from the unhatched cysts, thin membranes and other materials. The nauplii are transferred to 2 aquaria of 2 gallons and on RFG tank of 6 gallons. Seawater with 30 ppt salinity is used as culture medium. Temperature is 25 degrees Celsius and pH value is 7.5. The test run was done from December 22 up to 24, 1978.

Seawater is treated with a few drops of Ambracin (Oxytetrachline Hydrochloride) and when the color of nauplii turns from light orange to white, food in the form of bread flour, breadyest, and V-22 (vitamin-mineral additive) is given in small quantities every four hours, 4 times a day. Aeration is supplied by means of airhoses (without airstones). After one week, salinity is raised by 20 ppt every 2 days until it reachs the level of 90 ppt. The larvae, with all thoracopods fully developed but before sexual maturity, are transferred to a circular raceway where they are grown to maturity.

## Food Value

Newly hatched nauplii must be fed to the predator immediately for after two molting within 24 hours, individual dry weight and caloric value decrease by 20 and 27 percent, respectively.

Adult, or older and bigger larvae of artemia that have been fed with algal diet are a highly nutritious food for fish and crustacean larvae.

The use of older larvae cultured to appropriate size has several advantages:

- 1. The quantity of artemia cysts is reduced as the predator would need fewer of the larger larvae.
  - 2. Food quality of older larvae is higher than the 1st instar.
- 3. The predator spends less energy ingesting a specified biomass of older larvae or adults.
- 4. Strains of artemia whose first nauplii stages are unsuitable because of pollutants, too large to be swallowed, or do not satisfy nutritionally, can become an appropriate food for large cultured species by spreading the feeding of the nauplii over a number of days (Wickens, 1972).
  - 5. Analysis of 24 hour old nauplii (Utah strain)
    Ref: Nippon Sea Farmers Co. Ltd.

81.9% moisture

55.6% crude protein (dry weight)

18.9% crude fat (dry weight)

18.3% carbohydrates (dry weight)

7.20% ash (dry weight)

6. Composition of brine shrimp (San Francisco Strain)

Stage/age	Protein %	Fat %	Calories %	Reference
egg	52.31	26.06		Brick
Nauplius 2 hrs	50.21	15.92		. <b>u</b>
Few Hours	42.60	23.20	66.00	Dutrieu 1960
Few Hours	No. 100	15.09	58	Khmeleva 1968
I day	50	27.24	58.76	Coehn
Juvenile 6 days	59.72	7.00		Brick
Adult 10 dyas	62.78	6.51		.#

(UNIHI-TR, 1973)

## Feeding Habits and Food Preferences

In nature, artemia grazes on single-celled algae at all stages of life. They thrive in cultures of 3,000 adults or 12,000 nauplii per liter of seawater. Maximum growth is attained at salinity level of 35 ppt with 25-30 algal cells per m<sup>3</sup>. More females are born in broods of adults feeding on <u>Dunaliella salina</u>. Diatoms are not recommended as feed for artemia because their siliceous exoskeleton can not be digested. Recommended food is phytoplankton which can be grown with nitrogen and phosphorus fertilizers at the ratio of 16:1. (UNIHI-TR 1973).

Artemia is a non-selective obligate filter feeder (Barker-Jorgensen 1966). All particles neither too small nor too large (small sand grains to ciliates over 5 microns) are ingested by artemia. Digestion is most efficient when concentration of food is low. Artemia may starve when concentration of food is high as food is transformed into faeces-like pellets and excreted before they can be digested. Frequent feeding at low concentration gives the best growth results.

The animal is capable of regulating its rate of feeding in such a way that, as cell concentration increases, filtration rate maintains a constant maximum value while ingestion rate increases. When concentration reaches a value at which a constant maximum ingestion rate is attained, the filtration rate falls off. In older animals, the maximum ingestion rate is reached at a lower cell concentration. The maximum filtration is dependent on cell size, the total volume of cells ingested being the same for three species of plant cells — chlorella, Dunaliella and Phaeodactylum. Maximum filtration rate is maintained up to 50/mm³ for plant cells, or alternatively, the maximum number of plant cells ingested per animal per hour is in the region of 5.5 x 105 and the maximum number of sand particles is 40 x 105.

Artemia shows no appreciable ability to discriminate between plant cells and between nutritious and non-nutritious food. Artemia kept without food do not quickly empty their guts, which may appear colored with food after two weeks of starvation, but microscopically examined, revealed the contents to be almost entirely liquid. (Reeve, 1962).

Fujinaga (1969) states that it is possible to grow 50 grams of artemia per ton of water every day. Sorgeloos (personal communication) is of the opinion that it is possible to produce 1 kilo of cysts per hectare per day with a population of 100 million adults.

Artemia is sensitive to some compounds. High concentration of CO<sub>3</sub> and HCO<sub>3</sub> are lethal to artemia (Cole and Brown 1967). Potassium greater than 100 ml/L is lethal unless the Na/K ratio is at least 10:1. O<sub>2</sub> should be greater than 3 ml/L (UNIHI-TR 1973).

# Production of Artemia in Manmade Salterns in Iloilo

#### a. Initial Inoculation

After the successful results made from experimental runs of culturing artemia in water taken from the ponds of the writer, Dr. Sorgeloos, with the assistance of Mr. Einstein Laviña of SEAFDEC, suggested to inoculate artemia adults and nauplii in the concrete brine tank of the writer's salt plant as well as in his ponds. Salinity levels in the tank and in the pond were checked prior to inoculation. Salinity at the tank was 84 ppt, the earth pond 64 ppt. The initial stocking consisted of 500,000 adults and 20 million nauplii. Some 200,000 adults were stocked in the earth pond of 4.5 hectares. The rest were placed in the tank. Not being sure of existence of predators (Tilapia, gobies, and poecilia), the animals were placed in an enclosure of fine mesh nylon nets of about 50 square meters area and provided with a bamboo trellis on top where coconut branches were spread to act as sun shade. The water depth was 45 cms. The water depth in the concrete tank was 75 cms. No food was given to the animals as there was plenty of lablab in both places. After 4 days, it was observed that the animals at the enclosure became weak and many died due to over-crowding, wave action, and other factors like temperature and salinity fluctuation. The water was let in the main gates to supply water to the other ponds, salinity at the earth pond dropped to 42 ppt. A closer check showed that there were many small holes at the dike and water seeped into the pond when water level rose in the canals. A puddle trench had to be dug along the side of the dikes and refilled with new clayey soil. When the next high tide occurred, the dikes were checked and many leaks were discovered. The experiment in that earth pond was given up.

At the concrete tank, the animals thrived very well. The young nauplii grew to adults and began copulating 9 days after stocking. The adults had begun producing nauplii and cysts. No food was given for two weeks due to available food in the tank. When the tank water became more transparent (Secchi disc reading at 40 cm), very fine rice bran milk, produced through soaking and squeezing of rice bran through a very fine cloth bag, was applied in the tank. Transparency was reduced to 10 cm. Temperature fluctuations ranged from 25°C in the early morning hours to 32°C at 2:00 P.M. It was noted that the animals gathered along the walls of the tank which was shaded from the sun and that at noon time, most of the animals move to the bottom. To minimize the adverse effects of fluctuations in temperature, coconut branches were floated in the tank. It was observe that the animals hide themselves under the leaves when temperature rose.

When density of the animals increased, aeration was provided by converting a spray gun compressor and another air compressor (for refilling truck and tractor tires) into aerators. Expansion tubes were made out of 3-inch PVC pipes cut to 24 inches length and drilled with 3/16 inch holes to receive air valves. The ends were closed with 5 x 5 inch (1/4 inch thick) glass glued with epoxy. The expansion tubes were made to float in the tank and air hoses with large airstones were attached to them Enough air was pumped into the expansion tubes to aerate the whole water volume.

#### b. Stocking in Earth Ponds

Just adjacent to the concrete tank are earth salt concentration ponds where brine is produced preparatory to pumping into the brine tanks. Salinity in these ponds ranged from 85-130 ppt. When population density in the concrete tank increased to about 1200/liter, it was decided to stock in the concentration ponds. The water level in the ponds was 35 cms and water temperature rose to 35°C during noon time. To avoid its ill effects, coconut branches were laid in the ponds in rows parallel to the concrete dikes. Some 25 million animals of different age, were stocked in two ponds initially. After two weeks when population increased in those ponds, a large portion was transferred to a third pond just adjacent. It was noted that the ponds with salinity level of 130 ppt produced more cysts which floated at the southwest corners of the ponds. (Prevailing winds from the Northeast to Southwest). The cysts were collected with very fine-mesh scoop nets from plastic sheet lined collection corners, and washed of debris and algae before being stored in glass jars in hypersaline solution (250 ppt). Separation of fertilizecysts from non-fertile ones, and from foreign materials was done thru a series of washing at different salinity levels.

## c. Feeding

Food for the animals in the concrete tank consisted of rice bran milk extracted from 8 kilos of fine rice bran, which was soaked in tank water and squeezed out of a fine cloth bag. Water transparency was kept between 10-15 cms. Vigorous aeration was maintained continuously. Vitamins and mineral traces were supplied from commercial animal feed additives.

In the ponds, due to the presence of benthic algae, no food was given to the animals. The pond bottoms were raked twice a day to cause the water to become turbid and to suspend the algae. No aeration was given.

The animals thrived very well in all areas, and cysts and nauplii were produced at a fast rate. More nauplii were produced at salinity level of 70-80 ppt in the concrete tank, and more cysts were produced in the ponds with salinity level of 110-130 ppt. The concrete tank was

used to produce nauplii and to mature them for transfer to the ponds, while the ponds were used as cysts production areas. From 4,845 m<sup>3</sup> of water in 13,842 sq m of ponds, 18.5 kgs of cysts were collected in 65 days. Due to salinity fluctuations when occasional rain fall, cysts drop to the bottom of the ponds and mixed with benthic algae and silt. The problem of separating the cysts from other materials is still unsolved.

### d. Water Change

It was observed that the animals' activity slows down after a week from the last water change (maybe due to oxygen depletion as no aeration was provided in the ponds or lowering of food concentration). When fresh seawater from the river is introduced into the ponds, the animals become very active again and more cysts were produced. Salinity level was maintained by adding saturated brine or salt crystals to the pond water. The use of brine or salt to low salinity water is much cheaper than providing aerators. Besides, the new water brings into the ponds the naturally occuring foods in the river which comes from mangrove swamps.

#### e. Temperature and Salinity Ranges

- (A) Brine tank area 15 x 20 x 2 m

  Average water depth 75 cms pH value 7.5 8

  Salinity range 10w 84 ppt, high 180 ppt

  average for 37 days 93.4 ppt

  Temperature range 10w 25°C, high 37°C

  average for 37 days 31.1°C
- (B) Concentration pond No. 5 area 1760 m<sup>2</sup>

  Average water depth 35 cms pH value 7.0-8.2

  Salinity range low 90 ppt, high 170 ppt

  average 135.8 ppt

  Temperature range low 25°C, high 37°C

  average 34.3°C
- (C) Concentration pond No. 6 area 1598 m<sup>2</sup>

  Average water depth 35 cms pH value 7.0-8.5

  Salinity range low 70 ppt, high 170 ppt

  average 122.9 ppt

  Temperature range low 25°C, high 37°C

  average 34.5°C

### f. Food for Milkfish Fry and Other Species

Test stocking with 15 milkfish fingerlings (10 grams) show that the fishes thrived very well and that they grew to 200-250 gms each, after 72 days in the concentration ponds. Of course, rate of growth could not be very well approximated due to the very low stocking rate (15/1759 m<sup>2</sup>). Available food in the pond are artemia nauplii and adults, and benthic algae.

Test feeding was done with decapsulated cysts, young nauplii and adults to fry and fingerlings of milkfish, P. monodon, Metapenaeus ensis, tarpon E. Hawaiienses, and others. Milkfish fry (20-25 days old) can take 14-16 eggs per day. All the fry thrived very well, and the carnivorous species grew faster than milkfish. Mortality was almost negligible. This confirms the findings of Dr. Liao (of the Tungkang Marine Laboratory) that artemia nauplii is very good for milkfish fry during feeding experiments in SEAFDEC, Tigbauan in July, 1978. The young nauplii and adults of artemia fed with rice bran, flour, breadyeast and Vitamin B - complex extract or blue-green algae (spirulina sp., spirogyra, oscillatoria limnetica and mixed diatoms) and later on fed to the young of fish and shrimps make excellent food. The tests show that the culture and management of fry of commercial species could be much improved if kept in tanks or small raceways, and fed with decapsulated cysts, nauplii, older larvae, and later on adults of artemia in that sequence with blue green algae and mixed diatoms. Water quality could be better controlled and predators eliminated. Mortality could be kept to the minimum, and the young fish or shrimps may be stocked in rearing ponds in bigger sizes and healtheir conditions, which will have the best chances of survival. Chemical treatment for diseases and parasites could be easily performed in small tanks or ponds, as well as complete removal of other predatory species such as E. Hawaiienses (tenpounder) and Megalops sp. (tarpons) which look very similar to Chanos fry at very young stage.

#### References

- Benijts, et al. 1975. Changes in the Biochemical Composition of Early Larval Stages of the Brine Shrimp, paper presented at the 10th European Symposium on Marine Biology.
- Bowen Genetics of Artemia Salina, Biological Bull. Vol. 122 pp. 25-32 (1973).
- Claus, Benijts and Sorgeloos Comparative Study of Different Geographical Strains of Brine Shrimp. Spl. Bull. No. 2,
- Croghan Survival of Artemia Salina in Various Media, University of Cambridge Bull., Journal of Exp. Biology, Vol. 35 No. 1 pp. 234-242.
- Provasoli et. al. Nutritional Idiosyncracies of Artemia and Tigriopus, Annals of New York Academy of Sciences, Vol. 77 pp. 250-261 (1959).
- Reeve The Filter Feeding of Artemia Salina, Journal on Exp. Biology, Vol. 40, pp. 195-205 (1963).
- Sea Grant Tech. Report Feasibility of Brine Shrimp Production on Christmas Island, UNIHI-SEA GRANT (July 1973).
- Sorgeloos, Baeze-Mesa, Claus, Vandeputte, Benijts, Bossuyt, Bruggeman, Persoone and Versichele - Artemia Salina as Life Food in Aquaculture (Spl. Bull. No. 2, University of Ghent).
- Sorgeloos et al. Morphology of Artemia Salina (Unpublsihed).
- Sorgeloos and Bruggeman Decapsulation of Artemia Cysts by Oxidation Process, Unpub. 1978.
- Sorgeloos and Persoone Technological Improvements for the Cultivation of Invertebrates as Food for Fish and Crustaceans Aquaculture, 1975.
- Sorgeloos and Personne Automatized High Density Culturing of Brine Shrimp, Lecture at Annual Workshop of World Mariculture Society, San Jose, Costa Rica, 1977.
- Sorgeloos, et al. Research on the Culturing of the Brine Shrimp, paper presented at the 10th European Symposium on Marine Biology, 1975.

CASE STUDIES ON PRAWN CULTURE

Alfredo Lopez Private Sector

#### CASE STUDIES ON PRAWN CULTURE

#### Alfredo Lopez

Project Study: Conversion of An Existing Milkfish Pond to Prawn Culture in Negros Occidental

### A. Resume of Findings and Conclusions

Project Study

This is a project study on the conversion of an existing milkfish fishpond to prawn culture in Negros Occidental. The project site, an established milkfish fishpond in Negros Occidental, was found that it could be converted into prawn culture. Existing conversion procedures in other parts of the world would be modified to suit local conditions. The conversion was taken from the economical point of view wherein the capital outlay could be self-financed from the proceeds of the existing fishpond and the capability of the enterpreneur. In spite of opinions on the potential earnings of a prawn pond there has been no clear-cut study of implementing this on a commercial scale within reasonable limits. In the past, the primary crop was milkfish and the secondary crop was shrimp or prawn. This study aims to make the prawn the primary crop and milkfish the secondary crop.

The importance of this study is to determine the productivity in kilograms per hectare of the applicable technology; systems of management; and the defined modifications of technological input for commercial scale production. It also aims to find out the risk and cost of production, in order to define in real terms the profitability of commercial prawn culture.

Market Study

Most of the data for the market study were obtained from the Bureau of Fisheries and Aquatic Resources Statistics.

The supply study was done by correlating shrimp production in commercial vessels to the three sections of the fishing industry. By using 1963 as a base year, getting fishpond areas in production of 1974 and the fish production of the three sectors from 1963 to 1974, the estimated shrimp production as shown in Table 3.4 was compiled. A factor of about 3.60 percent of the total fish production is the shrimp production of the country. A supply projection was forecast to the year 1982 with two growth rates of 6.21 percent and 8.02 percent. By 1982, it is estimated to about 60,000 M.T.

The per capita intake of shrimps is about two kilograms according to NIST reports while the historical capita intake is 0.76 kgs. By using Dr. Russek's FAO formula and checking the degree of variance with the TFHS formula, the deficit of shrimp production to effective demand is 2,415 M.T. in 1977 to 509,000 M.T. in 1982.

On the basis of price fluctuation of two fish brokers, one in Manila the other in Bacolod, the prawn had an average price of \$25.00 per kilo while that of bangus was \$5.00 per kilo for 1976.

Foreign trade on shrimps showed a decline from 1969 to 1974. Japan was the major consignee of shrimp export while the United States had a low record. Exports of shrimps reached 20 percent of the total fish export in 1971 and declined to 7 percent in 1974. One main reason for the decline was poor quality. The BOI set standards in 1973 for shrimp export as shown in Annex A-D.

The marketing strategy was to sell one third of the total produce locally while the rest to be shipped to Manila. The average marketing cost of bangus and prawn is \$1.63 per kilo.

### Technical Study

Prawn was discussed primarily in the technical study. The present fishpond set up was remodelled from the economic point of view by combining adjacent areas, making peripheral canals, and installation of two gates in each rearing pond. Major areas of renovation are the maturation ponds and the prawn nursery ponds. The first set up would be for rearing 50,000 bangus and 275,000 prawns per three month cropping period.

Work would commence in early December when the third cropping of bangus is to be harvested. It is divided into three phases which would have a timetable of one year.

The culture process is rearing the fry in nursery ponds, stocking them in the transition pond, and rearing them to marketable size in about three months. Bangus has an average stocking rate of 3,000 pieces per hectare, prawn is 10,000 pieces per hectare.

The prawn fry, supply being the limiting factor of a full scale commercial prawn production, would be augmented by a hatchery. The technology is provided by the Aquaculture Department of SEAFDEC. Total production for bangus would be 33.5 tons and that of prawns 33 tons after the second year when all systems are fully operational.

### Management Study

The project will be funded by the proprietor. It will hire seven (7) personnel to run it. The total labor cost would basically be \$2,420.00 per month. Commissions would be production-oriented i.e. personnel shall earn \$0.05 per kilo of bangus and \$0.50 per kilo of pranws. All personnel shall be sent to SEAFDEC for training on various management programs.

Management of this study is divided into three areas: (1) water, food growth and feeding; (2) fry and nursery handling and (3) harvesting.

Pond recording and data collection should be kept regularly. Various forms of pond recording were taken from the SEAFDEC Leganes Station.

Management skills and knowledge of the technology operations is very important in the hatchery; therefore, job applicants would be limited to those trained in SEAFDEC or working with the SEAFDEC Aquaculture Department.

#### Financial Study

The total capitalization cost of the entire project would be \$\vec{y}407,345.00\$, divided into four areas: pond system renovation is \$\vec{y}68,000.00\$; hatchery system is \$\vec{y}120,000.00\$; movable equipment is \$\vec{y}84,000.00\$ and working capital requirements is \$\vec{y}134,500.00\$.

The fixed cost per hectare is \$1,400.00 while variable cost is \$4,140.00 or a total cost of \$5,540.00 per hectare. Sales would be \$22,900.00 per hectare during the first year and \$34,500.00 in the succeeding years of operations.

There are three items which are heavy expenditures: pest and pesticides, and feeds.

Profit for the first year is \$\mathbb{P}180,000.00\$ that of the succeeding year \$\mathbb{P}380,000.00\$. The return on investment for the first year is 21 percent, the second year 41 percent.

Break-even point based on constant production rate is \$\mathbb{P}13.20 \text{ per kilo of prawn and \$\mathbb{P}2.65 \text{ per kilo of bangus; break-even point on volume on the assumed price of \$\mathbb{P}25.00 \text{ per kilo of prawns and at \$\mathbb{P}5.00 \text{ per kilo of bangus is 430 kilos of prawns and 470 kilos of bangus.} The ratio of price differential is 5:1 and 90 percent of production rate.

A sensitivity analysis was done on this ratio with artificial plugging of prices to see break-even production rates.

## Summary and Conclusions

The project could be undertaken inasmuch as the present technology is available. The limiting factor to the success of the proposed hatchery project is the skill and knowledge of the operator and his personnel.

The amount of initial capital outlay needed for the project is quite substantial and, therefore, financing of the project is recommended. Although the rate of return is not as high as envisioned earlier, it is quite average for the industry as a start.

There are some areas of considerations which can be devised to reduce cost so that the whole set up could be easily financed.

It is therefore concluded that the idea of a commercial scale production of prawns is viable and feasible in the country not only for local consumption but also for export.

#### B. Introduction

Objectives of the Study

This study is based on the idea of expanding the prawn industry in the Philippines. Since it is considered one of the luxury species for culinary purposes here and abroad, there exists a big demand-supply gap; hence, it is high-priced and a potential dollar earner for the country. This project is undertaken for several reasons:

- 1. establish a small scale prawn hatchery thus solving the problem of limited supply of prawn fry,
- determine the numerical value in terms of kilograms per hectare of applicable technology,
- 3. find the risks and cost of production, and
- 4. find out in definite terms the feasibility and profitability of commercial prawn culture.

Scope and Limitations of the Subject

An existing fishpond located in Barrio Luna, Cadiz City, Negros Occidental whose main culture is milkfish will be redesigned for prawn culture. It is an ideal location since the fishpond is located between the mouth of two rivers with brackishwater whose salinity is between 15 ppt to 25 ppt. The culture technology used will be an adaptation of various technologies of shrimps and prawn culture of the United States, Japan, Taiwan, Philippines and some Southeast Asian countries.

The stocking material will be wild fry during the season and the hatchery fry during the non-breeding season. Costings of the study will be based on the 1976 prices since all materials gathered are within that year.

There is difficulty in acquiring correct data on prawn statistics because the Bureau of Fisheries has no specific item on prawn. Prawn data are included under the general item of "shrimps". Therefore, the market study is correlated with shrimp and fish data which is good only for 1974.

The management study are based on the author's experiences in running a fishpond. Existing labor laws and regulations were the basis of the study.

The financial study was done on the approved accounting procedures and existing Bureau of Internal Revenue laws.

#### Methodology

The marketing study data were compiled from statistics of the Bureau of Fisheries and Department of Natural Resources. Since no specific data were available for prawn, it was correlated with shrimps and fish. A five year projection of supply and demand from the Task Force on Human Settlements formula was taken and compared with Dr. Russek's Food and Agricultural Organization formula.

The prices gathered were from Mr. Eliseo J. Dingcong, a fish broker in Divisoria, Manila and Mr. Samuel Dewara, another fish broker in Banago, Pala-pala, Bacolod City. These were via personal communications.

The technical aspects were gathered mainly from the SEAFDEC Aquaculture Department.

The management side was based on the ten-year experience of the author on pond culture while fringe benefits were based on the various benefits extended by other progressive pond owners. Gathering of listed management programs to be done by technicians were drawn from the ongoing experiments in the SEAFDEC Leganes station and from SEAFDEC prawn cooperators program.

#### C. Technical Study

#### Project Site

The project site is a titled property located in Barrio Luna, Cadiz City, Negros Occidental. It has a total area of 101.94 hectares, 32.43 hectares of which is a fishpond, the rest planted to sugar and coconut. The project site is bounded in the north by Guimaras Strait.

It is between the mouth of two rivers; the Sicaba and Talaba-an rivers. It is fifty-six kilometers from Bacolod City and three kilometers from the main highway. A feeder road goes into the property. Cadiz City is six kilometers away.

The property is provided with electricity by the Victorias Rural Electric System Cooperative (VRESCO). The fishpond has five security lights and the houses of caretakers are likewise provided with lighting facilities.

Fishpond Description and Existing Set-up

The fishpond area is under weather condition Type III; rainfall is constant the whole year round with two to three months dry spell from April to June. The average annual rainfall over a twenty-year total is from 90 to 110 inches.

The tide fluctuation in Guimaras Strait ranges from 1.9 to 1.0 meter. The area has two tides fluctuation daily: the neap tide and the spring tide. The fishpond has an average elevation above zero datum of 0.8 meters wherein water could fill the pond with tides of 1.0 meter above and be easily drained. Water quality averages between 18 ppt to 25 ppt which is ideal for growth of prawn.

The fishpond has two main gates of reinforced poured concrete. Each has an opening of 2 meters wide and five meters long. All ponds are interlinked with secondary and tertiary canals.

The fishpond was made and enclosed in 1950 and was completely levelled in 1965. The soil is basically clayloam although at lower level it is sandy.

The present fishpond set up as shown in Table 1 has eight nursery ponds. The total area of the nursery ponds is 2.96 hectares with a stocking rate of 55,000. The rearing ponds have a total area of 26.44 hectares with a total stocking rate of 44,000 for rearing.

Rearing period is three months for a total of three croppings per year. Approximate harvest per crop is 12 tons of bangus at four pieces per kilo.

Table 1
Present Status of Fishpond and Stocking Rate of Milkfish

POND	DESIGNATION	AREA	STOCKING RATE
73 (1)	Nursery Pond	0.18	50,000 Fry
72 (2)	Nursery Pond	0.42	100,000
67 (3)	Nursery Pond	0.38	100,000
66 (4)	Nursery Pond	0.60	150,000
74 (5)	Nursery Pond	0.49	100,000
71 (6)	Nursery Pond	0.45	100,000
68 (7)	Nursery Pond	0.28	70,000
65 (8)	Nursery Pond	0.16 2.96	50,000 710,000
69 (1)	Transition Pond	0.78	15,000
60-A (2)	Transition Pond	0.96	20,000
79 (3)	Transition Pond	0.98 2.72	20,000 55,000
70 (1)	Rearing Pond	1.47	3,000
63 (2)	Rearing Pond	1.62	3,000
64 (3)	Rearing Pond	1.31	2,500
61 (4)	Rearing Pond	1.47	3,000
62 (5)	Rearing Pond	1.33	3,000
60 (6)	Rearing Pond	1.70	4,000
84 (7)	Rearing Pond	1.23	2,500
75 (8)	Rearing Pond	2.13	4,000
76 (9)	Rearing Pond	1.24	2,500
77 (10)	Rearing Pond	1.63	3,000
78 (11)	Rearing Pond	1.68	3,000
80 (12)	Rearing Pond	3.56	6,000
82 (13)	Rearing Pond	2.47 26.44	4,000 49,500
		32.12 Ha	814,500

# Description of Planned Set-up

The planned set-up was based from the economic viewpoint. Pond areas would be merged together to obtain the desired effect of a flow-through system. One is the inlet and the other the outlet, thus the need for two gates in each rearing period.

The plan consists of making peripheral canals or trenches five meters wide and seventy five centers lower than the general pond bottom. This would serve as refuge of prawns during hot climate and would facilitate pond preparation and harvesting. Thus the plan of constructing peripheral canals would entail big savings. To augment the flow of water of a pump would be used. This would add further to the flexibility of water management.

One of the many recommendations of prawn pond is to have a water level of one meter to 1.8 meters. However, the total excavation of the ponds proves to be uneconomical. Another reason is that with deeper excavation of the pond bottom, ferrous sulphate soil might be encountered. Smooth bottom ponds needed for culture of some fish are not required for shrimp culture.

A recent estimate to excavate a cubic meter of soil is \$2.50 to \$5.00 in Negros Occidental. Therefore, to excavate a hectare would entail \$25,000 to \$50,000 development cost. The peripheral canal renovation method would be done from a purely economic point of view. The materials excavated from the trenches would be used to strenghten and heighten dikes to be able to withstand the water pressure of a one meter deep pond and securing it from leakages.

Another consideration is that deep ponds using tidal fluctuations would be requiring wide concrete gates. These wooden gates if properly constructed and treated would last from four to six years. All gates would be remodelled to permit installation of three filtering devices to have an above par predation control.

The final set up as shown in Table 2 and Figure 2 would have four bangus nurseries of 1.53 hectares capable of handling 600,000 fry; two prawn nursery ponds of 1.09 hectares with a reservoir of 1.50 hectares; two maturation tanks of 0.34 hectares capable of handling 800 pieces of adult prawn; two bangus transition ponds of 3.23 hectares capable of handling 60,000 fingerlings; one prawn transition pond of 1.24 hectares capable of handling 100,000 prawns and eleven rearing ponds for polyculture of prawns and bangus with a total area of 29.30 hectares capable of rearing 50,000 bangus and 275,000 prawns.

Table 2 PROPOSED AND FINAL SET UP OF POND WITH THEIR STOCKING RATES

POND	DESIGNATION	AREA		STOCKING BANGU		STOCKING PRAWN	
BN <sub>1</sub>	Nursery Pond	0.42		200,000			
BN <sub>2</sub>	Nursery Pond	0.38		100,000			
BN3	Nursery Pond	0.28		100,000			
$BN_4$	Nursery Pond	0.45	1.53	200,000	600,000		·
PN <sub>5</sub>	Nursery Pond	0.60	•			500,000	
PN <sub>2</sub>	Nursery Pond	0.49	1.09			400,000	900,000
м	Maturation Tank	0.18	en e			800	
M <sub>2</sub>	Maturation Tank	0.16	0.34				800
$\mathtt{BT}_1$	Transition Pond	1.23		25,000			
BT <sub>2</sub>	Transition Pond	2.00	3.23	35,000	60,000		
PT	Transition Pond	1.24	1.24			100,000	100,00
$\mathtt{RP}_1$	Rearing Pond	2.25		4,000		20,000	en e
RP <sub>2</sub>	Rearing Pond	2.93		5,000		25,000	
RP3	Rearing Pond	5.46		10,000	*	50,000	1.
RP4	Rearing Pond	2.13		4,000		20,000	
RP5	Rearing Pond	2.61		5,000		25,000	
RP6	Rearing Pond	7.85		12,000		75,000	
RP7	Rearing Pond	6.07	29.30	10,000	50,000	60,000	275,000

37.11

# Legend:

BN - Bangus Nursery

PN - Prawn Nursery

BT - Bangus Transition

PT - Prawn Transition

RP - Rearing Pond

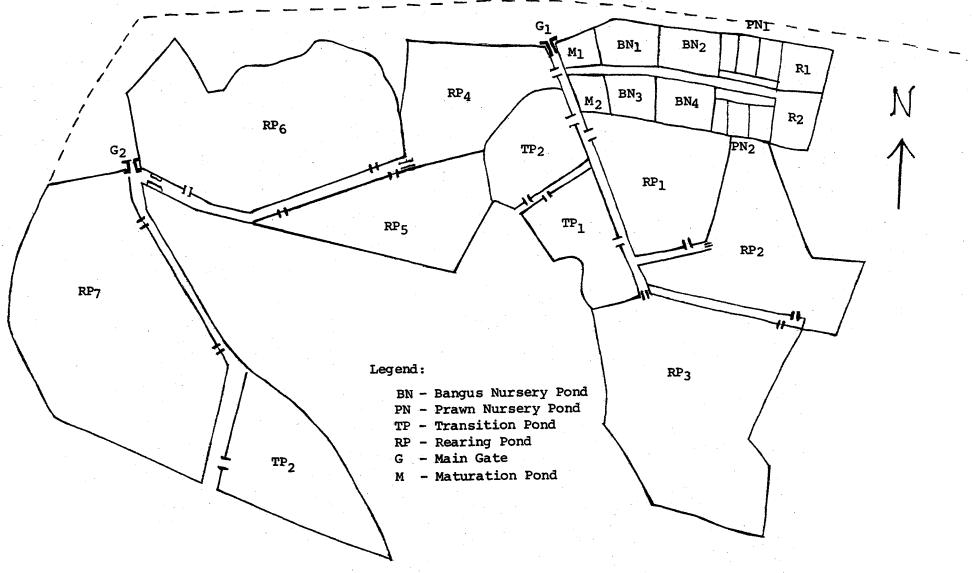


Fig.1 REVISED DESIGN OF PONDS

## Project Plan

As shown in Figure 1 and Table 2, the plan set up and the maturation ponds would read  $M_1$ ,  $M_2$ ; bangus nursery ponds are  $BN_1$ ,  $BN_2$ ,  $BN_3$ ,  $BN_4$ ; prawn nursery ponds are  $PN_1$ ,  $PN_2$ ; prawn transition ponds is PT; rearing ponds for polyculture are  $RP_1$  to  $RP_7$ . The hatcheries would be placed near the nursery ponds.

The maturation tanks would be excavated one meter deep. A bamboo netting would divide each pond into four. Inside this quadrant shall have a fish netting to make the lifting of gravel prawn easy.

The prawn nursery pond shall be divided into three sections with a foot irrigation canal near the secondary canal. A reservoir tank shall be excavated near it. This reservoir will have an installation of sand filters, a pump and piping of 2 1/2 in PVC to the nurseries.

Rearing ponds will have trenches excavated wherein the soil shall be reinforced and heightened the secondary dikes. Each rearing areas have two gates installed. Some of the old gates materials would be used if found usable.

Manual labor shall be used in the maturation tanks, peripheral dikes and installations of gates. The use of an LGP bulldozer for the reservoir tanks and BT<sub>2</sub> as high area would be hired.

A proposed contract rate of \$2.50 per cubic meter would be paid to manual labor and \$1.75 per cubic meter for rental of bulldozer. The carpenter caretaker would do all the carpentry work on gates and filters.

#### Description of a maturation tank

M<sub>1</sub> is 0.18 hectares and M<sub>2</sub> is 0.16 hectares. A total of 3,400 cubic meters would be excavated. The soil shall be placed along the dikes making it two meters wide and one meter high. Excess soil will be placed beside the main gate. Bamboo poles of 2 1/2 meters will be staked one meter apart. A bamboo screen will divide the pond into a quadrant. In each quadrant, a nylon netting of mesh would be spread and tied to the bamboo poles. Two hundred mature prawns would be placed in each quadrant with a sex rate of 3 males to 2 females. A total of 800 mature prawns would be the maximum capacity of each maturation pond.

### Description of a prawn nursery pond

Prawn nursery pond (PN<sub>1</sub>) is 0.60 hectares and PN<sub>2</sub> is 0.49 hectares. The ponds will be divided into three equal parts of longitudinal sections. A foot canal would be constructed near the secondary canal. The pond would have a water depth of 40 to 50 centimeters. A reservoir of 0.78 hectares will be bulldozed; it would generally be higher by 1/2 meter than the bottom of the nursery pond. An electric water pump of 2-inch diameter with a rated capacity of 500 gpm shall be installed. Three sand filters would be installed in the reservoir, one for the inlet the other two for the outlets. A piping system of 2 1/2 PVC perforated at the stand pipe end would be installed. A drainage collector pit made of wood would be placed at the foot canal. This pit is generally 10-20 centimeters lower than the general pond bottom connected lengthwise to a drainage canal.

### Description of transition and rearing ponds

In each transition pond, BT1; BT2; PT1; and rearing ponds RP1 to RP7, peripheral canals or trenches of five meters wide and 75 cm deep would be excavated. This would equal to 3.75 cubic meters of excavated soil per linear meter. It would be sufficient to fill the old dike with 1 1/2 meters of earth sideways and 1 1/2 meters from pond water bottom in height with a crown of 1 1/2 meter. This will secure it from major leakages and strengthen it to withstand a one meter high pond water.

A wooden gate would have the following features: it is 3 meters long and 1 meter wide. It has anti-seep boards on the sides and bottom. It has a brace to withstand all soil pressure. It has sets of board enclosures and three sets of screen attachments from coarse to fine and to the final bag nets. It would utilize scrap rubber on the board enclosures to make it water tight. Lastly, piling of bamboo poles at the bottom to prevent it from settling.

Each pond would have two gates, one for the inlet and the other for the outlet. The decision to use wooden gates instead of concrete ones are advantageous for two reasons; it is easily removed in case its placement is erroneous and the capital cost is lesser.

### Description of a hatchery

The prawn hatchery is situated near the nursery ponds. It will be a modified Galveston and SEAFDEC's Platon types. It will have two wooden 2-ton conical larvae rearing tanks and twenty-three one-ton tanks made of marine plywood, of which thirteen would be used for <a href="Chaetocerossp.">Chaetocerossp.</a> production (Figure 2)

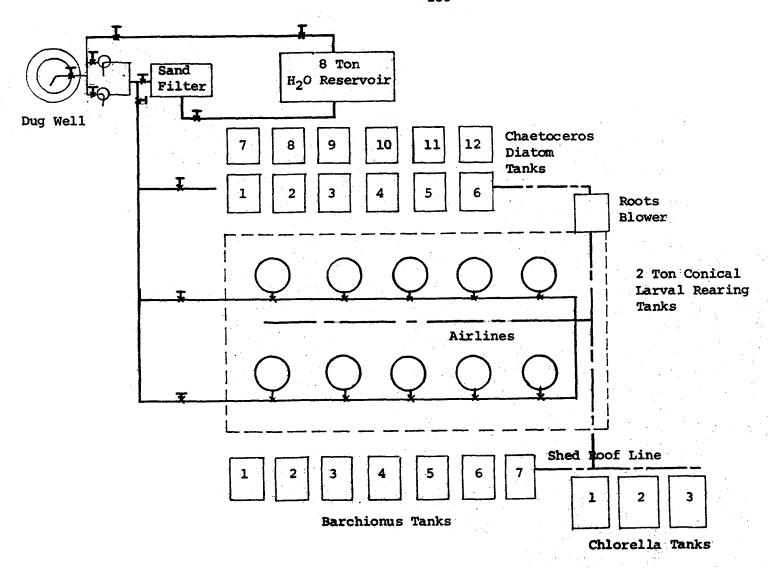


Fig. 2 PROPOSED HATCHERY LAY-OUT

Table 3
Timetable of Cost and Development

		Man/Days Required <sup>L</sup> 1	Tractor Hours	Cost <sup>L3</sup>
PHA	SE I			
1.	Maturation Pond <sub>1</sub>	15		₽ 5,000
2.	Maturation Pond <sub>2</sub>	15		5,000
3.	Prawn Nurseryl	<b>20</b> <sup></sup>		7,500
4.	Prawn Nursery2	20		7,500
5.	Reservoir	5	3	2,000
PHA	SE II			
6.	Transition Pond <sub>1</sub>	7	10	1,250
7.	Transition Pond2	7		1,250
8.	Prawn Transition <sub>1</sub>	7		1,250
9.	Rearing Pond1	15		3,500
10.	Rearing Pond <sub>2</sub>	15		4,180
11.	Rearing Pond3	30		6,710
12.	Rearing Pond <sub>4</sub>	15		3,380
13.	Rearing Pond <sub>5</sub>	15		3,860
14.	Rearing Pond <sub>6</sub>	30		9,100
15.	Rearing Pond7	20		7,320
РНА	SE III			
16.	Hatchery tanks & Buildings	s <sup>L</sup> 2 90	3 —	120,000
		326 Days	16	<b>¥188,800</b>

L<sub>1</sub> Based on the assumption that 20 men will work continuously for 8 hours and hiring of one D-4D LgP Tractor bulldozer.

L2 Four carpenters at work.

L<sub>3</sub> Figures are rounded.

Its water system would be supplied from a dugwell reinforced with concrete culverts seven meters deep. An electric motor of one horsepower will pump the water to an elevated sand filter and drained to an eight-ton water reservoir. Common salt would be used to adjust salinity during rainy season. Other equipment are ten (10) 300-liter tanks for spawning and various equipment for diatom concentrations; filter devices and pails for transport of fry to nursery ponds. A roots blower of 1.5 KVA will supply the air in the hatchery tanks. This would be a duplication of an electric pump and roots blower for standby purposes during down time or repair of the duplicate equipment.

## Timetable of cost and development

The work shall be divided into three phases of study as shown in Table 3. They are the transition and rearing ponds, the maturation and nursery ponds and the last would be the hatchery. This way, the management of the work will be smooth and will not overlap. The rearing ponds will be done one at a time so that production of bangus would not hamper in any way with the renovation. A detailed flow diagram of work phase is seen in Figure 3 in which it is divided into three phases, each number on top represents 15 days. The reference below the bar lines annotates the work area while the numeral above shows the approximate number of days alloted for the job.

## Start-up and completion of work

The best time to implement this renovation will be in the third cropping of bangus, between November and December when the nursery ponds are not in use. This would then be operational in time during the next bangus fry season which is in March,

The maturation ponds will be the first to be done so that when the December crop of prawns are in, selected big size prawns could be stocked as potential spawners. The prawn nursery and reservoir would be simultaneously constructed as well as the ground work for the hatchery to be started by this time, i. e. buildings, sheds, and water supply. Equipment will be purchased during this period and properly installed so that the last 30 days will be a test run and conditioning of tanks.

#### Culture process

The culture process would be by batch method wherein the prawn fry is grown in the nursery pond, transferred to a transition pond and finally reared to harvestable sizes in the rearing ponds. This is a continuous process. Pond preparation and food growing would follow soon after the pond has been harvested or transferred to another pond. Once the system has been in full operation, harvesting of prawns could be achieved in four months, one month for pond preparation and three months rearing for a total of three crops per annum.

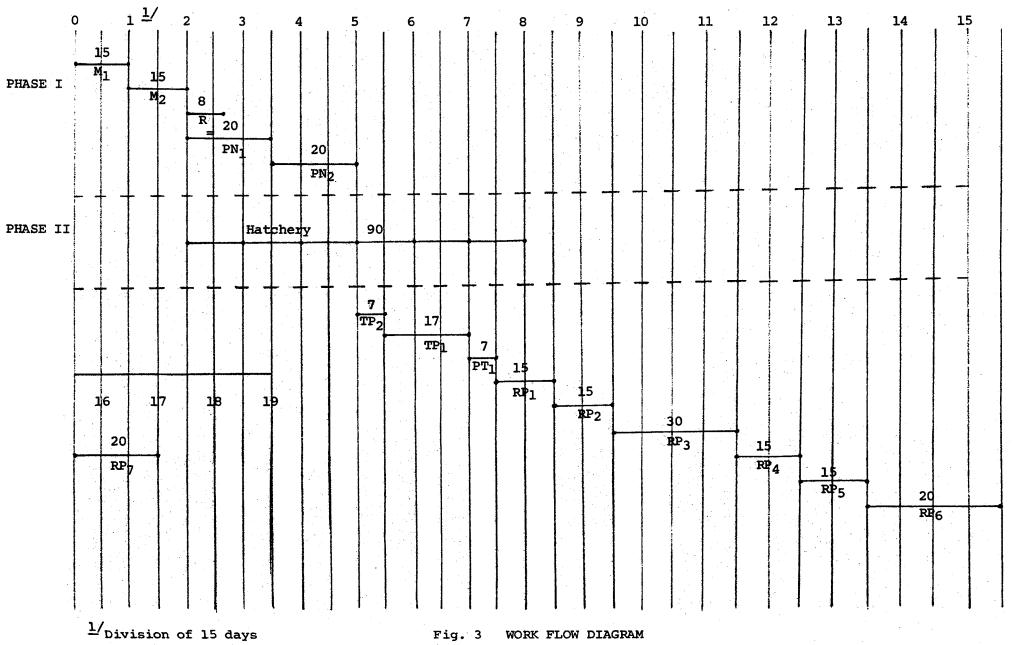


Fig. 3 WORK FLOW DIAGRAM

Table 4 shows the comparative stocking rates and mortalities of bangus and prawns. The survival indices are derived from using the denominator as the initial stock of fry to the nursery.

Table 4
RATES AND SURVIVAL INDICES

	Prawn Stocking Rate	Mortality Rate %	Survival Indices %	Bangus Stocking Rate	Mortality Rate %	Survival Indices %
Hatchery	50,000 <sup>L</sup>	1 70				
Nursery	1,000,000	50	50	200,000	30	70
Transition	100,000	30	35	25,000	10	63
Rearing	10,000	20	29	2,000	5	59

L<sub>1</sub> Per ton, Nauplius

The formula used for the survival indices is  $Sn = S_1 (1 - M_1 R_1)$ . This will indicate a true survival picture of the entire cropping period and individual stages of prawns.

### Hatchery process

Gravid spawners of stage four can be collected from the maturation pond twice a month to coincide with lunar cycle during the full moon and the new moon phases. It seems that the eggs of these gravid spawners during these phases of the moon have high incidence of good survival rates. Although this statement is non-conclusive, it does support experience.

These spawners are placed in spawning tanks of 300 liters individually, and will hatch within twelve (12) hours. Usually it spawns around 12 midnight to 3:00 a.m. The spawners are then removed in the morning while the eggs are collected and washed of debris. Eggs are collected with platform nets.

The eggs are then placed into a 300-liter hatchery tank with 28 percent seawater; when aerated mildly, they are hatched into nauplii within 12 to 16 hours. These nauplii are counted by the volume of one liter. Around ten samples would be ideal to get a good ratio number.

 $L_2$  Survival indices one for nursery to harvest  $S_n = S_n + 1$  (1-M.R.)

These nauplii are transferred to the conical hatching tank of 2 tons. Around 50,000 nauplii per ton are placed. In 15 to 18 days, these nauplii have grown to postlarvae stage and it is time to transfer to the nursery ponds.

#### Nursery process

The postlarvae (P5) are harvested from the hatchery tanks and acclimatized to the nursery pond water. It is acclimatized only to thermic and saline parameters. The pond has been prepared thirty (30) days beforehand to have a good growth of blue green algae. All the water that goes into the nursery passes two sand filters. At the inlet, water is pumped to a sand filter while at the outlet, water is fed gravitationally to another sand filter (see Figure 4). The outlet sand filter is connected to a 2 1/2 feet diameter PVC piping. piping runs through one side of the pond and water is controlled through a PVC stand pipe. This stand pipe has holes drilled at the uppermost water level of the reservoir tank to let water flow in when the stand pipe is pushed sideways. The collecting pit serves both as an outlet of water for the nursery pond and as catching pit for the harvest of juveniles. This collecting pit has a sand filter installed to prevent predators from swimming into the area. This is connected lengthwise to a drainage canal of one meter wide and 20 centimeters below nursery general bottom. Water exchange rate daily is between 20 to 30 percent of total water volume. Water depth is maintained at 50 cm to 60 cm.

The prawns are twice fed daily with two equal portions of 5 percent of their body weight. Feeding is done between 8:00 to 10:00 a.m. and 5:00 to 7:00 p.m. feeds are a mixture of grounded fishmeal, ground shrimps heads, corn bran, and sorghum bran.

#### Rearing process

The post larvae are stocked in prepared ponds ahead of bangus fingerlings. They are stocked at 10,000 fingerlings per hectare. These ponds have been prepared with lablab growth thirty (30) days before stocking.

Water at stocking time is between 30 to 35 cm and gradually increased every spring tide by 10 centimeters to the desired depth of one meter. Water exchange rate should be maintained between 10 to 15 percent water volume daily. Salinity at rearing period must be maintained between 14 to 25 ppt. This should be accomplished during the dry season from February to May by means of pumping river water at low tides.

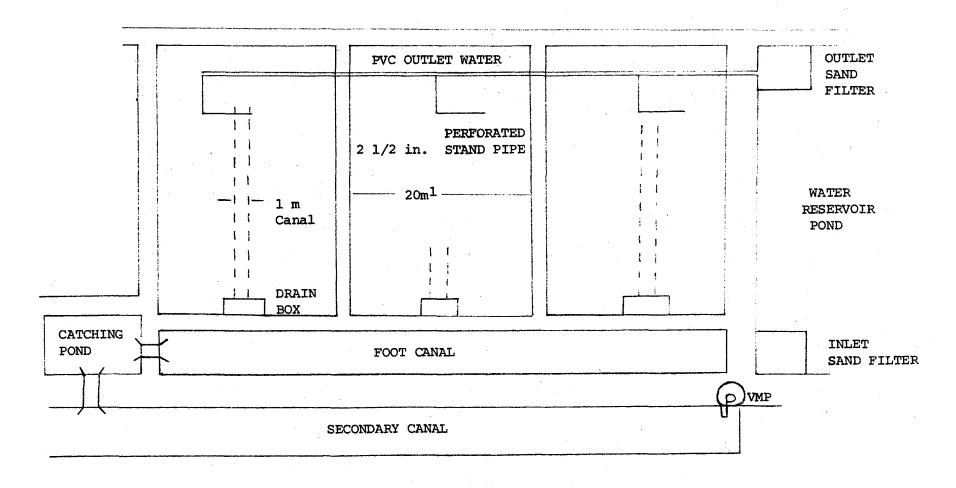


Fig. 4 NURSERY PRAWN POND

### Management

Single Proprietorship

This project will be a single proprietorship where the owner will finance the project from his own funds.

#### Labor

The area covered is thirty-six hectares since the optimum capacity of one man is only ten hectares. The project personnel requirement is one overseer for the whole project, four caretakers for bangus and prawns pond supervision, and two caretakers-technicians for the hatchery and the nursery ponds, or a total of seven.

Each personnel is provided with a house measuring 14' x 18' for themselves and their families, complete with housing facilities such as free lighting which is supplied by VRESCO as well as free medical care and hospitalization.

The overseer and the potential hatchery caretakers should have trained in prawn culture in the Prawn Cooperator's Program of SEAFDEC in Tigbauan, Iloilo. At present, there are four caretakers in the existing milkfish fishpond. The four caretakers will be assigned to the rearing ponds. While the two additional personnel will be hired for the nursery and the hatchery operations, all of them will be under the same supervision.

#### LIST OF PERSONNEL

Designation	Sex	Status	Basic <u>Salaries</u>	Living Allowance	Educ.	Prawn Seminar
Overseer	М	М	\$350.00/mo	₽50.00/mo	H.S.	SEAFDEC
Nursery Caretaker	M	M	300.00	50.00	Gr. 4	SEAFDEC
Hatchery Technician	M or	F M or E	· 300.00	50.00	н.s.	SEAFDEC
Pond Care- taker l	М	M	280.00	50.00	Gr. 4	SEAFDEC
Pond Care- taker 2	М .	М	280.00	50.00	Gr. 3	SEAFDEC
Pond Care- taker 3	M	M	280.00	50.00	Gr. 5	SEAFDEC
Pond Care- taker 4	M	М	280.00	50.00		-
		<b>p</b> /2	2.070.00	¥350.00		

The commission of the caretakers is \$70.05 per kilo of milkfish produced and \$70.50 per kilo produced of shrimps. This is divided equally among the personnel. The same benefit will be extended to prawn caretakers.

### Management and Supervision

Since <u>Penaeus monodon</u> is an omnivore, it requires more energy to produce with maximum results. Therefore, skilled personnel is required to be on look out all the time. Additional training of personnel is necessary in management of prawn. Prawn is delicate and raising it requires technical knowhow on the part of technicians. The technicians will be sent to SEAFDEC for the proper training on prawn management.

### Methods of Management

The methods of management are divided into three main items: water management, food growth, and feeding. Other minor items are procedures in counting of fry and stock transfer of bangus and prawn fry and juveniles.

### Water management

Water has many physical qualities some of which are directly relevant to aquaculture. The four basic relevant properties are temperature, salinity, dissolved oxygen, and pH. Some of these properties are interrelated.

Temperature of water is governed by solar radiation, the weather and the wind. The higher the temperature, the less dissolved oxygen a unit of water can hold. Like temperature, the higher the salinity, the less dissolved oxygen a water can hold. Good water management is a key to a successful fishpond.

### Nursery and Transition Ponds

The depth of water is maintained at 50 to 60 cm above the general bottom so therefore the average depth on the trenches would be 1.0 meter. At stocking time, water level should be at 25 to 30 cm. Temperature and salinities are measured during stocking time. A difference of 5°C gradient and 50 ppt above would induce stresses. Gradually increase water by 10 cm every incoming tide until the desired level is achieved. Water replenishment is done every spring tide and this should average 5 days, that is, there are three (3) draining days and two (2) filling days. Drain 10 cm only at a time; draining should be done only at the outlet gate. Replenish 15 cm at the inlet gate. Five (5) cm is a factor due to solar and wind evaporation of water. If shrimps are seen swimming above the surface during

daylight, it is a sign of stress or starvation or low dissolved oxygen levels and high water temperature. Replenish water immediately. If tides are not available, use the portaflow pump. Let the water flow into the inlet gate while draining a smaller amount at the outlet.

After heavy rains, whereupon there would be a salinity and temperature change, drain the fresh water by overflow at the outer gate and replenish water by tide or pump at the inlet gate.

### Rearing Pond

Generally, this is similar with the nursery and transition ponds; the only difference is that water is 1.0 meter on the general bottom and 1.3 meters at the trenches.

With the plankton method, general replenishment of water is done every 12 to 14 days to coincide with the moving period of last fertilization. If shrimp stress is noticeable, circulation of water must be resorted to. Place the portaflow pump inside to circulate the water. If stress persists, drain one third (1/3) of the water at the outlet gate while simultaneously replenish water at the inlet.

During the culture period, a daily check of dikes and gates should be done. Also, before draining for replenishment, the screen must be checked from damages and accumulated debris.

### Food Growing in Pond

There are two kinds of natural fish food growing in the pond -- lablab and plankton. Lablab is a Tagalog term for a biological association of decomposed phytoplankton and zooplanktons that grow at the bottom of the soil. It is usually greenish-brown in color. The predominant species of lablab is Oscillatoria spp.

Plankton, on the other hand, is a collection of microscopic organisms suspended in water. It is composed of phytoplankton and zooplankton.

There are five major considerations in brackishwater food production: (1) sunlight intensity, (2) temperature, (3) salinity, (4) organic content of soil, and (5) soil type.

#### Procedure in Lablab Production

- 1. Dry the pond bottom completely and dry it until it cracks.
- 2. Apply pesticides and mollusicide.

- 3. Apply organic fertilizer, chicken manure of two tons per hectare. One ton of chicken manure is equivalent to 40 sacks. Organic matter helps in developing algae. Soil containing 6 percent and above of organic matter produces good food growth.
- 4. Gradually admit water to about 10 cm.
- 5. After two days, apply two bags of 18-46.
- 6. Increase the depth of water gradually to about 25 cm.
- 7. If growth of lablab is few, re-drain the pond and apply again two bags of 18-46 per hectare. This condition is true if excessive rainfall was experienced after the first application.
- 8. If all five conditions are followed, lablab growth should be in sufficient quantity after 15 days to a maximum of 30 days.
- 9. To insure a steady growth of lablab with stocked fish, apply 1/4 bag of 18-46 every fifteen days after replenishment of water during the high spring tides. Do this if lablab growth is still insufficient after stocking.

If the lablab growth is still insufficient to sustain the growing fish until harvest time as in wont to be experienced in prawn-bangus production, the plankton method will have to be adopted. A lablab to plankton method would be economical due to less usage of inorganic fertilizer.

#### Procedure in Plankton Growing

Apply fertilizers on platforms, about 4 platforms per hectare or one on every corner, of 2 bags 18-46 at a rate of 20 kgs per hectare for two weeks to maintain water visibility of 20 to 30 cm. A Secchi dish would be employed to regulate plankton growth so it would not reach a danger level of 15 below.

#### Feeding Management

There are three feeding management procedures, one each for the nursery pond, the transition pond and the rearing pond. Although the recommended feeding rate of penaeid species as experimented in Australia was 3 percent of body weight, the 5 percent body weight is taken into consideration due to some species eating some of the feeds. Another consideration was that the cost of feeds as computed in the financial study was VI.10 or V3.30 per kilo to produce a kilo of prawn or it is approximately 13 percent of its wholesale price.

### Feeding in Nursery Pond

The nursery pond would accommodate roughly 100,000 fry per hectare. The average weight of the postlarvae would be about 500 mg and are expected to grow to about 5 grams a piece in two months' time. During the cycle, feeding will be about 5 percent of their body weight daily. The main constituent would be trash fish mostly tilapia. The tilapia fishmeal would be accumulated from previous harvest; cooked and sun-dried. Tilapia fishmeal would be placed in feeding rings. These are plastic hoses of one-inch diameter formed into loops by inserting the two ends together. This would prevent the feed from drifting to the different sections of the pond. The initial amount of feed would be one kilo daily; gradually increase its quantity to a maximum of 5 kilos daily taking into account the mortalities. There shall be a random sampling to be taken every two weeks to determine the average weight. If the feed under the feeding rings are not consumed, the amount of feed will have to be adjusted to their consumption.

#### Feeding in the Transition Pond

The transition pond would accommodate about 60,000 prawns per hectare. The 5-gram juvenile prawn would be expected to grow to 15 to 20 grams after two months. At this stage, the danger of cannibalism is well pronounced. The feed would be trash fish from the deep sea and tilapia, some copra meal, and animal protein. The animal protein would constitute frogs and rats. A feeding of 5 percent of its body weight should be maintained. Since the pond will be induced to plankton growth, this would minimize feeding.

#### Feeding in the Rearing Pond

The stocking rate would be about 10,000 fingerlings per hectare. The weight would be from 15-20 grams and they are expected to grow to 75-80 grams in two months. When the prawns have attained a desired weight, it is advisable to harvest them right away, allowing them to grow larger would increase mortality.

The feeding shall be 5 percent of its body weight, the feed stated for the transition pond shall apply likewise. This shall also utilize the feed mix efficiently. The feeding rate per hectare would be 10 kilos at the start to be increased to 25 kilos. This is on the basis that the expected harvesting per hectare would be 500 kilos taking into account the mortalities.

# Fry Management

The fry or seedling is the lifeblood of the bangus and prawn industry. To be assured of fry requirements of bangus or prawns, a method of recruitment must be made. The following are the recommended procedures for fry recruitment:

- a. Have three established fry agents whose integrity and honesty are well known;
- b. Have them quote the following items before accepting final delivery: the estimated number of fry; price offered; buying point; manner of payment; and where the fry would be inspected.
- c. Fry inspection should have these essential considerations: the condition of fry and quality of fry i.e. other species are not mixed.
- d. The estimated number of days since the time the fry were caught in the open sea; usually a period of three to seven days in a rough rule of thumb in order to have good survival rate of fry.

### Procedure in Counting of Fry

There are two basic procedures in counting of fry; the matching method and the percentage method.

### Matching Method

- 1. Have about 5 to 6 deep dish plate
- 2. Count 1,000 fry in one dish (subayan)
- 3. Match the other dish as with this subayan
- 4. Change the matched dish every 10 to 20 thousand fry counted. This is done because after a long time, the subayan becomes weaker and will tend to swim near the surface of water thus creating an optical illusion of a lesser number
- 5. Any discussion regarding the matched set will be treated in this manner: recount the doubtful dish accepted with the condition that if it is over 1,000, the buyer adds another thousand to the accepted number. If it is below 1,000, the seller gives the doubtful dish for free
- 6. The percentage of error in this manner depends upon the eyes of the one accepting it but an experienced person will incur an error of 1 to 5 per cent only.

#### The Percentage Method

- 1. Have a prior arrangement with the fry seller that all the fry baskets to be brought to the fishpond are of uniform number
- 2. Get 10 percent of the number of bags at random

- 3. Separate these bags from the rest to create a delineation
- 4. Use the matching method in counting on a per bag basis. Continue with the other 10 percent of the bags
- 5. If the bags are of the same number, get the total number, divide by the number of bags to find the average number per bag
- 6. Then multiply with the total number of bags brought by the fry seller to get the total number of fry
- 7. But, if the number per bag is uneven, do not accept because all the bags are not uniformly placed. Probabilities are that if this is the case, the buyer loses two-thirds everytime. If this is the case, revert to the matching method
- 8. If the number of bags are of the same number and the accepting person's eyes are experienced, the advantage of this method over matching method is that this is faster.

### Procedure of Stock Transport

Fry, either bangus or prawn, has to be transported with water. Polyetheline bags measuring 18" x 36" are used for this purpose. The fry are packed in double plastic bags with 10 liters of water; two parts sea water and one part fresh water. They are then placed in "buri" bags or cartons. The plastic bags are then inflated with oxygen. Bangus fry of 7,000 to 10,000 are placed into one bag roughly with 1,000 per liter of water. Prawn fry are from 3,000 to 5,000 per bag. To increase the number of prawn fry per bag, a block of ice must be placed outside the plastic bag just enough to bring temperature down by 5 percent. Bringing down temperature stimulates hibernation so that movement and oxygen levels will be at minimum. About 30,000 fry of P9 to P15 could then be accummulated.

The oxygen level is measured by collapsing the bag to water level then placing your hand below 10 inches from the top and fill with oxygen until there is a feel of resistance. The bag is then secured by twisting the top and tying it with two rubber bands. The estimated period of sustainable oxygen level for this method is from 18 hours to 24 hours.

### Pest and Predators Management Control

To insure good production on prawns and bangus, the growth of food should be maintained by eliminating pests and predators. Draining is one of the best methods of eliminating predators. Dry the pond bottom until it cracks for soil aeration purposes and to have a stable soil for lablab to develop. Drying is usually from seven to nine days.

Application of Gusathion A, an organophosphate insecticide will fully eradicate all fish species. This chemical has no residual effect and deterioration is fast that in seven days, it is safe to stock.

Brestan, Aquatin, Deuter are molluscide available in the market which are effective in their recommended rates.

Weeds at the sides of the pond are removed. They serve as hiding places of water snakes and compete with food nutrients.

Gates are checked for leakages and immediately repaired. The screens and the bag nets are checked for holes and dried algae growth are removed. Dikes are also checked for leakages. A method of repairing the dike is by digging a puddle trench at the middle of the dike, replacing the soil with new piles of soil, and compating the new soil.

Upon transfer of the fry to the transition pond, the nursery pond is left vacant in preparation for the next stocking process. The pond bottom is dried for two weeks while the following are being done:

- 1. repair of wooden gates
- removal of wrecks and other debris; e.g. coconut leaves, and plastics
- 3. removal of siltation of the sides and construction of a pathway on which the caretaker could walk around, and
- 4. repair of catching pond.

### Harvesting Management

Since the crop is a polyculture of prawns and bangus, each having different harvesting techniques, a procedure of harvesting has to be designed. Bangus, being easier to harvest is harvested first. It is done by draining the pond water and letting the fish swim against the current. Some prawns and shrimps would be included during the draining if harvesting is done in the evening.

Various catching and harvesting paraphernalia should be well prepared and brought to the pond site at least one day before the scheduled harvest.

### Methods of Packaging

The fish or shrimps are placed into the chilling box to kill them and lower their body temperature. The ratio of ice to fish is two blocks of 300-pound ice for every ton of fish with one more block of ice for transport purposes. They are then transferred into a wooden box measuring 12" high, 16" wide, and 24" long while awaiting to be packed.

Icing and packaging for shipment to Manila are done in a big wooden box measuring 48" in height, 54" in width and 72" in length. The box is built to withstand a content pressure of two (2) tons of ice and a ton of fish or prawns.

The general procedures for fish or prawn icing in a wooden box are as follows:

- 1. A four-inch bottom layer of crushed ice is evenly laid out and compacted to minimize thawing
- 2. This is followed by a layer of fish, each laid on its side, belly in one direction and all heads in another direction so that the first layer of ice is covered with fish. Each layer would be about 150 kilos of fish.
- 3. A 3-inch layer of crushed ice is then laid on the fish so as no fish would be visible. This is then compacted.
- 4. The placing of alternate layers of ice and fish is continuous until the box is filled. A box could hold seven (7) layers of fish.
- 5. The last layer on top would be 5" thick and covered with a plastic sheet to protect it from rain or wind. The cover is nailed to make it more secure and safe.

The same prodedure of packing applies to prawns. The only difference is that a chicken wire should be placed before each layer of crushed ice to prevent the weight of the upper layer from crushing the prawns.

Pond Recording and Data Collection

In every business enterpise, record keeping is a must if a business is to succeed. Recording of data should be kept regularly. Different forms of data collection may be obtained from the SEAFDEC Leganes Station. The informations should be properly entered and the forms kept for ready reference for decision making. The information guides the owner and technicians in evaluating the performance of the project and helps in finding ways to improve results.

#### Conclusions and Recommendations

The present technology of prawn culture could readily be adaptable if the following requirements are present: water salinity of 15 to 25 ppt is available and prawn fry or fingerlings can be readily obtained in sufficient quantity. Management techniques are easily taught to operators and technicians, especially with the assistance of SEAFDEC through the different seminars that they offer to those who are interested in the project.

The hatchery system has yet to be proven viable in a small scale program, in this connection it is recommended that various enterpreneurs dedictate themselves to hatchery process while others to prawn fingerlings rearing. This would help solve the problem of non-availability of prawn stocking materials locally.

It is true that the capital needed to invest in this venture is quite big and the rate of return in the first years of operation is not as high as to cover up for the initial capital; however, the profitability is there. The business forecast showed that prawn has a more stable price than bangus.

Thus, it is recommended that a fishpond owner should start prawn culture on a small area to gain experience after which he can cover the whole area to avoid big losses that might arise from miscalculations and inadequate knowledge and experience.

LARVAL REARING OF BIVALVE MOLLUSCS

Adam L. Young SEAFDEC Aquaculture Department

#### LARVAL REARING OF BIVALVE MOLLUSCS

#### Adam L. Young

Probably no more than two species of commercially important marine bivalves in the Philippines have ever been cultured thru their entire life cycle. The life cycles of the window-pane shell, Placuna placenta, the pearl shell, Pinctada maxima, the sun and moon scallop, Amusium pleuronectes, the oyster, Crassostrea iredalei and scores of other bivalves are entirely unknown. However, many investigators in the United States, Europe, Great Britain, Australia and New Zealand have made significant contributions to the field of larval rearing of bivalves and many of their techniques are adaptable to our tropical species. The larval stages of the green mussel, Perna viridis (Mytilus smaragdinus) for example, have been successfully reared (Young, 1979) thru the juvenile stages using such adapted techniques. This paper is a synopsis of such techniques for rearing the larvae of bivalve molluscs.

To avoid excessive citations (owing to the wealth of literature on almost every aspect of larval rearing), literature references will be kept to a minimum. Instead, a list of references is appended for the benefit of those who wish to delve deeper into the topic.

#### Broodstock

Only adults with mature gametes are collected as breeding stock. To determine general gonadal condition of a specific population it is sufficient to examine a few sample specimens. Mature eggs become well rounded in seawater, while spermatozoa swim actively upon introduction of seawater.

Adults with mature gametes may be kept in ripe condition for short periods of 1-2 weeks without food in 20-22°C aerated seawater, or for longer periods (1-2 months) if well fed. By maintaining 30-40 mature adults in a cold water (20-22°C) broodstock tank, a supply of viable gametes for experimental work can be assured year-round.

#### Induced Spawning

Most bivalves release their gametes into the water where fertilization and larval development occur. Spawning may be induced in a male or female by introducing gametes of the opposite sex. At times, it may be necessary to rapidly increase and/or decrease the water temperature before adding the sperm or egg suspension. The oyster, Crassostrea iredalei has been found to respond to either stimuli. The green mussel P. viridis does not respond to temperature fluctuations unless "conditioned" in cold water for a few days. They are stimulated to spawn by sudden cessation of water flow and/or by its resumption. The scallop Amusium is easily induced to spawn by raising the temperature of the water by 7-10°C.

If natural spawning occurs, care must be taken to discard excess sperms as these soon rot and foul the water. Fertilized eggs may be cultured at densities recommended below.

#### Rearing of Larvae

#### Seawater

Seawater to be used for rearing bivalve larvae must be free of pollution by metals, detergents or pesticides — all of which are directly toxic to larvae. Indirect toxicity can occur thru chelation of essential trace elements, inactivation of cilia, or inactivation of digestive enzymes. Freshly sand-filtered seawater has been used satisfactorily for larvae of mussels and oysters. If available, finer filters which can remove all particles bigger than 10 um will give even better results. As an alternative to the use of costly and possibly even growth-inhibiting additives for reduction of contaminants in seawater, strict attention should be paid to good housekeeping, frequent washing of larvae and avoidance of static water conditions.

#### Culture Vessels

Because of the corrosive nature of seawater and the great sensitivity of the larvae to traces of dissolved substances, culture vessels used for rearing bivalve larvae should be preferably those made of either glass, plastic or fiberglass and should be essentially cylindrical in shape, with the depth greater than the diameter.

## Food for Larvae

The best food for very young larvae is naked flagellates -- mobile, unicellular organisms of microscopic size (nannoplakton) without any cell wall but containing chlorophyll. In this regard, <u>Isochrysis galbana</u> and <u>Monochrysis</u> sp. have been found to be excellent food for mussel and oyster larvae. Later larval stages will feed on unicellular green algae which have a cell wall, and even on diatoms.

#### Larval Density/Food Concentration

Recommended concentration for optimum larval growth:

Larval lengtl	h <u>Num</u>	ber/ml	Algal cells/ml
50 - 100 um	15	- 30	30,000
100 - 200 um	8	- 10	50,000
200 - 300 um	5	- 8	80,000
300 um	+ 1	- 3	100,000

#### Water Management

Water should be changed at least every third day. To change water, the culture may be siphoned and the larvae collected in a sieve. With precise selective screening, the larvae can be separated from debris and only clean and healthy larvae should be returned to the culture vessels. Gentle aeration should be provided at all times. Bivalve larvae grow well at temperature between 28-30°C and salinities between 25-31 ppt.

#### Larval Development

Fertilized eggs normally develop into the first larval stage, the trocophore, 10-12 hours after fertilization. After another 12 hours they become well-formed straight-hinge veligers with a bivalve shell and a swimming organ called the velum. As growth proceeds, the umbo starts to form and gradually becomes distinct and/or prominent in most species. Mature larvae develop an eyespot on each side of the bivalve shell and soon are equipped with a functional foot for crawling and subsequent attachment to suitable substrates. Attached larvae (spats) soon metamorphose into the adult form.

#### Monitoring of Settling

When plenty of mature larvae are observed in the cultures, artificial substrates such as empty bivalve shells, tiles, or bamboo pieces should be suspended in the water to provide settlement substrates for the settling larvae. Spats may be fed algal cells up to 250,000 cells/ml and can utilize a wide variety of algal species. Spats may be transferred to the field at the size of 10-20 mm.

#### REFERENCES

- Chanley, P. 1975. Laboratoty culture of assorted bivalve molluscs.

  In: Culture of marine invertebrate animals. WL Smith and M.H.

  Chanley (eds.) Plenum Press, NY. pp. 297-317.
- Drinnan, R.E. and J.P. Parkinson. 1967. Progress in Canadian oyster hatchery development. Fish. Res. Bd. of Can., Biol. Sta. St. Andrews, N.B. General Series circular #15.
- Galtsoff, P.S. 1964. The American oyster <u>Crassostrea virginica</u> Gmelin Fisheries Bulletin of the Fish and Wildlife Service, Volume 64.
- Hidu, H. and M.S. Richmond. 1974. Commercial oyster aquaculture in Maine. Maine Sea Grant Bull. 2. U.S. Dept. of Commerce.
- Loosanoff, V.L. and H.C. Davis. 1963. Rearing of bivalve molluscs.

  <u>In:</u> Advances in marine biology. F.S. Russell (ed.) Academic Press, London. 1:1-136.
- Loosanoff, V.L. and H.C. Davis. 1963. Shellfish hatcheries and their future. Commercial Fisheries Review, Vo. 25. U.S. Dept. of the Interior, Fish and Wildlife Service, Wash. D.C., U.S.A.
- Matthiessen, G.C. 1970. A review of oyster culture and the oyster industry in North America. Contribution no. 2528, Woods Hole Oceanographic Inst., Woods Hole, Mass. U.S.A.
- Medcof, J.C. 1961. Oyster farming in the Maritimes. Bull. #131, Fish. Res. BD. Can. Ottawa.
- Quayle, D.B. 1969. Pacific oyster culture in British Columbia. Fish. Res. BD. Can. Bull. #169. Ottawa.
- Quayle, D.B. 1971. Pacific oyster raft culture in British Columbia. Res. BD. Can. Bull. #178. Ottawa.
- Ukeles, R. 1975. Views on bivalve larvae nutrition. <u>In: Proceedings</u> of the 1st Int'l. Conference on aquaculture nutrition. Oct. 14-15, 1975, Lewes/Rehoboth, Delaware. pp. 127-162.
- Walne, P.R. 1974. Culture of bivalve molluscs. The Buckland Foundation and Fishing News (Books) Ltd., England. 173.
- Young, A.L. 1979. Larval and postlarval biology of the tropical green mussel Mytilus smaragdinus Chemnitz 1785. (in press).

FARMING OF MUSSELS AND OYSTERS IN THE PHILIPPINES

Wilfredo G. Yap SEAFDEC Aquaculture Department

#### FARMING OF MUSSELS AND OYSTERS IN THE PHILIPPINES

#### Wilfredo G. Yap

- A. Culture approach in the Philippines
  - 1. Growing done in spatfall area
  - 2. No thinning
  - 3. Structures fixed to bottom
- C. Materials used
  - 1. Primary bamboo
  - 2. Secondary
    - a) mussels: polypropylene ropes
    - b) oysters: monofilament, oyster shells, old rubber tires
- C. Culture techniques
  - Broadcast (for oyster only)
  - 2. Stake
  - 3. Bitin presently applied to oyster only but basic principle applicable to mussels
  - 4. Tray good for growing loose oyster spats, not applicable to mussels
- D. Problems with present method
  - 1. Crowding results in uneven growth and distortions.
  - 2. Since space is the limiting factor, in mussels there is a larger number of spats lost simply due to lack of space.
  - 3. Siltation is greatly enhanced by the number of bamboo poles in the bottom. This results in environmental deterioration for mussels and oyster production.
  - 4. Materials used are very temporary in nature and have to be replaced very often. Alternative materials are very expensive with no intermediate alternatives.

#### E. Research Results in SEAFDEC

- 1. Coconut husks found to be very attractive spat collectors for mussels. Spat collection on polypropylene ropes enhanced greatly by insertion of coconut husks at regular intervals.
- 2. A method of thinning and transplanting developed using strips of sinamay to bind mussel spats to growing ropes.
- 3. Use of floating structures will be very convenient but rather expensive.
- 4. Production of 5-10 kg mussels per meter polypropylene rope can be attained in 6-8 months.
- 5. It seems possible to eventually evolve a larval monitoring program for oysters to find out time of laying down cultches to catch primarily C. iredalei.
- 6. Post-harvest life of mussels can be extended by chilling.
- 7. The brown mussel, the most widespread mussels in the Philippines, has very low aquaculture potential.
- 8. The green mussel should be classified as <u>Perna viridis</u> rather than <u>Mytilus smaragdinus</u>.

# POST-HARVEST PROCESSING OF OYSTERS AND MUSSELS

Rogelio Q. Gacutan SEAFDEC Aquaculture Department

#### POST-HARVEST PROCESSING OF OYSTERS AND MUSSELS

#### Rogelio Q. Gacutan

Not much preparative processing is accorded to oysters or mussels between harvest and consumption. In the Philippines, oysters and mussels are eaten within the same day of purchase for fear of product spoilage.

The relatively fast rate of degradation suggests a rapid microbial action. Microbiologically, oysters and mussels are a veritable depository of a wide spectrum of microbes and this is linked to their unique property of being able to concentrate, within their tissues, whatever bacteria are found in the external medium.

An oyster or mussel 3 inches long would, in a day, normally pass through its system 10 to 15 gallons of water (Hulburt and Hulburt, 1975). Considering that this water has its own natural load of microbes it would be easy for one to imagine the level of contamination that the oyster or mussel has initially.

Oysters harvested from culture sites which normally are muddy are packed right away into wooden boxes, bamboo baskets or sacks without washing or diminution of adhering soil particles and fouling organisms. These are then stored for a few hours in such containers, transported to markets for sale, and laid out on warm market stalls.

In transit, the oysters pick up an undetermined yet substantial load of microbes (mesophiles) to add to the initial number. Once in the market, the seller, as if motivated by a desire to keep fresh and prolong the shelf life of the product, keeps on sprinkling water. The practice only serves to spread soil-borne microbes on the table, increasing the possibility of their entry into the mussel flesh from which they should have kept away in the first place.

#### Fattening before/after harvest

In many places around the world, the harvested oysters or mussels are not brought immediately to markets for sale; these are transferred to specially designated areas either for "fattening" or for cleansing, depending on the location, season, etc.

In Marenne-Oleron, France, for instance, 28-month old oysters, on the approach of winter, are collected from the parcs and placed in 35 cm deep ponds ("claires") for 2 to 6 months (Anderson, 1977).

These claires are connected to the sea by a system of canals and gates that make possible regulation of the water flow and depth. In the claires is carried out the "greening" of the epithelium and gills with thick cultures of Navicula ostrearia. The green color conferred is the basis for acceptance. The "fines de claires" are kept in these facilities for 2 months at a density of  $10-15/m^2$  while the "les speciales," 6 months at  $3-5/m^2$ .

In Prince Edward Island, Canada the "relay" system is resorted to. Since all oysters are grown in contaminated public beds, these are moved upon harvest to uncontaminated leased grounds during the spring for a whole summer before marketing (MacKenzie, 1975). Although the move is for cleansing it is obviously for further growth, too.

In the Netherlands town of Waddenzee where mussels are cultured in muddy substrates the mussels are dredged at harvest and therefore in the process imbibe lots of silt and particles (Hulburt and Hulburt, 1975). Undesirable for consumption at this stage, they are moved down the Dutch Coast to the Rhine near Belgium and deposited on the sandy bottom of the bay. This operation likewise is obviously for cleansing and strengthening.

## The need for cleansing

Extensive investigations have been made on the public health aspect of oyster and mussel microbiology since Dodgson's (1928) study. As disease carriers they are able to harbor populations of <u>Salmonella</u> and <u>Shigella</u> as well as less pathogenic coliforms within their tissues. In fact the growth of the above-named genera in tissue homogenates continue to form the bases of control measures for the prevention of shellfish-borne gastroenteritis.

Isolated reports noted the presence of various pathogenic or potentially pathogenic organisms such as Spirochaetae anodontae (Fantham, 1907); Saprospira and Cistispira (Dmitroff, 1926); "Vibrios" (Elliot, 1926; Gacutan, 1974); Vibrio parahaemolyticus (Aoki et.al, 1967; Bartley and Slanetz, 1971), Mina herellea and Neisseria (Gacutan, 1974).

In the Philippines, the few studies on oysters have aptly dealth with coliforms (Salafranca, 1952; 1953) and on the natural bacteria flora with emphasis on spoilage-causing genera (Gacutan, 1974). Salafranca's first study (1952) positively showed the presence of coliforms and other indicators of pollution; the second discussed preparative treatments of oysters for consumption for the purpose of deactivating these organisms.

Although limited to a few sources (Salafranca got his samples from areas adjoining Manila and Binakayan; Gacutan bought his from Cubao Farmers Market and from Cavite) results of the studies may be expected of samples from throughout the archipelago and therefore could serve as models.

Carrying the work further, Gacutan (1978, unpubl. results) studied the various coliform genera and species isolable from Iloilo City oysters. The sampling lasted from September 1977 to January 1978. The potentially pathogenic Enterobacteriaceae observed were Eascherichea coli, Klebsiella pneumoniae, K. ozanae, Citrobacter freundii, Enterobacyer cloacae and E. agglomerans. The first 2 were observed in monthly samplings; the rest sporadically. It is to be emphasized that the better known causes of gastroenteric infections -- Salmonella, Shigella (and Virbio) were deliberately not included for some technical difficulties.

#### The need for detoxification, depuration

Fortunately the Philippine oyster industry is not faced with the immense problem of paralytic shellfish poisoning (PSP) which is experienced in temperate countries especially the US, Canada, Scotland, Norway, UK and Portugal (Loosanoff, 1973). This type of poisoning results from ingestion of bivalves which have consumed the dinoflagellates Gonyaulax catenella and G. tamarensis (Quayle, 1969; Prakas et.al, 1971; Loosanoff, 1973).

There is however a need to purge oysters of coliforms, Entebacteriaceae, and other potential pathogens in view of reports of gastroenteric disturbances due to oyster/mussel consumption. In other words, oyster should be depurated before sale in markets.

In countries with strict laws, the sale of oysters and mussels grown in areas confirmed to be polluted with sewage, and even the culture, may be restricted and shores closed. This was resorted to in the advent of human population growth centers as in Southern Mississippi specifically the traditionally oyster-rich Pascagoula river in 1961. Biloxi Bay in 1967, St. Louis Bay and Graveland Bayou in 1975 (MacKenzie, 1975). Reef closures due to pollution however leads to economic dislocation of small, subsistence oystermen. Certainly, there are other solutions.

The fattening process in claires being done in Marenne-Oleron, France, the relay system in Prince Edward Island, and the transfer from muddy to sandy substrata in Waddenzee are essentially depuration processes. There are instances when more refined and slightly more advanced technology is resorted to.

In Marenne-Oleron, after the oysters are harvested from the claires, the owner-culturist is required by law to transfer the same to cement basins to expel pseudofeces from the viscera (Anderson, 1977). The oysters are then sorted by size and shape, placed in baskets, and certified as to quality grade ("fines de claire," "speciales," etc.) and transported for marketing.

Each country has its own depuration policy. France and US have no fixed laws to abide by except when PSP is reported; while Spain and the Netherlands are two countries with very strict regulations. In Spain, any oyster/mussel earmarked for sale fresh in the country or outside must, by law, be depurated for 48 hours (Hulburt and Hulburt, 1975).

#### The depuration process, duration

The technology is relatively simple. Seawater (clean as sterilized) is pumped into large holding tanks and the load of impurities is quantified. The proper amount of chlorine (in France, ozone is used) is added and allowed to evaporate. The mussels/oysters are then placed on rocks in tanks, and the purified (treated) water is slowly pumped over for 48 hours. The oysters/mussels, now clean are placed in bags, sealed, tagged and rinsed. The draining takes 3 hours. These are then shipped unrefrigerated in closed trucks. When properly depurated, the samples should keep for 3 days (Hulburt and Hulburt, 1975).

The time involved to completely purge oysters of their coliform load should vary with each sample. While oysters are assured clean in 48 hours as in the above case, oysters from Mexico are deemed cleansed in 7 days (Ogle et.al, 1977).

# Processing to prolong keeping time and quality of oysters

Extensive characterization of the natural bacterial flora in the US (Colwell and Liston, 1960; Vasconcelos and Lee, 1972) showed a predominance of Pseudomonas, Vibrio, Achromobacter, Flavobacterium, to name a few. These two research groups have consistently shown a relatively high initial load of Pseudomonas and Achromobacter, two general linked with proteolysis. Philippine oysters (Gacutan, 1974) are characterized by a very low initial Pseudomonas content but very high Flavobacterium load. The latter is an indication of freshness.

On these counts, Philippine oysters should keep longer if processed properly. There is a tendency for Filipinos to eat their oysters immediately after steaming, never trying to keep some for the next day. Mussels are sometimes processed into a "bagoong" kind of preparation popular in the south. Raw-stock mussels are shucked, placed in bottles and salted for a fermentative process that assures an improved flavor, and, more importantly, freedom from pathogenic organisms.

In other countries, oysters-mussels intended for canning are placed in steaming machines for cooking. The shells open automatically during the heating, are shucked by hand, and placed in brine solution. The meats then float, enabling the worker to skim them off, washed, and placed in cans. Sauces are then added, heated in retorts and sealed (Hulburt and Hulburt, 1975; MacKenzie, 1977). Raw-stock mussels after cold shucking are placed in plastic containers, quick-frozen and sold.

#### References

Anderson, S.L. 1977. Proc. World Marcult. Soc. 8:373-386.

Aoki, Y., Hsu, S.T. and D. Chun. 1967. Endem. Dis. Bull. Nagasaki University. 8:191.

Bartley, C.H. and L.W. Slanetz. 1971. Appl. Microbiol. 21:965-966.

Colwell, R.R. and J. Liston. 1966. Appl. Microbiol. 8:104-109.

Dmitroff, V.T. 1926. J. Bact. 12:135-177.

Dodgson, R.W. 1926. Minn. Agr. Fish. Invest. Ser. II, 10:1-498.

Elliot, C. 1926. Am. J. Hyg. 6:755-776.

Fantham, H.B. 1907. Ann. Maq. Nat. Hist. (London) Ser. (7) 19:493-501.

Gacutan, R.Q. 1974. M.S. thesis (Unpubl.), U.P.

Hulburt, C.G. and S.W. Hulburt. 1975. Mar. Fish. Rev. 37(10):10-18.

Loosanoff, V.L. 1973. Proc. World Mar. Soc. 4:341-352.

MacKenzie, C.L. 1975. Mar. Fish Rev. 37(3):21-35.

MacKenzie, C.L. 1977. Mar. Fish. Rev. 39(1):1-13.

Ogle, J., Ray, S.M. and W.J. Wardle. 1977. Proc. World Maricult. Soc. 8:447-452.

Prakash, A., Medcof, J.C. and A.D. Tennant. 1971. Fish. Res. Board Canada Bull. 177:1-87.

Quayle, D.B. 1969. Fish Res. Board Canada Bull. 168:1-68.

Salafranca, E.S. 1952. J. Phil. Publ. Health Assn.

Salafranca, E.S. 1953. Phil. J. Fish. 2:90-106.

Vasconcelos, G.J. and J.S. Lee. 1972. Appl. Microbiol. 23:11-16.

POST-HARVEST HANDLING OF MUSSELS AND OYSTERS

Anselma S. Legaspi
Bureau of Fisheries and Aquatic Resources

#### POST-HARVEST HANDLING OF MUSSELS AND OYSTERS

#### Anselma S. Legaspi

Shellfish production particularly of mussels and oysters, has substantially increased due to the advent of mariculture. With increased production, problems of handling, processing, marketing and distribution have multiplied.

Post-harvest handling of mussels and oysters is beset with problems more than that of fish, not only because of its higher degree of perishability, but also because of adverse effects of its habitat, not to mention its bulk, which makes it more difficult to handle.

The problem is threefold: First, shellfish spoils more readily than fish because these contain far greater amounts of free amino acids. Second, oysters and mussels harvested from polluted water are heavily contaminated with bacteria (E. coli and A. aerogenes) which could cause food poisoning. Third, oysters and mussels when unshelled are bulky, hence troublesome and expensive to transport.

Researches and technological advancements have somehow minimized if not totally solved these problems.

#### 1. Perishable nature of mussels and oysters

On the problem of high degree of perishability, several studies have been undertaken both here and abroad to keep mussels and oysters alive for a longer period of time or to improve its shelf life.

Guevara et al. 1/ were able to prolong shelflife of mussels for four days by lowering storage temperature to 12°-14°C with the use of ice, but making sure that the byssus are not removed and that the mussels do not get in contact with the melted ice.

Boyd and Wilson<sup>2</sup> were also able to extend the shelf life of mussels for 4 days by storing them in ice in specially designed cardboard boxes and left at ambient temperature (15 to 18°C). However, they found out that even if the mussels stayed alive, after 2 days there is a degradation of quality.

 $<sup>\</sup>frac{1}{G}$ . Guevara, F. Abella, S. Canonigo and H. Bello. "Preliminary Study on the Handling, Transport and Depreciation of Green Bay Mussels." BFAR, Quezon City. (PTO).

<sup>2/</sup>N.S. Boyd and N.D.C. Wilson. "Handling and Processing of Raft-Formed Mussels," Proceedings of 18th IPFC Session, (Manila, Philippines; March 1978).

To prevent degradation of quality, they recommended that mussels should be stored at temperature between 5° and 7°C. Musseles stored at this temperature become unacceptable only after 5 days.

## 2. Contamination from Habitat

Gibson, in 19573/, recommended a three-phase purification method whereby the mussels are stored for 24 hours in chlorinated seawater (3 ppm) which is neutralized with sodium thiosulfate. This process is done twice. The shellfish function normally in the clean water, with the result that they filter out of their system any waste product likely to contain harmful matter. At the end of the second bath, the shellfish are bathed with chlorinated but not neutralized seawater. This causes them to close their shells and cease to function so that the shells themselves become purified, thus both the inside and the outside are practically purified.

Guevara et al. $\frac{4}{}$  recommend 24-hr storage of mussels in 3% iodized salt solution and storage in clean seawater.

# 3. Marketing and distribution problem

Marketing and distribution problems are brought about by the bulky nature of shellfish, particularly if they are to be marketed with shell on.

Modern processing technology makes it possible to process fish and shellfish in such a manner by which the above-mentioned problems are minimized, if not completely solved.

Mussels and oysters may be shelled and individually quick frozen or quick frozen in bulk, making transport and distribution less troublesome and less expensive.

Other fish processing methods, like pickling, drying, smoking, canning, bottling or converting shellfish into powder, have also partially solved the problem of marketing and distribution.

Acceptability was a marketing-related problem several years ago. This is no longer a problem though especially after the Bureau of Fisheries and Aquatic Resources sponsored a mussel cooking contest during its observance of Fish Conservation Week in 1977, during which more than forty (40) mussel recipes were entered. Twelve recipes were selected as winning entries.

 $<sup>\</sup>frac{3}{F}$ .A. Gibson, Fisheries Division.

 $<sup>\</sup>frac{4}{\text{Loc.}}$  sit.

<sup>5/</sup>Bureau of Fisheries and Aquatic Resources. "Mussel Recipes, Entries to the Tahong Cooking Contest Det. 1977".

These problems, together with other problems which I failed to mention here but do exist in the industry, could serve as "ticklers" for handling, processing and marketing technology.

# A SOCIO-ECONOMIC STUDY OF MOLLUSC FARMING IN THE PHILIPPINES

Aida R. Librero and Elizabeth S. Nicolas Philippine Council for Agriculture and Resources Research

# A SOCIO-ECONOMIC STUDY OF MOLLUSC FARMING IN THE PHILIPPINES

## Aida R. Librero and Elizabeth S. Nicolas

#### 1. Introduction

This study would attempt to lend insights into the technology, resource utilization and profitability of oyster and mussel sea farming as actually practiced in farmers' fields. For mussel, the biggest producer is Bacoor Bay in Cavite, although other potential areas for cultivation have been also identified. The mussel study included 30 operators from Bacoor, Cavite, while the oyster study included 163 operators distributed as follows: 99 from Ilocos, 6 from Cagayan Valley, 48 from Southern Luzon and 10 in Western Visayas.

#### 2. The operator and his farm

An average oyster/mussel farmer is male, 43 years of age and had received some formal education for about 6.3 years (Table 1). Some 10 percent of the oyster farmers and 7 percent of the mussel farmers were not able to attend school.

Table 1. Some characteristics of oyster and mussel farm operators.

Number of farms 163  Sex (percent)  Male 96  Female 4  Average age (years) 44  Educational attainment (percent)  None 10  Primary 19  Intermediate 41  High School 26  College 4  Average years of schooling 6.3  Operator with other occupation (percent) 80  Annual income from other occupation (P) 2418  Labor use (months)  Oyster/mussel operation 9.4  Not gainfully employed 1.5	Mussel	Total
Male Female  Female  Average age (years)  None None Primary Intermediate High School College  Average years of schooling Operator with other occupation (percent)  Annual income from other occupation (percent) Oyster/mussel operation Other occupation Other occupation  1.1 Other occupation 9.4	30	193
Female 4 Average age (years) 44 Educational attainment (percent) None 10 Primary 19 Intermediate 41 High School 26 College 4 Average years of schooling 6.3 Operator with other occupation (percent) 80 Annual income from other occupation (percent) 2418 Labor use (months) Oyster/mussel operation 1.1 Other occupation 9.4		
Average age (years) 44  Educational attainment (percent)  None 10  Primary 19  Intermediate 41  High School 26  College 4  Average years of schooling 6.3  Operator with other occupation (percent) 80  Annual income from other occupation (percent) 2418  Labor use (months)  Oyster/mussel operation 1.1  Other occupation 9.4	100	96
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College 4 Average years of schooling 6.3 Operator with other occupation (percent) 80 Annual income from other occupation () 2418 Labor use (months) Oyster/mussel operation 1.1 Other occupation 9.4	43	42
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Annual income from other occupation (7) 2418 Labor use (months) Oyster/mussel operation 1.1 Other occupation 9.4	6.3	6.3
Labor use (months) Oyster/mussel operation Other occupation 9.4	100	83
Oyster/mussel operation 1.1 Other occupation 9.4	2248	2386
Other occupation 9.4		
<del></del>	0.9	1.1
Not gainfully employed 1.5	8.6	9.3
	2.5	1.6
Years in oyster/mussel operation 8	7	. 8
Years operating present farm 7	· 7	7

Eighty three percent of the oyster/mussel operators were also engaged in other occupations mostly fishing which on the average, generated an annual income of \$\mathbb{F}2,386\$.

The mollusc farmer spent most of his time in these occupations, about 9.3 months, and only 1.1 months (full time equivalent) were devoted in the oyster/mussel farm. They were not gainfully employed for about 1 1/2 months. An average oyster/mussel farmer had been operating his present farm for seven years. Moreover he had at least one year experience before he started operating his present farm.

Majority of the farmers decided to enter into the oyster/mussel business due to either the discerned "profitability" or popularity of the business in their areas.

Oyster and mussel farms had an area of about 2,460 and 1,784 sq m, respectively, Western Visayas had the largest oyster farms averaging 10,800 sq m for the farms studied. Southern Luzon farms had an area of 4,843 sq m; in Cagayan Valley, 3,678 sq m.

Table 2. Distribution of oyster and mussel farms by region and farm size

	Ilœos	Cagayan Valley	Southern Tagalog	Western Visayas	A11	
Oyster						
500 sq m & below	84	17	56	-	68	
501 sq m & above	16	83	44	100	32	
Average area	434	3678	4843	10800	2460	
Mus <b>sel</b>	•					
600 sq m & below	_	_	50	_	50	
601 sq m & above	_	-	50	-	50	
Average area			1784	_	1784	
					4	

In engaging in sea farming, permit is secured from the municipal or city government. The permit is usually for one year, payable in installment, and renewable. The cost of permit was \$\mathbb{P}\$11.07 for oyster farms and \$\mathbb{P}\$12.55 for mussel farms.

## 3. Cultural practices

Four methods are used in oyster cultivation: broadcasting, hanging, lattice and stake (Table 3). The stake method was the only culture method reported in mussel farms. The simplest and the cheapest of the methods is the broadcast. In this method oyster shells are scattered on the river or sea floor. The stake makes use of bamboo poles, either split or whole. Here the slender end of the full lenght bamboos are staked in rows, one meter apart and about 10 feet deep during low tide. The lattice is made of bamboo slats placed either in a vertical or slanting position. The hanging method makes use of cultches or strands of oyster shells tied on polyethylene cord hanged from a horizontal line, either of bamboo, wire or polyethylene cord.

	Number reporting	Hanging	Stake	Lattice	Hanging/ Lattice	Broad-
	2 0 1 0 2 0 2 1 1		per cen	t		
Ilocos	49	3	40	43	14	<del>-</del> ,
Cagayan Valley	6	-	•••	-	-	100
Southern Luzon	48	69	31	-	-	_
Western Visayas	10	20	80	, . <del>-</del>	. <del>.</del>	-
All regions	163	21	39	26	10	4

Table 3. Culture method adopted by oyster farmsa/

Staking (or "tulus") was the culture method used by most oyster and all mussel farm operators studied. Among oyster operators, regional differences in adopted method was discerned. Operators in Cagayan Valley adopted the broadcast method while in Ilocos, both the stake and lattice methods were popular. Stake method was also more preferred in Western Visayas, Southern Luzon operators, however, use the hanging method where empty shells are suspended in nylon twines collectively called cultches.

Most (58 percent) of oyster and all mussel farms changed culture materials once a year (Table 4). The rest of the oyster farmers changed materials only once every two years or three years at most. Culture materials in the lattice or hanging lattice combination seemed to last longer with 41 percent each changing their materials only after 2 years of use and 12 and 24 percent, respectively, changing only after 3 years of use.

<sup>&</sup>lt;u>a</u>/All mussel farms employed the stake method.

Table 4. Frequency of changing culture materials by oyster farmers a

Culture - Method	Frequency				
	Once or twice/year	Once every 2 years	Once every 3 years		
		percent			
Hanging	91	9	12		
Stake	59	29	12		
Lattice	47	41	12		
Hanging/Lattice	35	41	24		
All Farms	60	29	11		

Bamboos used in all mussel farms surveyed were reportedly changed every year.

Thirty one percent of the oyster farmers reported having predators in their farms, the most common of which was the boring snail. Other predators were crabs and barnacles. In Cagayan Valley, 50 percent of the farmers complained of predators; in Southern Luzon and Ilocos, 35 and 30 percent, respectively.

Most farms (92 percent) did not eliminate these predators; the 8 percent who did employed the catch and kill method.

The setting pattern for oysters appeared to be bi-modal, the low peak in May and the high peak in September to October. This characterized the setting pattern in Ilocos and Southern Luzon. In Cagayan Valley shell broadcasting was in July and September. It was earlier in Western Visayas, notably in February to March. Most of the mussel operators did their staking in April except for 2 who reported that setting was done in March.

The major consideration in determining the data of harvesting was the size of the oyster or mussel (85 percent) followed by market demand (32 percent) (Table 5).

Table 5. Factors determining the date of harvesting oysters and mussels

Factors	Oyster	Mussel	Total
		percent a/	
Number of farms	163	30	193
Market demand	34	20	32
Size of product	85	80	85
Availability of natural feed	1	-	1
Weather condition	8	_	7
Need for cash	. 4	-	4

Total exceeds 100 because some respondents cited more than one factor.

Harvesting generally made use of boats to load products gathered. Collectors dived into the water and with the aid of a bolo, removed the oyster from their attachments. Or, the cultches could be picked up from the water. Some mussel operators pulled out the stakes instead.

Majority (55 percent) of the oyster/mussel farmers harvested several times while the rest harvested only once per season.

On the average, it took about 6.4 months for oysters and 8 months for mussel from setting to harvesting. For oysters, the rearing period was longest in Western Visayas, 7.4 months and shortest in Cagayan Valley, 5.3 months.

For the country as a whole, oyster appeared to be available the whole year round. Most of the farmers, however, harvested in April to May and in November to December. The time of mussel collection appeared to last from September to May similar to the oyster trend.

# 4. Farm production and disposal

Oyster production from 2,460 square meter farm totalled 396 cans or about 806 cans per half-hectare (Table 6). On the other hand, an average mussel farm of 1784 square meters cropped a total of 272 cans or an equivalent of 762.4 cans per half-hectare. Although the production per unit area of oyster and mussel beds are comparable, the value of the crop was different. The value of mussels per half-hectare was \$11,735 or almost twice as much as that of oysters (\$6,230). This is due primarily to the higher price of mussel per can (\$15.40 on average) compared to oysters (\$7.73 per can).

Table 6. An	ual cropping	rate	in ovster/mussel	farms in	the	Philippines
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Items		Oyster	Mussel	
Number of farms		163	30	• .
Area per farm (sq m) Quantity collected (c	cans) a/	2460	1784	
Per farm		396	272	
Per half-hectare:	Quantity	806	762	
	Value (F)	6230	11735	

a/One kerosene can is equivalent to approximately 19 liters.

Among the regions, oyster farms in Ilocos were the most productive, followed by Southern Luzon, Cagayan Valley, and the least, Western Visayas (Table 7). In terms of productivity per farm, Southern Tagalog had the highest. Moreover, the price in Western Visayas, \$\mathbb{Z}3.94\$ per can, was very much lower than that in Southern Tagalog which was \$\mathbb{Z}11.54\$. Presumably, there is a greater demand for oyster in Southern Tagalog than in any of the other regions. With the high price, coupled with high yield, a farm in this region earned a gross income of almost \$\mathbb{Z}10,000\$ per year compared with only \$\mathbb{Z}2,800\$ for Western Visayas or \$\mathbb{Z}585\$ per farm for Cagayan Valley.

Table 7. Quantity and value of oyster produced by region

Region	Per Farm			Production	
	Area Production		Value	per 1/2 ha	
	has.	cans	pesos	cans	
Ilocos	434	165	713	1901	
Cagayan Valley	3678	292	585	397	
Southern Tagalog	4843	820	9641	847	
Western Visayas	10800	715	2820	331	
All regions	2488	396	3413	806	

Table 8. Oyster production by method of culture

	No. of	Area	Prod	uction
Culture Method	farms	per farm	per farm	per half-ha
		sq m	<u>c</u>	ans
Stake	63	1603	212	661
Hanging	45	5698	872	765
Lattice	42	472	213	2255
Hanging/Lattice	· 7	245	198	4032
Broadcast	6	3678	292	397
All Farms	163	2460	396	806

Oyster farms using the combination of hanging and lattice methods attained the highest production, 4032 cans per half-hectare followed by farms employing only the lattice method, 2255 cans per half-hectare. The least yield was obtained using the broadcast.

# 5. Marketing practices and prices

Most (97%) of the farm produce were sold, the rest were eaten (2%) or given away (1%).

Majority (93%) of the farmers sold oyster in shelled (with shell) form while 21 percent sold their crop without shell. All the Cagayan Valley operators studied and one out of four of the Ilocos producers sold oyster without shell. Unshelled oysters were sold in "ginebra" bottles. After removing the meat, the empty shells are broadcasted back to the oyster bed for spot collection.

Majority (59%) of the oyster/mussel operators sold their harvest through direct wholesale, others by direct retail (23%) and by contract (20%). Surprisingly, market outlets for mussel were farther (15.6 kms) compared to oyster (3.4 kms).

Price of oysters appeared to have an upward trend during the period. Starting from \$2.89 per can in January prices went up to \$2.49 in June (Figure 1). During the latter months of 1974 oyster price averaged \$7.17 per can more than double the price in the first six months of the year. The price in 1975 was even higher averaging \$2.58 per can.

Among the different regions, operators in Southern Luzon received the highest price while the lowest price occurred in Cagayan Valley.

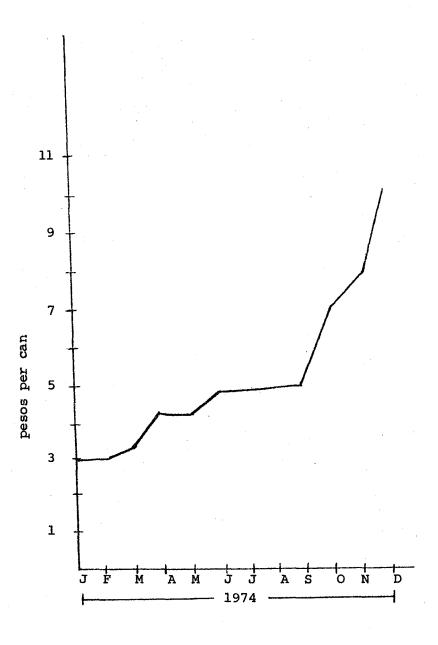


Figure 1. Monthly prices received for eyster, 163 sample farms, 1974

# REVIEW OF RECENT PROGRESS ON MUSSEL CULTURE IN THE PHILIPPINES

Rodolfo N. Pagcatipunan and Inocencio A. Ronquillo Bureau of Fisheries & Aquatic Resources

# REVIEW OF RECENT PROGRESS ON MUSSEL CULTURE IN THE PHILIPPINES

Rodolfo N. Pagcatipunan and Inocencio A. Ronquillo

Sea farming, particularly green bay mussel (Mytilus smaragdinus) culture, in the Philippines has been given emphasis in recent years. With the decrease in hectarage in the farming areas of Bacoor Bay (part of Manila Bay) due to the Greater Manila reclamation project, other areas are being developed. These areas include Samar, Panay, and Negros Islands. Mussel farmers have limited finances and use available local materials like bamboo. Farming is not intensive.

#### Mussel Farming Areas

1. Bacoor Bay - Located at the southwestern portion of Manila Bay, Bacoor Bay is the biggest mussel producing area in the Philippines, with approximately 1,350 hectares devoted to mussel farming and an estimated yearly production of 33,000 tons of live mussel (Pagcatipunan, 1974). Mussels are also gathered from the wild in other areas of Manila Bay, attached to rocks in brackishwater, old piles of fish corrals, sunken vessels, etc. The price of mussel range from \$\mathbb{P}\$3 to \$\mathbb{P}\$5 per kilo (\$\mathbb{P}\$7.35 = US\$1), depending on the season and supply.

In areas of 2 to 10 meters depth, farmers utilized bamboo stakes as spat collectors where mussel grow until harvest. The Greater Manila reclamation project, which is expected to be finished within five years, has already reduced the Bacoor mussel farming areas by half. Eventually, deep areas at Bacoor and shores of the provinces of Bulacan, Pampanga and Bataan will have to be utilized. These areas are exposed to the southwest monsoon and are suited for mussel farming. Other areas of the country will also have to be developed as sources of mussel.

2. Northern Panay Area - Northern Panay is a new mussel producing area. Fishermen used to gather green mussels from the wild. Mussel farming was started in 1974 at Sapian, Capiz by the local government with the help of Bureau of Fisheries and Aquatic Resources personnel and a U.S. Peace Corps Volunteer. A big corporation which ventured into the project attained a production of 300 tons of live mussel per hectare per year. Mussel farming easily spread to outlying towns of Capiz. The present culture area in the province of Aklan is approximately 100 hectares. The method of culture widely used is stationary plot made of bamboo, from which synthetic rope nettings, measuring 2 x 5 meters are tied. Production of 50 tons per hectare was attained in this area.

The northern Panay area (Capiz and Aklan provinces) have limited areas for expansion. The bays are small and the potential areas are limited to mud flats of approximately 1,000 hectares which are exposed during low tide. Mussel farmers utilize only the deep portion which is the river path. Due to presence of mussel plots, siltation resulted and changed the course of the river. This condition made these areas shallow and unproductive. There is now a need to develop deeper areas further out the bay.

In Capiz mussel used to sell at \$1.20 to \$1.50 a kilogram, live with shell. At present, it is selling at \$70.60 due to increased production and few outlets in the island. Some are airshipped to Manila (approximately 250 air miles) but shipment cost is higher than the cost of the mussel.

3. Magueda Bay - Maqueda Bay in Western Samar, is another new mussel farming area. The bay includes Villareal Bay and part of Zumarraga Channel which is approximately 87 sq nautical miles with average depth of 4 meters, all potential sites for mussel farming.

Mussels are usually gathered from the wild since these are found in natural beds in the area. Farming was started by a native farmer at Jiabong, Samar. In 1975, the Bureau of Fisheries and Aquatic Resources established a one-hectare demonstration farm in the same town. Now there are new farms established including those in Villareal town at the other side of the bay.

The development of mussel farms in the area is quite slow. There is not much demand for mussel due to the abundance of fish. The area developed is less than 20 hectares. With availability of local materials such as bamboo and farmers' hesitance to spend more on labor, the only method of mussel culture used is staking. The price of mussel range from \$1\$ to \$2\$ per kilogram.

4. Negros Occidental - Himamaylan in Negros Occidental is another new mussel producing area. The farming method used is the same as that in Capiz. Negros Occidental, however, has limited area for expansion, with a few hectares at the most available for mussel farming.

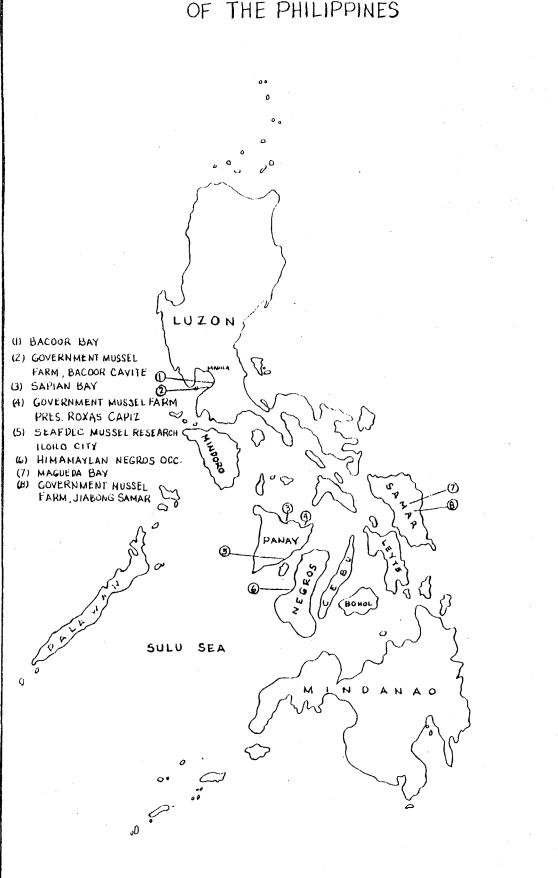
#### Research Undertaken

The Southeast Asian Fisheries Development Center (SEAFDEC) in Iloilo is undertaking research on the biology of mussel. The Bureau of Fisheries and Aquatic Resources conducts applied research at its farms on the various methods of mussel cultivation. Attempts to transport and grow mussel seeds and breeders in various areas of the country were green mussel are absent have not met much success.

#### References

- Blanco, G. J. Status and Problem of Coastal Aquaculture in the Philippines, Coastal Aquaculture in the Pacific Region. FAO Rome, Italy, 1972. pp. 60-67.
- Pagcatipunan, R.N. Bay Mussel Fisheries. BFAR Newsletter, April to June 1974.
- PCARR. Philippines Recommends for Mussel and Oysters, 1977.

# GREEN BAY MUSSEL PRODUCING AREAS OF THE PHILIPPINES



# A CASE STUDY OF MOLLUSC FARMING

Ruperto Angodung
Association of Negros Occidental Fishpond Operators

#### A CASE STUDY ON MOLLUSC FARMING

#### Ruperto Angodung

Our objective is to study the different kinds of molluscs that are being farmed locally for market and the different farming methods and practices used by the farmers to attain maximum production of any species being farmed.

To attain this objective three rivers in Negros Occidental were visited: Su-ay River, Talaban River and Hinigaran River. River and the Talaban River were found to have a fresh water source from the mountains; the Hinigaran River is actually an inlet with no fresh water stream that flows into it except for the small fresh water creeks that give a very low volume of fresh water especially during dry season. The salinity of these three rivers were found to range from 5 ppt to 25 ppt. Salinity increases down the river towards the sea. The best growth of molluscs can be observed when the salinity is between 15 to 25 ppt. Of the many different species of molluscs found in the market, only oysters (Ostrea malabonensis, Ostrea iredalei, and Ostrea cucullata, "talabang chinelas" in Tagalog; "nad saytil," "daligdig" in Ilocano, could also be found in abundance during April and May but no extensive culture has been found. The only culture of Greenshell can be found in the experimental SEAFDEC farm in Himamaylan. Greenshells found in the market are gathered from bamboo posts of old "tangaban" (current fish trap). They grow very well in certain deep areas of the Hinigaran River. On the other hand, oysters are cultured extensively in three rivers, especially in the Hinigaran River. According to the records of the Municipality of Hinigaran, there are about 80 hectares of oyster farms along the Hinigaran River.

For purposes of this study, the Hinigaran River oyster farms were chosen. The oyster farms extended from 200 sq m lots to the larger farms of 6 hectares. Perhaps, it is worth mentioning that it was in the Hinigaran River that the first oyster culture was started. The site of this oyster culture experiments was started by Dean Villaluz and first implemented on the site by the late Director Montalban in 1927. The site was a small lot beside the house of the experimental station of the former Division of Fisheries of the Bureau of Science.

Chosen for this experiment was an area of about 1,000 sq m along the bank of the Hinigaran River. The experiment used two (2) methods namely, the bamboo stake with oyster shells attached to it and bamboo raft that were sunk to about one (1) foot above zero datum. Culture of oysters, while practiced continuously by a few for domestic use, did not grow to these extensive areas until about 1950.

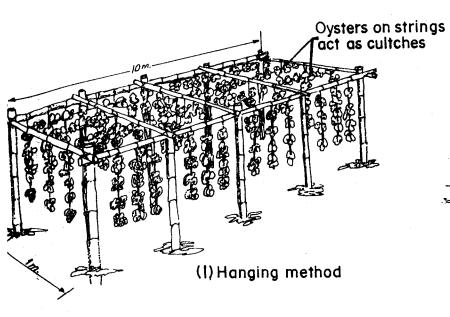
For our case study on mollusc farming namely, oyster (Ostrea malabonensis) (talaba), we have chosen the oyster farm of Mr. Jose Sarrosa which has a total area of about 5 hectares. In this particular farm, Mr. Sarrosa uses four (4) different methods of culture namely, 1) Hanging method, 2) Stake method, 3) Broadcasting method, and 4) Stone method.

- 1. Hanging Method. The hanging method consists of threaded empty shells with 1 1/2 meter length of polyethylene cord no. 6, provided with a knot as suspension with intervals of six inches from each empty shell. The cultches are hung from a long horizontal bamboo pole. These threaded empty shells are suspended about 1 foot from the bottom. Of all the four (4) methods used, this is the most profitable because oysters grow rapidly and in abundance. This method does not create rapid siltation so that there is always a continuous flow of oyster food with the river current during the incoming tide or the outflowing ebb. However, the farmer complains that threading the empty shells, hanging the clutches and constructing the stand are tedious and involve much expense. Another problem that he encounters with this method, as he starts to inspect and collect mature oysters, is poachers. He continues to harvest every two (2) weeks. Harvesting is done by untying the nylon strings from the horizontal bamboo. Each stringful of mature oysters are replaced with new ones having empty shells as clutches. The nylon thread can be re-used many times.
- 2. Stake Method. The stake method consists of planting stakes about two (2) meters long and spaced about 2 1/2 meters apart. These bamboo stakes or posts are stuck securely on the river floor. Empty oyster shells are embedded on the stake to act as oyster clutches. These clutches are placed on the portion of the bamboo about a foot from the river floor. Harvesting starts about six (6) months after the stakes are placed. The harvesting method used is to unclutch the matured oysters from the pole and allow the others to grow to bigger sizes. The stakes are replaced as the bamboo pole begins to rot. His problem on this method is, again, poachers. The method may not be as expensive as the hanging method, yet the cost of bamboo must be taken into consideration. He has observed that oysters grow faster on older bamboos.
- 3. Broadcasting Method. This method involves spreading oyster shells over the river floor. This is the most inexpensive method because one does not have to buy practically anything. The only cost involved is labor cost of spreading the oyster shells, The shells are grouped with 30 or 20 empty shells in each group and spaced at a distance of about one-half meter. Harvesting is done only when the oysters are fully matured, which takes about 8 to 12 months. As the oysters begin to cluster, thus forming a mass or group, the mass is lifted from the river floor every 20 to 30 days depending on the lowest ebb. This is done to prevent the group from being completely covered with silt. The farmer does not have much problem with poaching in this method.

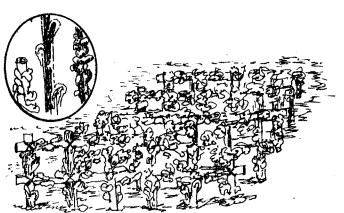
4. Stone Method. The stone method is used along river banks. close to the fishpond dikes. Actually, the stones are placed along these dikes on the ocean floor to prevent too much erosion on the fishpond dikes caused by wave action and river current. Oyster shells are placed between the stones. Oysters are allowed to grow and are harvested after 8 to 12 months by peeling off the matured oysters from the stones. Only oysters that adhere above the silted river floor are harvested. Stones used for this purpose range from 8 to 16 inches in diameter. This method cannot be used on river floors due to rapid siltation.

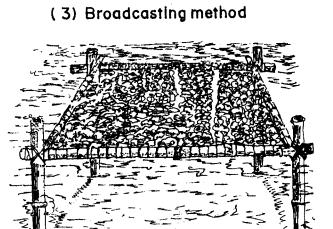
The most ideal harvestable oysters are 2.5 to 3 inches long in the right valve. Throughout the year the farmer produces, on the whole 6-hectare area using these four (4) methods, about 8,000 kerosene cans of matured oysters. The oysters are sold locally wholesale at \$\mathbf{y} 5.00 per can.

According to an old saying from the people who derive their livelihood from Hinigaran River, oysters, greenshells, and crustaceans (prawns, shrimps, crabs) are at their healthiest or best growth during the months of the year that have the letter R in the spelling.



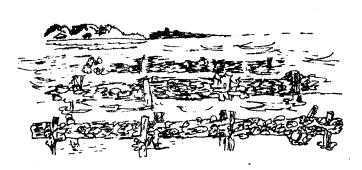






(2) Stake method

Tray method





Log method

(4) Stone Method

# TECHNOLOGIES FOR POPULATION CONTROL OF TILAPIA IN THE PHILIPPINES

Rafael D. Guerrero III Central Luzon State University

# TECHNOLOGIES FOR POPULATION CONTROL OF TILAPIA IN THE PHILIPPINES

# Rafael D. Guerrero III Central Luzon State University

## Introduction

Tilapia is one of the most important foodfishes cultured in the world (Bardach et al., 1972). One species, <u>Tilapia mossambica</u>, is extensively cultivated in over 25 countries.

T. mossambica was introduced to the Philippines in 1950. Other tilapia species were imported in 1973 (T. nilotica) and 1977 (T. aurea). No record is available for the introduction of the fourth species, T. zillii, which was first recognized in 1974.

Culture of tilapia is an important source of low cost animal protein in developing countries. It is easy to breed, resistant to parasites and diseases and economical to grow. Tilapia farming in the Philippines has been found to be profitable (Tidon and Librero, 1978).

A major problem faced by tilapia culturists throughout the world is frequent breeding in ponds which leads to overcrowding and stunted growth. In countries where marketable size fish is large, a harvest of small-sized fish fetches a lower price.

Many techniques have been tried to solve the over population problem of tilapia in ponds. These techniques include monosex culture, polyculture with pisivorous fishes, cage culture, hybridization and sex reversal (Guerrero, 1975).

This paper reviews the technologies for population control of tilapia tested in the Philippines.

#### Monosex Culture of Tilapia

Monosex culture for controlling tilapia reproduction was first applied in East Africa (Maar et al., 1966). The technique is done by manually separating the sexes of tilapia. Males are generally preferred over females because of their faster growth.

Guerrero and Guerrero (1975) tested monosex culture of male <u>Tilapia mossambica</u> at the Freshwater Aquaculture Center in CLSU, Nueva <u>Ecija</u>. Males stocked at 10,000/ha gave a net production of 730 kg/ha of harvestable size fish in 60 days.

The technology for monosex culture is relatively simple and can be easily imparted to fishfarmers in the Philippines. Its application, however, for large-scale production may be hampered by the lack of post-fingerlings for sexing.

### Culture of Tilapia with Piscivorous Fishes

Stocking of piscivorous fishes in tilapia ponds has also been applied in the Philippines. In this technique, reproduction of tilapia is cropped by the carnivorous species which are usually of higher value.

The mudfish, Ophicephalus striatus, has been cultured with T. mossambica in freshwater ponds to control reproduction of the latter (Inland Fisheries Project, 1975). Poor recovery of the mudfish at harvest was attributed to cannibalism and escape.

The brackishwater Aquaculture Center in Leganes, Iloilo has evaluated the efficiency of the tenpounder (Inland Fisheries Project, 1976a) and tarpon (IFP, 1976b) in controlling the reproduction of T. mossambica. Use of the two carnivorous species in brackishwater ponds has shown promise.

# Sex Reversal of Tilapia

Since the work of Clemens and Inslee (1968) on the induced sex reversal of <u>T. mossambica</u> using synthetic hormone, the technique has been successfully applied on <u>T. aurea</u> (Guerrero, 1975), <u>T. nilotica</u> (Guerrero and Abella, 1977) and <u>T. zillii</u> (Woiwode, 1976).

Artificial sex reversal involves the feeding of sexually undiffirentiated tilapia fry with hormonal steroids (e.g., methyltestosterone and ethynyltestosterone) to achieve masculinization of genetic females. Application of the technique for commercial production of T. mossambica has been demonstrated to be economically feasible (Guerrero, 1976).

The sex reversal method of population control for tilapia requires intensive culture facilities for effective treatment and a hatchery for producing the needed fry.

## Cage Culture of Tilapia

The culture of <u>T</u>. <u>aurea</u> in floating cages was found effective in controlling reproduction of the fish in the United States (Pagan, 1969). Cage culture of <u>T</u>. <u>nilotica</u> in the Philippines also indicated effectiveness of the technique in limiting reproduction (Guerrero, 1978).

Mouthbrooding <u>T. mossambica</u> were found by Guerrero (1975) in cages stocked with females only. These females were believed to have successfully mated with males outside the cages. Cruz and Laudencia (1976) reported that feeding of <u>T. mossambica</u> breeders in cages with ipil-ipil leaf meal significantly reduced production of young compared with the unfed fish.

## Hybridization of Tilapia

All-male broods have been produced with the hybridization of tilapia species in Malacca (Hickling, 1960), Brazil (Lovshin, 1975) and Israel Pruginin et al., 1975). In the Philippines, the crossing of male T. aurea and female T. nilotica has yielded 75% male hybrids (Guerrero, unpublished data).

### Summary

Technologies for the population control of tilapia such as monosex culture, sex reversal and cage culture have been evaluated and found effective in the Philippines. Application of the monosex culture and sex reversal techniques has increased yields of marketable-size <u>T</u>. mossambica. Control of <u>T</u>. nilotica reproduction has been achieved by cage culture.

#### Literature Cited

- Bardach, J.E., J.H. Ryther, and W.O. Mclarney. 1972. Aquaculture. Wiley-Interscience, New York. 868 p.
- Clemens, H.P. and T. Inslee. 1968. The production of unisexual broods by <u>Tilapia mossambica</u> sex-reversed with methyltestosterone. Trans. Amer. Fish. Soc. 97(1):18-21.
- Cruz, E.M. and I.L. Laudencia. 1976. Effects of the two levels of ipil-ipil leaf meal as supplemental feed on the reproductive performance of Tilapia mossambica raised in cages. XII(2):105-107.
- Guerrero, R.D. 1975a. Use of androgens for the production of all-male <u>Tilapia aurea</u> (Steindachner). Trans. Amer. Fish Soc. 104(2): 342-348.
- . 1975b. Cage culture of male and female <u>Tilapia mossambica</u> with and without supplementary feeding in a fertilized pond. CLSU Scientific Journal. IX(2):18-20.
- Guerrero, R.D. and L.A. Guerrero. 1975. Monosex culture of male and female <u>Tilapia mossambica</u> in ponds at three stocking rates.

  <u>Kalikasan</u>, Philipp. J. Biol. 4:129-134.
- Guerrero, R.D. 1976. Culture of male <u>Tilapia mossambica</u> produced through artificial sex reversal. Paper presented at the FAO Technical Conference on Aquaculture, Kyoto, Japan. 26 May 2 June, 1976. 3 p.
- Guerrero, R.D. and T.A. Abella. 1976. Induced sex reversal of <u>Tilapia</u> nilotica with methyltestosterone. Fish. Res. J. Philipp. 1(2): 46-49.
- Guerrero, R.D. 1978. Studies on the feeding of <u>Tilapia nilotica</u> in floating cages. Provisional Report No. 2 Aquaculture. International Foundation for Science, Stockholm, Sweden. pp. 55-69.
- Hickling, C.F. 1960. The Malacca Tilapia Hybrids. J. Genetics. 57(1):1-10.
- Inland Fisheries Project. 1975. Use of dalag for biological control of tilapia reproduction. In: IFP-TR No. 7, Second Half FY 1975. U.P. Diliman, Q.C., pp. 67-70.
- . 1976a. The culture of tilapia in brackishwater ponds using tenpounder to control reproduction. In: IFP-TR No. 9, First Half of CY 1976, U.P. Diliman, Q.C. p. 16-24.

- using tarpon to control reproduction. In: IFP-TR No. 10, Second Half of CY 1976, U.P. Diliman, Q.C. pp. 41-51.
- Lovshin, L. 1975. Progress report on fisheries development in Northeast Brazil. International Center for Aquaculture Research and Development Series No. 9. Auburn University, Auburn, Alabama. 11 p.
- Maar, A., M.A.E. Mortimer, and I. Van Der Lingen. 1966. Fish culture in Central East Africa. FAO, Rome. 158 p.
- Pagan, F.A. 1969. Cage culture of tilapia. FAO Fish Culture Bull. 2(1):6.
- Pruginin, Y. et al. 1975. All-male broods of <u>Tilapia nilotica</u> x <u>T. aurea</u> hybrids. Aquaculture. 6(1975):11-21.
- Tidon, A.G. and A.R. Librero. 1978. A socio-economic study of tilapia farming in the Philippines. Research Paper Series No. 10. SEAFDEC-PCARR Research Program, Los Baños, Laguna, Philippines. 92 p.
- Woiwode, J.G. 1977. Sex reversal of <u>Tilapia zillii</u> by ingestion of methyltestosterone. Bureau of <u>Fisheries</u> and Aquatic Resources Technical Paper Series. Vol. 1, No. 3. 5 p.

# TILAPIA NUTRITION UNDER FRESHWATER CONDITIONS

Emmanuel M. Cruz
Central Luzon State University

#### TILAPIA NUTRITION UNDER FRESHWATER CONDITIONS

#### Emmanuel M. Cruz

Research on the nutrition of <u>Tilapia</u> in the Philippines, is still in the conception stage compared to poultry, swine and cattle nutrition. Most of the exploratory nutrition experiments were conducted at the Freshwater Aquaculture Center under aquarium, hapa and pond conditions and at the College of Inland Fisheries under cage condition. Both stations are located at Central Luzon State University in Muñoz, Nueva Ecija.

Experiments on the nutrition of <u>Tilapia</u> in freshwater involve the testing of rations using various ingredients in different proportions normally utilized in the manufacture of animal feed. Two approaches in feeding <u>Tilapia</u> have been carried out at CLSU. First is the feeding of materials that will supplement what is already available in the pond with the idea that certain elements or compounds essential to the proper nutrition of the fish are produced by the pond or environment where the fish is reared. This approach is often used for feeding tilapia at low to moderate density and in fertilized ponds.

The second approach which is complete feeding is applicable in the case of ponds stocked at high densities and in all types of intensive culture units, i.e., cage culture, race way culture, and pen culture. A complete ration adequate in its nutrient content is offered since the fish becomes entirely dependent on the quantity and quality of nutrients added in the diet and the natural feeds may not be present in quantities and proportions to balance a nutritionally incomplete ration.

Preliminary studies on the determination of the protein requirements of Tilapia sp. revealed the following results:

Species Le	evels of protein (%)	Reference
Tilapia mossambica fingerlings	30-38	(5)
Tilapia mossambica fry	38-45	(2)
Tilapia mossambica (all-male)	25	(4)
Tilapia nilotica	20-30	(9)
Tilapia Hybrid (Male Nile x tilapia		
Female Java tilapia)	30	(3)

Screening of feedstuffs as feed supplement and as part of a complete ration had also been undertaken. The following ingredients have been tested as feed supplement for <u>Tilapia</u> nilotica.

Rice bran	(1)
Copra meal	(1)
Ipil-ipil leaf meal	(8)
Mulberry leaf meal	(8)
Kangkong leaf meal	(8)
Hydrilla meal	(8)

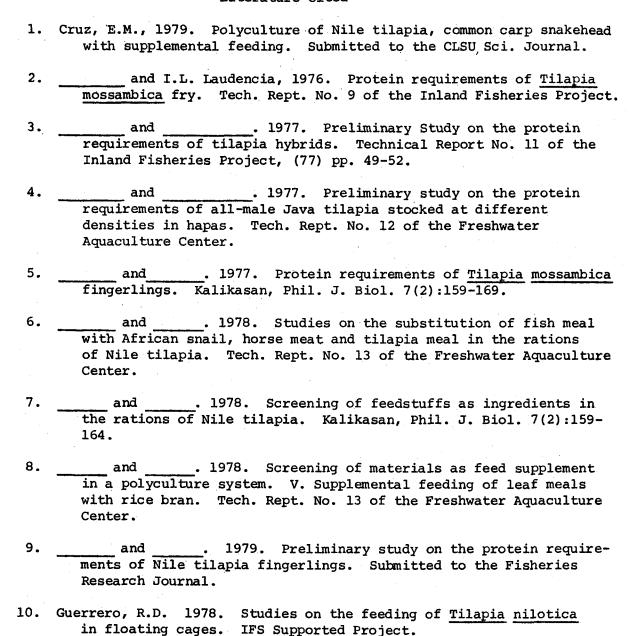
Similarly, the following with promising results were tested as part of a complete diet for <u>Tilapia nilotica</u>.

Ipil-ipil leaf meal	(6)
Rice bran	(6,10)
Copra meal	(6,10)
African snail meal	(7)
Horse meat meal	(7)
Tilapia meal	(7)
Soybean meal	(6)
Mulberry leaf meal	(6)
Cracked rice	(6)
Sorghum	(6)
Fish meal	(6,10)

The following research studies should be conducted to be able to scientifically formulate a nutritionally adequate ration for tilapia.

- a. Protein-energy ratio.
- b. Levels of fats and essential fatty acids required by tilapia.
- c. Essential vitamins needed.
- d. Essential minerals needed.
- e. Utilization of non-conventional feedstuffs.
- f. Formulation of effective feed at the least cost.

#### Literature Cited



SOME ADVANCES ON TILAPIA CULTURE IN THE PHILIPPINES

Romeo D. Fortes
UP College of Fisheries
Leganes, Iloilo

#### SOME ADVANCES ON TILAPIA CULTURE IN THE PHILIPPINES

#### Romeo D. Fortes

## Introduction

Since the publication of "Philippines Recommends for Tilapia 1976" by the Philippine Council for Agriculture and Resources Research (PCARR), more efforts have been directed towards developing new technologies for the culture of tilapia in both fresh and brackishwater systems. New culture systems were developed and new species were introduced. Tilapia aurea from Israel and the red or golden tilapia from Taiwan (claimed to be a mutant of T. nilotica) have been added to the list of available tilapia species in the country (the other species being T. mossambica, T. nilotica and T. zillii). No doubt, tilapia has risen into major importance as pond fish in the country, and even in the world. Attempts to evolve management procedures for its efficient culture, and re-examination of desirable species for culture, have been made.

#### Recent Advances

#### 1. Brackishwater

Tilapia research at the U.P. Brackishwater Aquaculture Center in the last 4 years has been focused solely on <u>Tilapia mossambica</u> since many studies have yet to be done on this species, not only to develop means to increase its production but also to offer solutions to the problems it has caused in many fishponds. This is not to say, however, that work will not be done on other species in the country. BAC has started acclimating some 60 pieces of <u>T. nilotica</u> in its ponds in preparation for its 1979 research projects.

Work on T. mossambica at BAC is aimed at generating new technologies for its maximum utilization as a culture species.

### Production of Fry and Fingerlings

The increasing demand for tilapia fry and fingerlings has opened up avenues for research on tilapia culture. Researchers at BAC developed outdoor hatcheries and techniques for the mass production of fry and fingerlings of T. mossambica. One such technique involves the use of small ponds provided with concrete trenches and collecting pits. Known number of female tilapia were held in these ponds, with the male introduced at the appropriate time and at the correct sex ratio, then allowed to spawn. After spawning, sexes are again separated. this method of separation of sexes before and after spawning increased the production of fry significantly even at higher salinities.

When tarpon was used as a biological control for tilapia reproduction in a milkfish-mixed sexes tilapia combination, an increased in total production was attained at 1:6:10 ratio (tarpon-milkfish-tilapia). Higher production was also obtained in a polyculture of milkfish and all-male tilapia at 1:2 stocking ratio.

### Biological Control

The use of biological means as a management technique in controlling excessive reproduction of tilapia in ponds has been applied. Researchers at BAC developed a biological control method that proved effective in reducing to the minimum the number of unsatisfactory-size tilapia from ponds. Tenpounder and tarpon were found to be effective in thinning down undesirable-size fish when added at the proper time, size and ratio.

## Supplemental Feeds

Several agricultural by-products were tested as feeds for tilapia. The response of tilapia, in terms of production, was highest where ipilipil leaves were fed. A mixture of distillery wastes and rice mill sweepings also showed encouraging results. A conversion factor of 2.5 to 2.6 was obtained. Tilapia was also found to use piggery wastes efficiently as feed.

#### 2. Freshwater

Refinement of methods and techniques for the culture of tilapia in freshwater system has also been a continuing process. Work done at the Central Luzon State University Freshwater Aquaculture Center (FAC) at Muñoz, Nueva Ecija and in other government agencies have increased significantly. However, only a few of these can be presented because most of the data have not yet been made available.

## Production of fry and fingerlings

Methods in producing fry and fingerlings described in the "Philippines Recommends for Tilapia 1976" and modifications of these techniques have made seed production progress a little bit. In the simple hatchery project of the Bureau of Fisheries and Aquatic Resources at Region VI, Molo, Iloilo City, for instance, the use of hapas supplemented by cages and a few concrete tanks plus a stable supply of water, allowed extension workers to produce several thousands of <u>T. nilotica</u> fry. From this project, at least 10,000 fingerlings were distributed to no less than 25 agencies and individuals in the province of Iloilo. With interest in tilapia obviously regained, refined hatchery techniques need to be generated.

#### Feeds for Tilapia

Practical rations for tilapia have been studied at the FAC. Of the various feedstuffs screened, ration containing rice bran and fish meal gave the best conversion efficiency. Ration containing copra meal, fish meal and mulberry leaf meal also gave acceptable weight increment for Tilapia nilotica. The same ingredients (rice bran and fish meal) at approximately 1:3.3 ratio was fed to Nile Tilapia stocked in cages at 250/M<sup>3</sup> and a conversion factor of 2.02 was obtained with survival rates of from 98% to 100%. Such studies should be contained because of the need of the industry for such information. For example, fish cages in some lakes in Laguna have been reported to produce up to 15 tons of tilapia per cage (20x25x2.5 m) in 6 months, fed only with rice bran. Fish in cages require the necessary nutrients which rice bran cannot provide. Protein requirement for tilapia (T. mossambica) was reported to be within 29% to 38% crude protein. It is therefore necessary to develop feed for tilapia particularly those that are raised in cages. Furthermore, design and installation of cages need further investigation.

#### Pond Culture

Increasing pond production per unit area without necessarily increasing labor and material inputs, except stocking density of fish, has been attained in one study at the FAC. A significantly high net production of <u>T</u>. <u>nilotica</u> was achieved by raising the stocking density by 100% (10,000/ha to 20,000/ha).

#### References

## Published Reports

- Cruz, E.M. and I.L. Laudencia, 1978. Screening of feedstuffs as ingredients in the rations of Nile tilapia. Kalikasan: The Philippine Journal of Biology. 7(2), pp. 159-164.
- Cruz, E.M. and I.L. Laudencia, 1978. Protein requirements of <u>Tilapia</u>
  mossambica fingerlings. Kalikasan: The Philippine Journal
  of Biology, 6(2). pp. 177-182.
- Guerrero, R.D. 1976. Culture of <u>Tilapia nilotica</u> at two densities with fertilization and supplemental feeding. Fisheries Research Journal of the Philippines, 1(1), pp. 39-43.
- Inland Fisheries Projects, 1976A. The culture of tilapia in brackish-water ponds using tenpounder to control reproduction. In: Inland Fish. Proj. Tech. Rept. No. 9, First Half CY 1976. NSDB Proj. No. 7103 Ag. UPCF, Diliman, Q.C. pp. 31-50.
- Inland Fisheries Project, 1976B. Culture of tilapia in brackishwater ponds using tarpon to control reproduction (I). In: Inland Fish. Proj. Tech. Rept. No. 10, Second Half CY 1976, NSDB Proj. No. 7103 Ag. UPCF, Diliman, Q.C. pp. 41-51.
- Tilapia Committee, 1976. The Philippines Recommends for Tilapia, 1976.

  Philippine Council for Agriculture and Resources Research, Los
  Baños, Laguna.

### Unpublished Reports

- Aspray, R.T. Report of the on-going <u>Tilapia</u> <u>nilotica</u> propagation proj. BFAR VI, DFO, Molo, Iloilo City, Aug. 4, 1978.
- Camacho, A.S. and E.S. Tubongbanua. Use of agricultural by-products for fish production, Summary of Project Accomplishment, NSDB-UPS Project No. 7804 Ag. (1978).
- Camacho, A.S. and V.L. Corne. Studies on the relative response of <u>Tilapia mossambica</u> to some agricultural by-product as feeds (completed research project, Inland Fisheries Project, Brackishwater Aquaculture Center (1977).

- Dureza, L.A. and C.L. Gempis. Mass production of <u>Tilapia mossambica</u> fingerlings in Ponds (BAC Project No. 7801, Monthly Report June, 1978).
- Dureza, L.A. and C.L. Gempis. Influence of selected factors on the number of <u>Tilapia mossambica</u> fry produced in nulon net enclosures in brackishwater ponds (NSDB-UPS Project 7807 Ag. Monthly Report, June, 1978).
- Fortes, R.D. Evaluation of tenpounder and tarpon as biological controls for tilapia reproduction in brackishwater ponds (Doctoral Dissertation Draft, Auburn University).
- Fortes, R.D. and T.U. Abalos. Culture of tilapia in brackishwater ponds using tarpon to control reproduction Trial II (Completed Research NSDB-UP Inland Fisheries Project, BAC).
- Fortes, R.D. and V.L. Corne. Study on the mixed culture of milkfish and tilapia with tarpon as a biological control for tilapia reproduction (Completed Research, NSDB-UP Inland Fisheries Project, BAC).
- Guerrero, R.D. Cage culture of <u>Tilapia nilotica</u> (A summary, College of Inland Fisheries, CLSU, N.E.).

POST-HARVEST HANDLING AND PROCESSING OF TILAPIA

Gloria Guevara
Bureau of Fisheries & Aquatic Resources

#### POST-HARVEST HANDLING AND PROCESSING OF TILAPIA

#### Gloria Guevara

### Introduction

In the Philippines where prevailing temperature is high, the fish catch begins to deteriorate at a very rapid rate. In order to effectively use all the fish produce, there is a need to improve and develop proper methods of handling and distribution in order to delay spoilage, as well as to introduce methods of fish utilization. Efforts should be concentrated on the elimination of wastage in processing, marketing and distribution and on development of new fishery products out of least utilized fish.

Tilapia is considered to be a nutritious low cost freshwater fish. It is well accepted as food, although in some areas the marketability of tilapia is quite poor because of improper handling.

## Post-harvest Technology

Tilapia is usually packed in wooden boxes (kaha), tubs (bañera) or baskets (kaings). The catch is transported to different markets immediately after harvest while the fish is still alive. Icing is not necessary when transporting over short distances. Usually, the source of fish is near outlets or markets and fish reach the consumers in a few hours. Proper handling techniques should however be observed.

The use of ice would preserve quality of tilapia transported over long distances. Crushed ice should be interspersed with fish, the ratio of ice to fish depending on the distance of the inland market. Re-icing should also be carried out in order to maintain quality during the time required to sell the fish. If packaging and icing are well done, fish would be in excellent condition even after an overnight journey from the source to the market.

Fish retailed in public markets are arranged in stalls according to species and size. Retailers sometimes remove the ice because some consumers do not like iced fish. Although tilapia is not commonly found in supermarkets, it could be sold either or frozen like any other fish.

## Processing

Acceptability of tilapia is still a problem in some areas. However, introduction of new methods of processing like freezing, filleting, and formulations from minced fish like fish balls, fish cakes and sausages, and other convenience food items have partially solved the problem. To encourage utilization of tilapia, several studies on processing have been conducted both here and in other Asian countries. Some of these methods are:

- 1. Drying Dried tilapia usually comes in the form of butterfly fillets. One limitation of drying is the additional labor involved in removing the scales particularly when done in commercial quantity. This could, however, be solved with the use of mechanized scalers.
- 2. Smoking Trials on smoking <u>Tilapia mossambica</u> have also been made using the conventional method. However, although the taste is acceptable, the general appearance is not.

In Nigeria, a smoked minced tilapia product is consumed directly as a food constituent in such dishes as soups and stews. The smoked minced tilapia is said to have a moisture content of about 25%. No mould growth was noted for at least 60 days when stored at 20°C.

- 3. Fermentation Tilapia has been found to be a good raw material for our 'buro' and could be a substitute for mudfish or 'dalag'.
- 4. Canning Studies undertaken by BFAR and NIST have led to the canning of tilapia. Formulations were tested and modified to obtain products with high acceptability.
- 5. Fish Meal Some of the catch which are not utilized for human consumption may be converted to fish meal. In some cases, unsold dried tilapia are ground into meal for animal feed.

Fish offal from canning and filleting constitute about 40% to 50% of the total weight of fish. This could be utilized for fish meal using the wet reduction method.

# A SOCIO-ECONOMIC STUDY OF TILAPIA FARMING IN THE PHILIPPINES

Aida R. Librero and Elizabeth S. Nicolas Philippine Council for Agriculture and Resources Research

## A SOCIO-ECONOMIC STUDY OF TILAPIA FARMING IN THE PHILIPPINES

Aida R. Librero and Elizabeth S. Nicolas

# 1. Introduction

This study would attempt to assess present technology, productivity and profitability of tilapia fishponds in the country. The study covered 131 tilapia pond operators coming mostly (93%) from Luzon, specifically in Cagayan (29%) and Isabela (29%) in Northern Luzon, Central Luzon (21%), and Southern Luzon (16%). Data refer to 1974 operations.

More of the tilapia farms (59%) adopted polyculture systems particularly tilapia-carp combination (21%) and tilapia-bangos (11%). The rest were stocked with one or more of the following species: mudfish, carp, catfish, gourami, crab and shrimps. Fifty-four out of 131 operators monocultured tilapia in their ponds particularly in Cagayan Valley and in Southern Luzon.

# 2. The operator and his farm

The tilapia operator is a male about 49 years of age and had received formal education for more than 9 years. More than one-fourth reached or graduated from college while 29% and 45% had high school and elementary education, respectively.

The tilapia operator has had some 7 years experience in fish farming. Majority cited that the main reasons for engaging in tilapia farming were to supplement the food requirement of the household and to have an additional source of cash income.

Tilapia farming appeared to be a part-time job for the operators with only 1.5 months spent in the fishpond and most of their time spent in other occupations (9.3 months) mainly farming. Others were engaged in small business and employment. From these occupations, an operator derived an annual income averaging \$75059.

The majority of farms (83%) were privately owned of which 63% were inherited (Table 1). Among leased fishponds, 6 out of 23 farms were leased from the government.

Most of the farms (66%) were operated commercially, that is, a major fraction of their output was sold. One-third of the farms were subsistence or backyard fishponds where production is wholly used for home consumption. Most of the commercial farms were found in Southern Luzon and Cagayan Valley while subsistence farms were found in Ilocos.

Table 1. Pond ownership and type of fishpond by region

Item	Ilocos	Cagayan Valley	Central Luzon	Southern Luzon	Other regions	Phils.
Number of farms	15	58	28	21	9	131
Pond ownership (number)					-	202
Owned		- /		1- /		•
Purchased	6	$20^{\underline{a}}$	8	4 <u>b/</u> 9 <u>b/</u>	2	40 <u>b</u> /
Inherited	8	37	15	/ <u>ط</u> و		69 <u>D</u> /
Leased						
Private	1	1	5	6	4	17
Government	1	· _	-	3	2	6
Type of fishpond (percent)						
Commerical fishpond	33	71	54	91	78	66
Home fishpond	67	29	46	9	22	34

 $<sup>\</sup>frac{a}{T}$ Two farms were part of the lots acquired by the operators as homestead.

Majority (64%) of the farms surveyed were started between 1971 and 1974. The earliest fishponds, however, were started before 1950.

Table 2. Distribution of tilapia fishponds by farm size and type of stock.

Farm size		Tilapia-	Tilapia-	Tilapia	All
(sq m)	Tilapia	Carp	Bangos	Others	Farms
No. of reporting	54	27	36	14	131
500 or less	18	12	12	• 1	43
501-9,999	25	10	15	<u></u> ·	50
10,000 & above	11	5	9	13	38
Ave. area (sq.m)	4,715	3,620	6,405	30,193	7,677

Compared to milkfish ponds, tilapia fishponds could be described as small. Of the 131 farms studied 33% had areas of 500 sq m or even less (Table 2). Majority of the farms were more than 500 sq m in size but less than 1 hectare. While only 29% was more than 1 hectare in size the biggest was a 10-hectare farm in Bicol.

boone was partly purchased and partly inherited.

Of the 131 farms, only 22 maintained nursery ponds.

## 3. Cultural practices

General repair and cleaning of the pond preparatory to stocking were not regularly practiced in tilapia farms. Both were done only when the operator deemed it necessary. However, pond cleaning was done by about one-fourth of the respondents prior to every stocking.

Majority (63%) did pond levelling to make available the essential nutrients in the soil.

The most common pest/predators in the pond were mudfish, tenpounder, frog, goby, reptiles, birds, snails, flat worms and eels.

Table 3. Pest elimination practices

Item	All farms
Practiced pest elimination (%)	
No	24
Yes	76
Methods of eliminating pests (%)	
Catch and kill	92
Use of pesticides	4
Both	4
Pesticides used (number)	
Tobacco dusts	1
Endrin	5
Basudin	.1
Aquatin	. 1
2, 4-D	ī
Rate of pesticide application/half hectare	
Tobacco dust (kg)	33
Endrin (oz)	5
Basudin (kg)	400
Aquatin (oz)	8
2, 4-D (oz)	7

The majority of operators (76%) practiced pest elimination (Table 3). The "catch and kill" method was the most common way of eliminating pests. Only 8 percent used pesticides. Pesticides used were endrin, tobacco dust, basudin, aquatin and 2, 4-D.

Table 4. Pond fertilization

Item	Mono- culture	Poly- culture	All Farms
Number of respondents	54	77	131
Practiced pond fertilization (%)			
Yes	30	47	.40
No	70	53	60
Frequency of application (1%)		•	
Prior to stocking	31	11	19
Only when needed	63	86	79
Once a month	6	3	2
Types of fertilizers applied (numb	er) <del>a</del> /		
chicken manure	12	24	36
Carabao dung	3	5	8
Urea	1	5	6
Ammonium sulfate		4	. 4
14-14-14		1	1
16-20-0	1	.—	1

 $<sup>\</sup>frac{a}{s}$  Some respondents applied more than one kind of fertilizer.

Fertilization is not a common practice in tilapia ponds (Table 4). Only 30% is monoculture and 47% in polyculture ponds practiced fertilization. Of these, the majority fertilized the pond only when needed, the rest did so prior to stocking or regularly once a month. Here, the usual practice is to apply chicken manure every 20-30 days.

Organic fertilizers were most commonly used like chicken manure (69%) and carabao dung (15%). A few applied inorganic fertilizers like urea, ammonium sulfate, 16-20-0, and 14-14-14.

Most tilapia operators gave supplementary feeds, usually of more than one type. Rice bran and white ants were most commonly given with the latter given only in Ilocos and Cagayan Valley (Table 5).

Dried shrimps, starter mash and bread crumbs were applied in a few farms. Others fed their stocks with chopped, succulent vegetables such as papaya leaves, camote and kangkong tops and even crushed coconut and kitchen left-overs.

Table 5. Supplementary feeding by type of stock

Item	Mono- culture	Poly- culture	All Farms
Number of farms	54	77	131
Gave supplementary feeds		number	
Yes	34	63	97
No	20	14	34
Types of feeds given a/			
Rice bran	31	48	. 79
White ants	6 .	17	23
Shrimps	1	4	5
Starter mash	3	. 1	4
Bread crumbs	1	3	4
Others	2	8 .	10

a/Majority of operators gave more than one type.

b/Chopped papaya leaves, camote and kangkong tops, crushed coconut and kitchen left-overs.

Supplementary feeds were given according to body weight or size of the stock. Feeding was usually done three times a day and adjusted as body weight increased. Hence, the actual rate of feeding during the rearing period could not be estimated.

# 4. Stocking and cropping practices

Stock of tilapia fry/fingerling were either gathered or purchased or freely entered the pond or given free by BFAR. More than one-half of the operators got their tilapia seeds from BFAR. Experienced farmers have learned to keep some tilapia breeders for their own supply.

Sixty two out of 131 farms were not stocked with tilapia seeds since the usual practice in these ponds was to harvest only the full grown fish, allowing the young ones to grow.

The size of stock determined the date of cropping. Others considered market demand, home consumption needs, weather conditions, and need for immediate cash.

Table 6. Factors determining the date of cropping and methods of cropping

Item	All Farms
Number of respondents	131
Factors determining date of cropping-	number
Size of stock	86
Demand for species	47
For home consumption	45
Need for cash	10
Weather condition	18
Availability of feed	3
Method of cropping b/	
Gill netting	44
Pond draining	35
Cash netting	33
Seining	11
"Pasubang"	6
Use of scoop net	13
Others	12
and the second of the second o	

a/Respondents gave more than one factor.

Gill netting, pond draining and cast netting were commonly used in harvesting. The use of gill nets was popular in Southern Luzon and to some extent in Cagayan Valley where cast nets were more preferred.

An average monoculture farm produced 197 kilos of tilapia equivalent to 209 kilos per half-hectare. Monoculture farms in Central Luzon were the most productive yielding on average 465 kilos per half-hectare. Productivity of farms in Cagayan Valley and Southern Luzon was comparable, 181 kilos and 160 kilos per half-hectare, respectively.

An average tilapia-crop pond yielded about 388 kilos per half-hectare composed of 52 percent tilapia and 48% carp. Other polyculture farms had lower aggregate production. Tilapia-bangos farms had an aggregate yield of 212 kilos per half-hectare composed of 42% tilapia and 50% bangos while tilapia-others produced only 240 kilos per half-hectare, 47% tilapia and 53% other species.

 $<sup>\</sup>frac{b}{Respondents}$  gave more than one method of harvesting.

Table 7. Annual fish production

Region	Monoculture			Polycult	ıre Farm	s	
	farms	Tilapia	-Carp	Tilapia	-Bangos	Tilapia-	others
e e e e e e e e e e e e e e e e e e e				kilos per	farm		
Ilocos	80	21	57	11	27	324	60
Cagayan Valley	94	107	108	1200	675	110	134
Central Luzon	559	607	375	498	681	156	203
Southern Tagalog	292	304	<b>2</b> 53	45	149	53	38
Other regions	100		-	246	1325	122	230
Philippines	197	146	135	271	736	143	164
		kilos per half-hec			nalf-hec	tare	
Ilocos	86	240	652	5	13	604	112
Cagayan Valley	181	139	140	300	169	160	195
Central Luzon	<b>4</b> 65	379	234	50	68	121	158
Southern Tagalog	<b>1</b> 60	294	275	18	60	12	10
Other regions	100	<u> </u>	-	30	161	47	88
Philippines	209	202	186	90	122	112	128

Table 8. Annual cropping rate by use of fertilizer

Item	Used fertilizer	Did not use fertilizer	
	kilos pe	r half-hectare	
Tilapia Tilapia-carp	677	167	
Tilapia	299	110	
Carp	300	79	
Tilapia-bangos	•	•	
Tilapia	60	34	
Bangos	191	66	
Filapia-others			•
Tilapia	170	71	
Others	188	103	

Fertilizer-using farms appeared to have obtained relatively higher yield per half-hectare than non-users. With the use of fertilizer, tilapia yield in pure culture averaged 677 kilos per half-hectare or four times as much as that obtained by non-users while fish yield in tilapia-carp fishponds average 599 or three times as much.

Table 9. Annual cropping rate by use of supplementary feeds

Item		Used suppleme feeds	-	Did not use supplem feeds	
			kilos per	half-hectare	
Tilapia		316		146	
Tilapia-carp					•
Tilapia		196		227	
Carp		196	•	148	
Filapia-bangos					
Tilapia	•	63		26	
Bangos	:	138		92	
Tilapia-others		•			
Tilapia		120		98	
Others		137		140	•

Application of supplementary feeds likewise increased fish yield. Monoculture farms using supplementary feeds yielded more than twice as much as the non-users. However, polyculture farms using supplementary feeds yielded only slight increases in fish production. For instance, tilapia-carp using supplementary feeds derived 392 kilos per half-hectare of fish compared to 375 kilos obtained by non-users. Other polyculture ponds showed a similar trend in yield.

Most of the output in both monoculture and polyculture farms are sold at market outlets as near as 2 kilometers to as far as 87 kilometers.

# 5. Cost and returns

Table 10. Costs and returns in tilapia farms

Type of farm	Gross Receipts	Total expenses	Net returns	Rate of Over expenses	f return Over fixed capital <sup>a</sup>
	pesos per half-hectare		percent		
Pure tilapia	884	482	402	83	119
Tilapia-carp	1580	638	942	148	240
Tilapia-bangos	782	282	500	177	676
Tilapia-others	1028	493	535	109	270
All farms	930	403	527	131	262

a/Value of fishpond land was excluded.

It appeared that tilapia farming becomes more profitable when done in polyculture with other fishes especially carp. Per half-hectare, tilapia-carp farms attained a gross receipts of \$1580 compared to only \$884 in monoculture farms. The average for all farms was \$930 per half-hectare.

A tilapia farm used an annual operating capital of \$\mathbb{V}403\$ per half-hectare a large proportion of which was used to pay for hired labor. Tilapia-carp farms incurred the biggest expense (\$\mathbb{V}638\$ per half-hectare) and tilapia-bangos farms the least (\$\mathbb{V}282\$).

Net profit in polyculture farms was higher than in monoculture farms. Tilapia-carp farms obtained a profit of \$\mathbb{V}942\$ per half-hectare, thus, about \$\mathbb{F}1.48\$ of net profit is returned to the operator for every peso spent in operating his farm or \$\mathbb{V}240\$ return to his fixed capital excluding land. Of course, if the value of land is added, this rate will be considerably reduced. Monoculture farms obtained a net profit of \$\mathbb{V}402\$ per half-hectare or a rate of return over expenses of 83%. For all farms, net return was \$\mathbb{V}527\$ per half-hectare.

The use of fertilizers increased production and thus, income in tilapia farms. Users of fertilizers among monoculture farms attained a net return of \$1465 per half-hectare, about 57% higher than that obtained by non-users. Likewise in polyculture farms, fertilizer users profited more (\$768 per half-hectare than the non-users (\$7427).

Table 11. Costs and returns in tilapia farms

Item		fertilizer	Use of Supplementary feeds		
1 cen	Did use	Did not use	Did use	Did not use	
		pesos	per farm		
Monoculture farms					
Gross return	738	1693	1693	929	
Total expenses	356	544	556	373	
Net returns	382	1149	1137	556	
Dalamalkana 6					
Polyculture farms Gross returns	2275	1566	1996	1650	
	929	660	835	670	
Total expenses Net return	1346	906	11161	980	
Nec Teratu	1340	300	11101	. 500	
		pesos pe	r half-hecta	re	
Monoculture farms					
Gross returns	2827	1376	2939	593	
Total expenses	1362	442	965	238	
Net return	1465	934	1974	355	
Polyculture farms					
Gross return	1298	737	1268	576	
Total expenses	530	310	530	234	
Net returns	768	427	738	342	

Supplementing the natural food of tilapia in ponds brought more profit to the operator. Among monoculture farms, users of supplemental feeds netted about #1974 per half-hectare while non-users netted only #355 or 5.6 times lower. The same relationship of net returns was observed among polyculture farms.

# 6. Problems and other information

Lack of technical support was cited as a major problem by the operators especially in Cagayan Valley where almost 50% of the operators received no technical support. Improper construction of pond gates and dikes also beset many of them. Other problems cited include flood and water pollution, low supply of fingerlings, unavailability of credit, insufficiency of capital and high price of inputs.

Table 12. Problems in tilapia farming

Item	Ilocos	Cagayan Valley	Central Luzon	Southern Luzon	Other regions	Phils.
Number of respondents	15	58	28	21	9	131
			num	ber		
Lack of technical support	• 2	24	4	8	1	39
Lack of proper infrastructure	7	4	10	2	2	25
Land grabber and poachers	2	17	10	2	1	22
Flood and water pollution	-	5	1	4	2	17
Low supply of fingerling	<del>,</del> –	6	6	4	1	16
Unavailability of credit	<b></b> :	11	· 3	_	2	16
Insufficient capital	3	5	-	3	2	13
High price of inputs	1	6	4	-	<del>-</del>	11

a/Including red tape in the processing of loan application.

Majority cited credit assistance from the government as one of the ways that will help improve the tilapia industry. More than one-fifth suggested technical assistance from the government while another one-fifth suggested continuous supply of fingerling.

Improvement of the industry could also be made possible through cooperation among fishpond operators viewed as follows: first, it would provide informal sessions regarding proper fishpond management, second, there will be a continuous supply of fish seed if communal fishponds are set-up, third, source of "bayanihan" labor is possible and, lastly, financial assistance among them would be available.

Table 13. Extension Assistance

Item	Number of farms
Reached by extension worker	
Yes	63
No	68
Recommendations provided for	
Stocking techniques 4/	22
Management practices during rearing C/Cultural practices prior to stocking	19
No recommendations given	10
Followed recommendations	
Yes	48
No	5

Includes rate of stocking, polyculture of tilapia and sexing of tilapia fingerlings prior to stocking.

About one-half of the operators had not been reached by government extension workers. Those reached by extension workers are provided information on proper stocking and management practices while a number of them were not given any information. Of those who received recommendations from extension workers, 91 percent followed them.

 $<sup>\</sup>frac{b}{\sqrt{b}}$  Water level to be maintained in the pond at rearing stage and the practice of supplementary feeding.

C/Pond lay-out, proper dike construction, fertilization, "lumut" and "lablab" growing and pest elimination.

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Appendix Table 1. Cash and non-cash receipts in tilapia farming

Item	Tilapia	Tilapia- Carp	Tilapia- others	Tilapia bangos	All Farms		
Number of farms	54	27	36	14	131		
	pesos per farm						
Cash farm receipts	·						
Fishes sold	517	625	991	4140	1057		
Non-cash farm receipts Value of fishes used							
at home Value of fishes given	161	423	258	370	264		
away	122	96	55	209	108		
Change in inventory	33	<b>-</b>	13	<b>-</b>	<b>-</b>		
Sub-total	316	519	326	579	372		
Total Farm Receipts	833	1144	1317	4719	1429		
	pesos per half-hectare						
Cash farm receipts	548	863	774	686	688		
Non-cash farm receipts Value of fishes used							
at home Value of fishes given	171	584	201	61	172		
away	129	133 <sup>.</sup>	43	35	70		
Change in inventory	35	<del>-</del>	10	<b>-</b>	-		
Sub-total	335	717	254	96	242		
Total Farm Receipts	1580	1580	1028	782	930		

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Appendix Table 2. Cash and non-cash expenses per farm by type of stock

Item	Tilapia		Tilapia-carp		Tilapi	Tilapia-others		Tilapia-bangos	
T CEIII	Amt.	ૠ	Amt.	8	Amt.	*	Amt.	8	
Cash expenses								ı	
Fry/fingerlings bough	t 25	. 7	5	2	17	3	347	23	
Chemicals bought	2	i		_		-	4	-	
Fertilizers bought	7	2	6	2	3	1	104	7	
Supplementary feeds	57	15	32	12	60	12	7		
Hired labor	98	26	101	38	179	36	482	32	
Value of commission	27	7	73	27	87	17	173	11	
Food for laborers	32	8	8	3	2	_	11	1	
Transportation	6	2	22	8	15	3		_	
Equipment purchased	81	21	20	7	58	12	152	10	
Lease	28	7	-	<u>-</u>	36	7	137	9	
Interest borrowed		-						_	
capital		-	-	_	30	6	16	1	
Miscellaneous	18	5	<b>2</b>	. 1	16	3	82	5	
Sub-total	381	100	269	100	503	100	1518	100	
on-cash expenses									
Fry/fingerlings gathe	red/								
given free	25	33	35	18	79	61	58	31	
Unpaid family and									
exchange labor	39	53	25	13	33	26	47	25	
Change in inventory	-	_	73	38	<b>-</b>		79	42	
Other non-cash									
expenses	10	14	60	31	17	13	4	2	
Sub-total	74	100	193	100	129	100	188	100	
otal Expenses	1457	_	462	_	632	· · · · · · · · · · · · · · · · · · ·	1706	_	

Appendix Table 3. Costs and returns from tilapia farming, 1974

		Polyculture			
Item	Mono-	Tilapia-	Tilapia-	Tilapia-	All
·	culture	carp	others	bangos	Farms
Number of farms	54	27	36	14	131
Farm receipts	pesos per farm				
Cash receipts	517	625	991	4140	1056
Non-cash receipts	316	519	326	579	389
Total	833	1144	1317	4719	1445
Farm expenses					
Cash expenses	381	269	503	1518	513
Non-cash expenses	74	193	129	188	126
Total	455	462	632	1706	639
Net cash farm income	136	356	488	2622	543
Non-cash farm earnings	242	326	197	391	263
Net farm earnings	378	682	685	3013	806
		pesos per half-hectare			
Farm receipts					
Cash receipts	549	863	774	686	688
Non-cash receipts	335	717	254	96	242
Total	884	1580	1028	782	930
Farm expenses					
Cash expenses	404	372	392	251	333
Non-cash expenses	78	266	101	31	70
Total	482	638	493	282	403
Net cash farm income	145	491	382	435	355
Non-cash farm earnings	257	451	153	65	172
Net farm earnings	402	942	535	500	527

CAGE CULTURE OF TILAPIA IN LAGUNA DE BAY

Andres M. Mane SEAFDEC Aquaculture Department

## CAGE CULTURE OF TILAPIA IN LAGUNA DE BAY

#### Andres M. Mane

## Introduction

The culture of tilapia in net enclosures in Laguna de Bay is a recent development. It started in 1974 when a few enterprising fishpen operators tried to culture <u>Tilapia mossambica</u> in nursery compartments of their pens after the milkfish fingerlings have been released in the grow-out compartments.

Tilapia culture in fishpens, however was discontinued due to poor harvests. In almost all cases, the fish escaped by burrowing under the bottom line of the fence net.

With the success of raising tilapia in floating cages in Lake Bunot, San Pablo City the culture of this species in Laguna de Bay was revived, but this time in cages and not in fishpens.

## Tilapia Cages in Laguna de Bay

Tilapia is cultured in Laguna de Bay in fish cages constructed similarly as the fishpen, except for the net flooring which prevents the fish from burrowing into the mud bottom and escaping. The net resembles an inverted mosquito net and is tied securely to bamboo poles staked firmly on the lake bed.

The framework of the cage is made of bamboo poles braced together by lashing bamboo horizontally about 1 1/2 m above the water level.

The cage net (mest size = 0.5 - 2.5 cm) is made of either nylon or polyethylene materials. The upper rim of the net is tied to each pole one meter above the water level and the bottom line is tied about 30 cm below the lake bottom.

The fish cages range in size from 50-200 m<sup>2</sup> and are arranged in clusters or modules of from two to twenty units. They are located in places protected from the strong winds at water depth of not less than two meters.

## Sources and Production of Fish Seeds

T. mossambica and Tilapia nilotica are the principal species cultured in fish cages. Of the two, preference is given to the latter in view of its faster growth and larger size.

- T. mossambica fingerlings are purchased mostly from brackish-water ponds in Malabon, Rizal and in Bulacan Province where the fish is considered a nuisance in milkfish ponds. It is quite difficult to obtain fingerlings from this source as they are available only after the milkfish are harvested.
- T. nilotica fingerlings are obtained from nursery ponds along the edges of Laguna de Bay, principally in the towns of Calamba, Los Baños, and Bay, Laguna where production of T. nilotica fingerlings is fast becoming an industry. Production is undertaken by small-scale operators in nursery pond areas of 200-300 m<sup>2</sup>. Larger areas are now being devoted to tilapia fingerling production in these localities. The practice is likely to spread to other places around the lake.

Fingerlings are produced by breeders stocked in fertilized nursery ponds after predators have been removed. Breeders are stocked at a density of  $2/m^2$  and a sex ratio of one male to two females. Supplemental feeds consisting of rice bran are given when the supply of natural food is low.

As soon as fry appear, they are scooped and placed in hapa nets inside the nursery ponds where they are grown to fingerling size. Fry are given supplemental feeds until they are big enough to be distributed to fish cage operators.

## Rearing to Marketable Size

Tilapia fingerlings (3-4 cm long) are transported from nursery ponds to fish cages in oxygenated plastic bags or in tin tubs (500 1. cap). They are usually stocked at a rate of about  $20-25/m^2$ . A higher stocking density of  $50/m^2$  can be used provided supplemental feeding is given. Stocking is done early in the morning or late in the afternoon.

The fish subsist mainly on natural food in the water. Supplemental feeds consisting of fine rice bran and kangkong (<u>Ipomoea reptans</u>) leaves are given when natural food is scarce. Fine rice bran is broadcast in minimal amounts in the morning while the kangkong leaves are placed in patches in the cages so as not to interfere with the free movement of the fish. Feed supply is replenished after much of it has been consumed by the fish.

Tilapia fingerlings reach marketable size (10 pcs/kg) in 4-5 months when stocked in February or March. However, if the rearing period goes through the cold months of December and January, seven to eight months of rearing is needed before the fish can be harvested.

## Harvesting and Marketing

Harvestable fish are first concentrated in one corner of the cage by pulling the net up after having been loosened from the bamboo frame. They are bailed out with long-handled scoop net into tin tubs or styrofoam boxes filled with water at 20 percent of their capacity. The containers are then covered with polyethylene nets or with wood to prevent the fish from jumping out. The water in the container is changed every so often. The fish can be kept alive in this condition from 4-6 hours after which they become weak and die.

Tilapia are marketed alive to command higher price. Live tilapia costs about twice as much as the dead fish. Dead fish are packed with ice for storing when they cannot be marketed within the day.

Problems of the Tilapia Cage Industry

The following major problems beset the tilapia cage industry in Laguna de Bay and are constraints to its expansion and development:

- 1) Lack of standard breed that will give optimum production performance There are four species of tilapia that have been imported into the Philippines, namely: T. mossambica, T. nilotica, T. zillii, and T. aurea. Except for T. aurea which are now kept for breeding purposes, the rest have found their way into wild waters and have interbred and crossbred, resulting in populations which cannot be identified genetically and production performance which cannot be evaluated.
- 2) Lack of fingerling supply There is a general lack of fingerlings to supply the needs of tilapia cage operators in Laguna de Bay. As a result, the cages that have already been set remain unstocked for months. This situation has discouraged prospective investors from going into tilapia cage farming in the lake.
- 3) Insufficient methods of producing seed fish For lack of information on improved techniques in hatchery and nursery operations, production of fingerlings has been inefficient and the economic profitability of this venture is still doubtful.
- 4) Lack of information on proper nutrition There is a dearth of information on the kinds, levels, and methods of feeding that will stimulate accelerated production of tilapia. The practice of allowing the fish to subsist only on natural food makes the present culture methods inefficient and most often uneconomical.

- 5) Lack of information on the proper fish cage design and construction At present, tilapia fish cages vary in design and materials used. It is important that design and construction be standardized to effect efficient and economical culture operations, considering the harsh weather conditions and maximum longevity of the cages.
- 6) Lack of marketing facilities and imperfection of the market Tilapia commands high prices when sold alive. For lack of facilities, like live-fish wells and tanks in market places, the fish die before they are sold. Thus a limitation is placed on the amount of fish that can be marketed. There is a need to develop various ways of processing tilapia.

## Conclusion and Recommendation

The tilapia cage industry in Laguna de Bay is still in its infancy. It has developed through the years without the benefit of modern technology. Presently, it is beset with numerous problems, a good number of which are technical in nature. Research studies must therefore be undertaken to solve, or at least alleviate, these problems. The industry will certainly benefit from packaged technology resulting from these resources.

APPENDICES

PROGRAMME

# Technical Consultation on Available Aquaculture Technology in the Philippines February 8-11, 1979

## Programme

## February 8

0800 0830

REGISTRATION
OPENING CEREMONIES

WELCOME ADDRESS

Dean Domiciano K. Villaluz Chief, Aquaculture Department SEAFDEC

## REMARKS

Dr. Elvira O. Tan Director, Fisheries Research Division Philippine Council for Agriculture and Resources Research

RATIONALE AND GUIDELINES
Dr. Joseph C. Madamba
Director
Asian Institute of Aquaculture
SEAFDEC Aquaculture Department

INTRODUCTION OF KEYNOTE SPEAKER
Dr. Rafael D. Guerrero III
Dean, College of Inland Fisheries
Central Luzon State University

## KEYNOTE ADDRESS

Ms. Elizabeth Samson Executive Director Fishery Industry Development Center

0930

Break

1000

PRESENTATION OF BRIEFS FOR MILKFISH Chairman: Dr. Rafael D. Guerrero III Rapporteurs: Prof. Melchor M. Lijauco Prof. Virgilio Dureza

1230	Lunch
1330	CONTINUATION OF BRIEF PRESENTATION
1530	Break
1600	GENERAL DISCUSSION FOR MILKFISH  1. Currently available technology in given disciplines for milkfish
	<ol> <li>Production potential of available technology</li> </ol>
February 9	
0800	CONTINUATION OF GENERAL DISCUSSION  3. Technology gaps in milkfish aquaculture
	<ol> <li>Linkage mechanism for transfer of appropriate milkfish technology</li> </ol>
1000	Break
1030	PRESENTATION OF BRIEFS FOR PRAWNS Chairman: Dean Rogelio O. Juliano Rapporteurs: Dr. Arsenio S. Camacho Mr. Wilfredo C. Yap
1230	Lunch
1330	CONTINUATION OF BRIEF PRESENTATION
1530	Break
1600	GENERAL DISCUSSION FOR PRAWNS  1. Currently available technology in given disciplines for prawns
	<ol> <li>Production potential of available technology</li> </ol>
	3. Technology gaps in prawn aquaculture
	<ol> <li>Linkage mechanism for transfer of appropriate prawn technology</li> </ol>
1830	COCKTAILS

February 10	
0800	PRESENTATION OF BRIEFS FOR MOLLUSCS Chairman: Dr. Elvira O. Tan Rapporteurs: Ms. Priscilla C. Borja Ms. Anselma Legaspi
1000	GENERAL DISCUSSION FOR MOLLUSCS  1. Currently available technology in given disciplines for molluscs (mussels and oysters)
	<ol> <li>Production potential of available technology</li> </ol>
	3. Technology gaps in mollusc aquaculture
	4. Linkage mechanism for transfer of appropriate mollusc technology
1230	Lunch
1330	PRESENTATION OF BRIEFS FOR TILAPIA Chairman: Dr. Catalino de la Cruz Rapporteurs: Mr. Pedro Acosta Sr. Prof. Romeo D. Fortes
1500	Break
1530	GENERAL DISCUSSION FOR TILAPIA  1. Currently available technology in given disciplines for tilapia
	<ol><li>Production potential of available technology</li></ol>
	3. Technology gaps in tilapia technology
	4. Linkage mechanism for transfer of appropriate tilapia technology
February 11	
0800	PRESENTATION OF REPORTS BY COMMODITY CHAIRMEN  1. Milkfish  2. Prawns  3. Molluscs  4. Tilapia
0900	Break

0930	DISCUSSION OF REPORTS
1100	ADOPTION OF REPORTS
1230	Lunch
1330	FORMULATION OF AN AQUACULTURE TECHNOLOGY VERIFICATION PROGRAM FOR THE PHILIPPINES
1530	Break
1600	FORMU TION OF ALTERNATIVE TECHNOLOGY TRANSFER STRATEGIES FOR AQUACULTURE DEVELOPMENT IN THE PHILIPPINES
1800	CLOSING

OPENING CEREMONIES

## WELCOME REMARKS

# D.K. Villaluz Chief SEAFDEC Aquaculture Department

When the country's outstanding workers in a single given industry gather as you are here gathered, something momentous for the industry must be expected.

This technical consultation comes at a time when the industry is looking for ways to develop to a higher level.

Fish farming has entered a stage in which it has become more dependent on advanced technology. Aquaculture has always had a great potential in this country. We have the physical resources; we have had ample support and encouragement from the government; we have a relatively well-organized and strong private industry sector; we have progressive fish farmers who have provided the entrepreneurial talent; and we have the market.

But what the industry has sorely lacked through all these years is a solid technology base that could ensure its success and sustain its steady development.

This technical consultation is meant to provide all of us working for and in the industry valuable information on what the industry needs in terms of technology. Of more immediate importance, it aims to determine and evaluate the available technology, which should be substantial by now, so that these can be put together, refined and improved on if necessary, and brought to the attention of the nation's fish farmers.

There are three things I urge of you. The first is necessary to accomplish the tasks you have set out to do in the next four days and that is to be extremely critical but objective in evaluating the research results and the technologies that you or the agencies you represent have produced; the second which goes with the spirit of social justice that our government has adopted as a guideline for every endeavour is to see to it that the packages of technology you are expected to develop will not be biased towards the bigger fish farmers; and the third which is vital to the future of the aquaculture development program in this country and in the Asian Region is to look at this technical consultation not as a forum for discussing the comparative merits or relevance of one's findings or one's institution's programs but as an occasion for proving to the people in the industry that you have indeed their welfare and progress foremost in your minds.

While individually you possess diverse expertise and represent different institutions, collectively you are a single team working for a single purpose. If we keep this in mind, I have no reason to expect that our efforts will come to anything but success.

It is my pleasure to welcome you to the Aquaculture Department of the Southeast Asian Fisheries Development Center. I hope your stay will be pleasant and your work fruitful.

#### A CRUCIAL PERIOD FOR FISHERIES

## Keynote Address

by

Ms. Elizabeth D. Samson
Executive Director
Fishery Industry Development Council

Fisheries is entering a crucial year. A keen perception of the situation and an appreciation of the events of the past few years tell us that the vast potentials for a take-off are evident and the momentum for attaining these potentials are indeed underway. I feel that 1979 can be the opportune time to shift to higher gear. For although the road ahead is still fraught with obstructions, at least the horizon is in sight.

In our studies of the fisheries development process, we have identified technology transfer as the single most critical step in bridging the gap between attainable potentials of fishery development and the pervasively low productivity of a large segment of society. While the progressive entrepreneurs are way ahead in the application of new techniques that have pushed their own output levels to several multiples of present national averages, there remains a highly traditional sector whose returns for capture or culture efforts barely cover subsistence requirements.

Various researches and studies have been undertaken by research and educational institutions and the private sector which show the vast potentials of our fishery resources as an important food item and an income-producing activity. The researches in aquaculture have been varied and extensive, covering such areas as culture techniques, post-harvest handling/processing, aquaculture engineering and various commodities, notably milkfish, prawn, molluscs and tilapia.

SEAFDEC and the other institutions represented here today have made this existing body of knowledge possible. A very progressive and aggressive sector of private industry has contributed significantly to this body of knowledge.

But with such knowledge either already available or visibly attainable, why then does not industry in general automatically respond? Looking at the line-up of scientists and practitioners participating in this workshop, the answers will surely surface during the next three days. But may I, as a planner and a generalist leave with you the following general suggestions for your consideration in formulating the technology packages:

- 1. Research efforts need to be consolidated, including, but not limited to, government, academic, and private efforts.
- 2. They should be focused on a common direction, in line with national development efforts.
- 3. They should be set in priorities and duplication should be minimized in recognition of the reality of scarce resources (i.e., manpower and financing) versus competitive uses, as well as opportunity costs.
- 4. They should be supportive of other programs (like credit, marketing, education) which can carry research efforts all the way to their full impact on the industry.
- 5. All avenues for the dissemination of technology established through research should be explored, including private industry-to-private industry arrangements, with the government acting as facilitating agent.
- 6. More emphasis than ever before should be placed on cost-benefit analysis. The final stage of technology transfer (commercialization) can only be reached if the technique is proven to be economically viable.
- 7. Lastly, since fisheries is still a highly traditional sector of society where change is often greeted with doubt, if not apprehension, social considerations cannot be ignored.

This workshop is very timely and the apparent interest it has elicited is encouraging. Aquaculture is a high-growth industry and, fortunately, the Philippines has the natural resources for it and, thanks to the scientists and the innovative members of the industry, our techniques are undergoing an exciting pace of improvement. The decision of the workshop organizers to concentrate on four commodities already implies an alignment with government goals of supplying local protein requirements and expanding exports.

The Ministry of Natural Resources, and the FIDC in particular, eagerly anticipates the output of this workshop. It will be an invaluable input into our policies and programs and another visible evidence of interagency and government-industry cooperation in the interest of resource management and fishery development.

CAPSULE PROPOSALS

MILKFISH

TITLE: Credit for Small Fish Farmers

OBJECTIVES: To provide the mechanism and facility by which easy

credit can reach small fish farmers.

## SIGNIFICANCE:

Most small fish farmers are unable to avail themselves of credit. A mechanism should be arrived at that will make it reasonably easy for a small fish farmer to benefit from available credit facilities and enable him to sustain farm production.

BUDGETARY REQUIREMENT:

TITLE: Culture of Milkfish by Increased Substrate System
OBJECTIVES:

- 1. To determine if "Increased Substrate System" of milkfish farming can be economically applied on a commercial scale.
- 2. To compare the efficiency of nylon screen vs. old fertilizer sacks in producing lablab.

## SIGNIFICANCE:

Research at the Brackishwater Aquaculture Center indicate appreciable increase in production of marketbale milkfish when lablab organisms are allowed to grow on nylon screens thereby increasing grazing area.

## PROPOSED METHODOLOGY:

Six one-hectare ponds will be used in this study. The treatments will be (1) control, (2) nylon screen substrate, and (3) old fertilizer sack substrate. There will be two replicates for each treatment. Stocking density will be 3,000 fingerlings per hectare at an average weight of 3 grams. Rearing period will be 3 months per run. All ponds will be prepared following the conventional method of growing lablab.

## BUDGETARY REQUIREMENT:

(1)	Salaries and wages	<b>¥</b> 30,000
(2)	Maintenance & operating	
	expenses	45,000
(3)	Capital Outlay	36,000
(4)	Equipment Outlay	5,000
	Total Requirement	¥116,000

VIRGILIO A. DUREZA

TITLE: Electivity Indices in Food of Milkfish

## OBJECTIVES:

Obtain thorough information on food preferences of various stages of <a href="Chanos chanos both">Chanos chanos both in freshwater and saltwater environments.</a>

# SIGNIFICANCE:

Data on food preferences in relation to growth and survival are vital to aquaculture.

## PROPOSED METHODOLOGY:

Application of standard enumeration and gravimetric methods in observing the occurrences of food items in the guts of the fish at various stages of life, and of the same food items occurring in the habitat.

BUDGETARY REQUIREMENT: No estimate at the moment.

JOSE CARREON

TILE: Field-Testing of Milkfish Fingerling Stunting

## **OBJECTIVES:**

To determine effectiveness of the "Increased Substrate System" in sustaining good health of stunted milkfish fingerling.

## SIGNIFICANCE:

Most fishpond operators experience shortage of fingerlings because of dependence on supply from others. This is due to lack of awareness of existing technology and fear of high mortality and expensive feeding requirements for maintaining healthy stock. Research at the Brachishwater Aquaculture Center show good health and survival of stunted fingerlings at the stocking rate of 15 fish per square meter without artificial feeding.

## PROPOSED METHODOLOGY:

One or two nursery ponds at the Bureau of Fisheries and Aquatic Resources Demonstration Fishfarm at Molo, Iloilo City can be used in this verification study. The methodology shall be that of the BAC using 60% increased substrate level.

BUDGETARY REQUIRMENT: 175,000.00

VIRGILIO A. DUREZA

TITLE: Field-Testing of Milkfish Penculture Technology in Lake
Mainit and Lake Bato

#### **OBJECTIVES:**

- 1. To verify effectiveness of milkfish pen culture technology developed in Lake Laguna and in other suitable lakes such as Lake Mainit in Mindanao and Lake Bato in Bicol.
- 2. To adapt milkfish penculture technology developed in Lake Laguna to suit conditions in Lake Mainit and Lake Bato.

## SIGNIFICANCE:

Milkfish culture in fishpens is highly productive. The problems of pollution and typhoons, however, in Laguna Lake threaten the stability of the industry. Field-Testing of the technology in other areas will help in expanding the industry.

## PROPOSED METHODOLOGY:

Suitable sites in Lake Mainit and Lake Bato for fishpen culture of milkfish will be selected.

Commercial-size fishpens (1-2 has) will be constructed in Lake Bato and Lake Mainit.

Technology for milkfish culture in pens developed by the private sector in Laguna de Bay will be applied and evaluated in Lake Bato and Lake Mainit.

## BUDGETARY REQUIREMENT:

**#**250,000.00

RAFAEL D. GUERRERO III

TITLE: Increased Production of Milkfish by Multi-Sized Stocking and Stock Manipulation

#### **OBJECTIVES:**

Field testing of the mixed-age/multi-sized method of milkfish culture with continuous harvesting and replenishing to obtain increased production.

## SIGNIFICANCE:

The superiority of polyculture of different species of fish in increasing pond production has been well established. However, even in monoculture yield can be enhanced by stocking different sized and continuously harvesting the marketable size fish while replenishing depleted stock.

## PROPOSED METHODOLOGY:

Different sized (at least three) of milkfish fry, fingerlings and early juveniles will be stocked at a certain ratio and at high stocking densities in brackishwater ponds. Improved methods of stock manipulation will be observed. Harvesting methods other than gill netting will be tried to keep the fish in satisfactory condition for market.

BUDGETARY REQUIREMENT: F45,000.00

HIRALAL CHAUDHURI

TITLE: Milkfish Culture by "Kitchen Pond" Method

## **OBJECTIVES:**

- 1. To determine the carrying capacity of a culture pond supplemented with lablab grown from a separate pond.
- 2. To find out the best ratio between the lablab pond and the culture pond.

## SIGNIFICANCE:

It has been observed that environment suitable for the growth of lablab organisms is not compatible with well-being of the fish. So the concept of separating the lablab pond from the growing pond has a sound basis.

## PROPOSED METHODOLOGY:

Six one-hectare ponds will be used in this experiment. This facility can be made available at BAC. Some modifications can be done by constructing small compartments within the pond for lablab production at a ratio of 1:4 and 1:8 for the four ponds at two replicates each while the remaining two ponds shall be control pond using the conventional system.

## BUDGETARY REQUIREMENT:

1.	Personnel (Salaries & Wages)	<b>¥</b> 30,000
2.	Maintenance and Operating Expenses	30,000
3.	Equipment Outlay	5,000
4.	Capital Outlay	4,000
	Total Requirement	¥69,000

VIRGILIO A. DUREZA

TITLE: Production of Milkfish Fingerling in Freshwater Ponds and Cages

## **OBJECTIVES:**

To develop technology in producing milkfish fingerlings in freshwater ponds and cages.

## SIGNIFICANCE:

Milkfish fingerlings used in fishpens especially in Laguna de Bay are produced in brackishwater fishponds in Malabon, Rizal and in Bulacan Province. The fingerlings are transported in live-fish boats and land vehicles which take about 6 hours or more and are subjected to a number of stress factors that result in high mortality. Producing them in freshwater pounds by the shores of the lake, will not only lessen stress factors but also make them available already acclimatized to freshwater resulting in less mortality.

## PROPOSED METHODOLOGY:

- 1. Fry will be purchased in like manner as fry intended for brackishwater ponds.
- 2. They will be acclimatized by gradually reducing salinity to freshwater level.
- 3. They will then be cultured to fingerling size in freshwater ponds in the same manner as in brackishwater ponds.
- 4. The fingerlings will then be stocked in fishpens.
- 5. Mortality will be compared to that of fingerlings raised in brackishwater ponds.
- 6. The same procedure used in freshwater ponds will be applied to raising fingerlings in fish cages.

BUDGETARY REQUIREMENT: \$100,000.00

ANDRES MANE

TITLE: Packaging of Technology for Fishpen Culture of Milkfish Developed by the Private Sector in Laguna de Bay

## **OBJECTIVES:**

- 1. To gather and evaluate technology practiced by the private sector for the culture of milkfish in fishpens.
- 2. To recommend technology for field-testing under commercial conditions in Laguna de Bay and other suitable lakes in the Philippines.

## SIGNIFICANCE:

Technology for culture of milkfish in pens has been developed by the private sector. The technology, however, varies from one farmer to another and has not been standardized. Packaging of the appropriate technology will contribute to the stability of the industry.

## PROPOSED METHODOLOGY:

Surveys will be conducted on practices of successful fishpen farmers in Laguna de Bay. These practices will be evaluated to determine their technical and economic merits. Technology for the fishpen culture of milkfish as practiced by the private sector will be packaged.

BUDGETARY REQUIREMENT: \$750,000.00

RAFAEL D. GUERRERO III

TITLE: Propagation of Selected Algae in Milkfish Ponds

## **OBJECTIVES:**

- 1. To identify the fastest growing algal groups that could serve as the most suitable food for milkfish.
- 2. To develop a process by which these groups of algae could be efficiently propagated.

## SIGNIFICANCE:

Food for milkfish must be grown fast, efficiently, and as cheaply as possible. Without adequate food no one can raise marketable fish. At present pelletized feed is impractical because of its cost as against the selling price of the commodity.

## PROPOSED METHODOLOGY:

- 1. Identify algae and diatoms which are complementary to each other.
- 2. Proliferate in pond.
- 3. Distribute to fish farmers for trial and use.
- 4. As participants, require the fish farmer to submit reports on rates and kinds of fertilization, methods of culture and production.

## BUDGETARY REQUIREMENT:

CARLOS S. DAVID

TITLE: Site Selection Studies for Establishment of Milkfish
Broodstock Farms

#### **OBJECTIVES:**

- 1. To determine criteria for siting a broodstock farm and selecting appropriate holding structures.
- 2. To establish two or three experimental broodstock farms and operating these under environmental influence and with proper nutrition.

#### SIGNIFICANCE:

Available information show that captive milkfish undergo sexual maturation in natural coves without hormonal manipulation. The project may come up with the requirements in producing sexually mature milkfish and leave hormonal treatments to spawning activity which requires highly trained personnel.

## METHODOLOGY:

Criteria will be evolved on the basis of available biological information. Site survey will be conducted. Experimental broodstock farms will be established in selected sites to determine food and environmental requirements of sexual maturation in captivity.

BUDGETARY REQUIREMENT: \$250,000 per year for 3 years.

FLOR LACANILAO

TITLE: Sociological Aspects of Milkfish Industry

## OBJECTIVES:

- 1. To identify sociological aspects peculiar to the industry.
- 2. To study in-depth effects of studied aspects on growth of industry and formulate programs how to use them to advantage.

## SIGNIFICANCE:

This is a neglected study which may explain many least understood phenomena of the industry.

## PROPOSED METHODOLOGY:

Systematic survey and study by competent expert.

BUDGETARY REQUIREMENT: Flexible

TITLE: A Survey of Fishponds Affected by Acid-SO4 Soils

## **OBJECTIVES:**

- To characterize this soil type, from different areas, initially, in Panay, for appropriate laboratory tests.
- 2. To prepare a map showing extent of this soil type.
- 3. To correlate production figures of ponds within the area covered (Panay-wide) with soil acidity.

## SIGNIFICANCE:

Roughly 60% of Philippine milkfish farms are known to be affected by acid-soil conditions. In addition, extensive areas around Southeast Asia are in ecological situations where this problem could be met.

## PROPOSED METHODOLOGY:

- .1. Characterize soil types.
- 2. Refine laboratory procedures for determining potential acidity of soil.
- 3. Survey fishponds and obtain production information.

BUDGETARY REQUIREMENT: \$250,000 (1 year)

A. S. CAMACHO

TITLE: Transfer of Fertilization Techniques in Ponds Within and Between Regions

## **OBJECTIVES:**

- 1. To determine effects on yields of immediate transfer of fertilization techniques from well-managed and productive farms and from experimental ponds to less productive farms within and between regions.
- 2. To determine constraints involved in such transfer.

## SIGNIFICANCE:

Production in ponds vary widely from farm to farm both within and between regions. Differences in local conditions contribute to yield variations such as environment, management or operation, and others.

## PROPOSED METHODOLOGY:

In a region, the fertilization techniques of a well-managed and productive farm shall serve as one model. The other model will be that of the experimental farm (research institution). Three farms will be selected from among the low producing areas in the same region. The two models and that of the owner's technique will be tried simultaneously in each farm.

The same set up, this time in 3 ponds in another region, will be tried. Results from the trials will be monitored and compared. Other management and operational constraints will be evaluated.

## BUDGETARY REQUIREMENT:

The pond operators involved shall shoulder expenses for pond inputs such as fertilizers, lime, etc.

Other expenses include:

Supplies and materials	<b>73,000</b>
Travel	6,000
Others	1,000
Equipment (field kits, etc.)	5,000

Total #15,000

TITLE: Milkfish and Prawn Culture in Freshwater Ponds

## **OBJECTIVES:**

- 1. To determine potential milkfish and prawn production in freshwater ponds.
- 2. To develop technology in milkfish and prawn production in freshwater ponds.

## SIGNIFICANCE:

If found feasible, milkfish and prawn can be produced where they are consumed.

# PROPOSED METHODOLOGY:

Methodology can be summarized as follows:

- a. Stocking density experiments
- b. Fertilization experiments
- c. Polyculture experiments
- d. Feeding experiments
- e. Cost analysis and verification studies.

# BUDGETARY REQUIREMENT:

	Milkfish	Prawn	Total
Personnel			
Research Aide (1)	<b>y</b> 7,800	<b>y</b> -	¥ 7,800
Laborer (3)	14,235	· <b>-</b>	14,235
Honorarium	6,000	6,000	12,000
мов			
Supplies & materials	20,000	10,000	30,000
Traveling expenses	2,000	2,000	4,000
Repair and Maintenance	5,000	5,000	10,000
Communications	500	• · ·	500
Sundries	2,000	2,000	4,000
Administrative	1,000	1,000	2,000
Equipment	10,000	10,000	20,000
Capital Oulay	15,000	15,000	30,000
Totals	<b>¥</b> 83,535	¥51,000	<b>P</b> 134,535

TITLE: Culture of Specific Blue-Green Algae Species

## **OBJECTIVES:**

- 1. To identify the best natural pond-grown food for fish and prawn.
- 2. To develop culture techniques vis-avis fertilizer and pond conditions.
- 3. To reduce nitrogen fertilizer requirements in the long run.

## SIGNIFICANCE:

It will maximize growth of cultured species per unit area. It will mean more efficient utilization of fertilizers and lower production cost.

## PROPOSED METHODOLOGY:

Isolate identified blue-green algae species.
Culture identified species for inoculation in ponds
to established predominance.
Determine feasibility of different culture and management
systems.

# BUDGETARY REQUIREMENT:

To be determined by a technical committee.

C. DE LOS SANTOS, JR.

TITLE: Pond Culture of Artemia salina as Supplementary Food for Fish and Crustacean Postlarvae and Juveniles

### **OBJECTIVES:**

To test feasibility of culturing <u>Artemia salina</u> in brackishwater ponds, and as supplementary live food for fish fry and crustacean postlarvae.

# SIGNIFICANCE:

Success in culturing <u>Artemia</u> in brackishwater fishponds will make the animal available at very low cost. Optimum survival and faster growth of fish fry and crustacean postlarvae would be attained thereby conserving such resources, lowering production cost, and assuring ample seed supply for the industry.

## PROPOSED METHODOLOGY:

- 1. Decapsulate Artemia cysts in large volume.
- 2. Incubate cysts as required and culture to young adult age.
- 3. Innoculate previously identified ponds with the animals.
- 4. Instruct pond operators in culture techniques.
- 5. Make test runs on feeding <u>Artemia</u> nauplii and adults to milkfish fry and Penaeus monodon postlarvae in nurseries.

Target - 4 ponds in Iloilo province as test ponds with owners cooperating

# BUDGETARY REQUIREMENT:

Manpower: 1 SEAFDEC Technician

1 BFAR Extension worker

Cost of Artemia cysts, chemicals, travel expense and honoraria

**7**25,000

PRAWNS

TITLE: Small-Scale Sugpo Hatcheries for Private Sector

## **OBJECTIVES:**

- 1. To transfer sugpo hatchery technology to the private sector.
- 2. To spread the technology and help small fish farmers maintain fry supply throughout the year.

# SIGNIFICANCE:

This will assure fry supply and help small fish farmers and others who are engaged in prawn farming and related activities.

## PROPOSED METHODOLOGY:

Intensify training programs in small-scale sugpo hatchery operations.

# BUDGETARY REQUIREMENT:

a.	Personnel (contractual)	<b>#</b> 15,000
b.	Maintenance & Operating Expenses	50,000
c.	Equipment Outlay	30,000
đ.	Broodstock	15,000
e.	Capital Outlay	80,000
	Total	¥190,000

ANDRES COMIA

TITLE: Field Testing of Some Potential Feeds in Different Regions of the Country

## OBJECTIVES:

To determine the effects of some formulated feeds on prawn yield under various environmental conditions.

### SIGNIFICANCE:

Formulated feeds which are found to increase production can be disseminated to fish farmers. This will increase their yield, improve income, and make prawns available to more people.

## PROPOSED METHODOLOGY:

SEAFDEC will prepare the feeds and sell these to cooperators at cost. Cost of all other pond inputs will be shouldered by the cooperator. Daily collection of data like temperature, salinity, DO will be undertaken by the cooperator. Monthly weight sampling will be done by the proponent. Duplicate ponds of 1 ha or less for each feed and control will be required of the cooperator. At least 4 ponds will be needed.

# BUDGETARY REQUIREMENT:

#10,000/cooperator

FELICITAS P. PASCUAL

TITLE: Larval Production Barangay Prawn Hatcheries in Selected Sites OBJECTIVES:

- 1. To evaluate Barangay hatchery technology developed at SEAFDEC, Tigbauan, Iloilo by field testing in selected sites.
- 2. To extend this simplified hatchery technology to the private sector.

#### SIGNIFICANCE:

There is a shortage of stocking materials in the prawn hatchery. Small-sized barangay hatcheries would enable prawn farmers to produce their own seeds. When hatchery is located in areas where seawater is rich in desirable algal feeds, the elaborate system of producing natural feeds in the laboratory can be dispensed with.

## PROPOSED METHODOLOGY:

A preliminary survey will be made to select suitable sites by conducting preliminary runs using a mobile hatchery. A semi-permanent pilot hatchery will be constructed next in cooperation with the prawn farmer. Field testing of the hatchery technology will be done in each location.

# BUDGETARY REQUIREMENT: (For each location)

a.	Personnel (contractual)	¥10,000
b.	Maintenance and operating expenses	60,000
c.	Equipment and other facilities	40,000
	Total	<b>#110</b> _000

TITLE: Large-Scale Production of Sugpo Spawners and Nauplii

#### **OBJECTIVES:**

To test technology developed at SEAFDEC in mass producing nauplii by maturation and rematuration of sugpo broodstock through eyestalk ablation.

## SIGNIFICANCE:

Lack of sugpo spawners is one of the greatest constraints in the development of the prawn industry. Broodstock development by eyestalk ablation has been successfully attained in both pond reared and wild adult sugpo. Simplified, the technique will help mass production of sugpo seed needed by the industry.

# PROPOSED METHODOLOGY:

Adult sugpo (at least one year old) collected from ponds and from the wild shall be at minimum sizes of 90 g for females and 50 g for males. Females will be ablated unilaterally. The broodstock system may be land-based tanks or offshore pens depending on location and other requirements. Supplemental feeding will be provided.

# BUDGETARY REQUIREMENT:

a.	Personnel (Contractual)	<b>P</b> 15,000
b.	Maintenance & Operating Ex	penses 50,000
c.	Equipment outlay	30,000
d.	Cost of broodstock	15,000
e.	Capital outlay	80,000
	Tot	al ¥190,000

TITLE: Mass Production of Artemia salina Cysts

### **OBJECTIVES:**

- 1. To test technology developed in mass production of <a href="Artemia">Artemia</a> cysts in fishfarmers' salt ponds in different regions of the country.
- 2. To demonstrate the technique in decapsulating <a href="Artemia">Artemia</a> cysts.

## SIGNIFICANCE:

Although brine shrimp is one of the most improtant live feed for marine fish and prawn larvae throughout the world, its production area is limited, and its price extremely high. It has been demonstrated in a fish farmer's salt ponds that Artemia can be produced on a commercial scale. Extension of the technique will help in mass producing this important larval food and save foreign exchange.

## PROPOSED METHODOLOGY:

Artemia culture will be tried in salt beds or in ponds of very high salinity. Experience gathered in the pond culture of Artemia and in cyst-decapsulation will be tried in different locations.

BUDGETARY REQUIREMENT: \$400,000.00

TITLE: Maturation of Spawners in Private Prawn Ponds

# OBJECTIVES:

To explore the possibility of maturing ablated prawns in private fishponds in various areas.

# SIGNIFICANCE:

Success of this project will help solve the spawner supply problem of private hatcheries.

## PROPOSED METHODOLOGY:

One pond each will be selected from Barotac Nuevo, Iloilo; Pontevedra, and Batan, Aklan. Basis for selection will be depth, freedom from salinity fluctuation, feed availability and broodstock source. Maturation pens measuring  $10 \times 10$  m will be constructed in the selected sites. One year old or older females will be ablated and stocked with males on a 1:1 ratio at 80 prawns per pond.

BUDGETARY REQUIREMENT: \$230,000

WILFREDO G. YAP CEFERINO DE LOS SANTOS, JR. TITLE: Intensive Culture of Sugpo

## **OBJECTIVES:**

To study thoroughly the requirement for intensive culture of sugpo particularly stocking rate, amount and kind of feed, water management, and harvesting for export.

# SIGNIFICANCE:

With intensive culture, prawn yield will increase and enable the country to meet local and export demand for this food item.

### PROPOSED METHODOLOGY:

- 1. Determine the safe stocking rate per hectare for areas where electricity is not available.
- 2. Determine nutritional requirement so that a proper feed formulation can be made.
- 3. Determine water management requirements.

# BUDGETARY REQUIREMENT:

- 1. SEAFDEC assistance for pond design.
- 2. Production of SEAFDEC formulated feeds.
- 3. \$15,000 for pond construction and mechanical equipment.

RUPERTO ANGUDONG, JR.

TITLE: Nursery Pond Management for Sugpo Fry

# **OBJECTIVES:**

To test improved techniques for rearing sugpo fry in nurseries to obtain high rates of survival and growth.

## SIGNIFICANCE:

High mortality of <u>Penaeus monodon</u> occurs at every phase of its culture resulting in low production. Besides, there is acute shortage of sugpo fry. Increasing survival rate in nurseries will help increase production of juveniles for raising to marketable size.

# PROPOSED METHODOLOGY:

Hatchery bred sugpo fry (P5) will be stocked in well prepared nursery ponds of fish farmers. The ponds will be treated with lime and fertilized adequately. A suitable piscicide will be used to clear the ponds of predators and competitors. Supplementary feed will be provided. Harvesting will be done after three or four weeks.

# BUDGETARY REQUIREMENT:

a.	Personnel (contractual)	<b>≱</b> 10,000
b.	Maintenance & Operating Expens	es 40,000
c.	Cost of fry	100,000
d.	Equipment outlay	20,000
e.	Capital outlay	30,000
	Tota	1 \$\frac{1}{200,000}\$

MOLLUSC

# A. For Verification

	<u>Title</u>	Proponent
1.	Deep Water Mussel/Oyster Farming Using Floating Structures	Wilfredo G. Yap SEAFDEC
2.	Fish-Shellfish Culture in Fishponds	J. A. Carreon UPCF
3.	Socio-Economic Aspects of Aquaculture Technology	Aida R. Librero SEAFDEC
4.	Establishment of a Pilot Mussel Team in Areas Without Spatfall using Trans- planted Spats	Wilfredo G. Yap SEAFDEC
5.	Rationalization of Verification Studies' Methodologies for Various Aquaculture Technologies	Emmanuel Encarnacion SEAFDEC
6.	Field Testing of Available Post Harvest Technology and Handling, Transporting and Marketing Mussels from Source to Metro Manila Markets	Anselma S. Legaspi BFAR
В.	For Research	
1.	Larval Rearing of <u>Placuna placenta</u> up to Post-veliger Stage	Neon C. Rosell UPCAS

TITLE: Deep Water Mussel/Oyster Farming Using Floating Structures
OBJECTIVES:

- 1. To determine economics of deep water oyster/mussel farming in the Philippines using locally available materials.
- 2. To field-test various engineering designs under local weather conditions.

## SIGNIFICANCE:

Unit production of molluscs is dependent on water depth (other variables being similar). Annual production of up to 600-1000 ton/ha could be attained in deep waters with high productivity.

## PROPOSED METHODOLOGY:

Different materials and design shall be tried and their economics determined: Long-line system using plastic buoys, fiberglass buoys and concrete buoys shall be compared with raft-systems. The area selected is Batan Bay, Aklan.

BUDGETARY REQUIREMENT: \$150,000

WILFREDO G. YAP

TITLE: Establishment of a Pilot Mussel Team in Areas Without
Spatfall Using Transplanted Spats

### OBJECTIVES:

To determine the economics of farming mussels in areas without spatfall.

## SIGNIFICANCE:

Interest in mussel farming is high but, unfortunately, spatfall is limited to very few areas. Other areas with farming potential most likely exist. Dissemination of seed stock could make this low-cost protein source available to wider area.

## PROPOSED METHODOLOGY:

Areas with potential for culture shall be selected on the basis of biological indicators -- presence of large population of filter feeders. A test farm of 500 hectares will be constructed using either raft or fixed structures depending upon site condition. Target areas: 4 sites in different regions.

Cooperation of local institutions (BFAR Stations, schools) shall be solicited for manpower input.

BUDGETARY REQUIREMENT: \$15,000

WILFREDO G. YAP

TITLE: Field-Testing of Available Post Harvest Technology on Handling, Transporting and Marketing Mussels from Source to Metro Manila Markets

## OBJECTIVES:

To determine adoptability of laboratory tested technologies in commercial scale.

To assess feasibility of transporting and marketing mussels from source to Metro Manila markets.

### SIGNIFICANCE:

This will solve handling, marketing and distribution problems of mussel producers.

## PROPOSED METHODOLOGY:

Available technology on handling mussels, like prolonging life by lowering storage temperature with ice and special containers, depuration, and fattening, will be tested in commercial scale with the cooperation of a willing mussel producer.

ANSELMA S. LEGASPI

TITLE: Fish and Shellfish Culture in Fishponds

### **OBJECTIVES:**

- 1. Improve food-chain interactions in production ponds.
- 2. Maximize utilization of fish food organisms.
- 3. Diversify production of harvestable protein biomass in a given production pond.

### SIGNIFICANCE:

The feasibility of mixed cultivation of shell fish and fish in traditional brackishwater fish culture facilities offer diversification opportunities for protein production.

### PROPOSED METHODOLOGY:

Use of traditional estuarine culture ponds with good tidal water exchange systems and the following cultivable organisms:

- a) Crassostrea iredalei (Faustino), a filter feeder. Spatted collectors to be set in hanging or longline, or in trays, inside the pond.
- b) Siganus sp., the rabbit fishes well known as nibblers on "aufwuch" organisms are potentially compatible organisms for mixed culture with oysters.

J.A. CARREON

TITLE: Transfer of Oyster Farming Technology from Producer-Regions to Non-Producer Regions

#### **OBJECTIVES:**

- 1. To introduce the concept of oyster farming to more areas in the Philippines where desirable species occur.
- 2. To determine appropriate techniques in each locality considering its topography, available resource and climatic condition.

### SIGNIFICANCE:

Oysters are widely distributed and utilized in the Philippines. Dissemination of the culture technology can create a new industry in some areas, help improve socio-economic levels and increase the availability of this protein-rich crop in the selected areas.

## PROPOSED METHODOLOGY:

Look for prospective cooperators in strategic localities in the country who are willing to try the technologies, and with the help of competent extension workers, plan out regular extension service to these cooperators.

## BUDGETARY REQUIREMENT:

Variable, depending upon the number of sites. Capital costs should come from private sector.

WILFREDO G. YAP

JOSE A. CARREON

TITLE: Larval Rearing of <u>Placuna placenta</u> Up to Post-Veliger Stage OBJECTIVES:

- To evolve a technology in induced spawning and rearing of early larval stages.
- 2. To obtain basic data on food requirements of larval stages.
- 3. To produce seedlings under controlled conditions for stocking in farming areas.

### SIGNIFICANCE:

This would undoubtedly improve recruitment. Moreover, successfully breeding and rearing of the species to settling stage would provide sufficient supply of seedlings for stocking.

### PROPOSED METHODOLOGY:

Induced spawning by trying/testing all known methods applicable to some mollusc species. Strip spawning was successfully tried before but the trocophore died. Several chemicals are known to elicit spawning in a number of mollusc species and some may be effective in P. placenta.

# BUDGETARY REQUIREMENT:

In view of the availability of support facilities at SEAFDEC, additional budgetary needs would be minimal. An allocation of \$\noting{1}50,000.00\$ would be sufficient.

NEON C. ROSELL

TITLE: Trace Metals in Bivalves (Mollusc and Oyster)

# **OBJECTIVES:**

- To study trace metals in bivalves, particularly, mercury, zinc and lead.
- 2. To determine methods of reducing trace metal contamination in oyster and mollusc.

### SIGNIFICANCE:

Monitoring trace metals in bivalves, particularly those from polluted waters, is important for the protection of the consumer. In more developed countries maximum allowable limits are observed.

### PROPOSED METHODOLOGY:

- Oysters and molluscs will be collected from polluted waters and compared to those from unpolluted sources, as to mercury and zinc content.
- 2. The effect of depurating bivalves on the concentration of metals will be studied.
- 3. The possibility of reducing trace metal content by various methods of processing will be explored.

# BUDGETARY REQUIREMENT:

No estimate. Must include funds for:

- 1. Atomic absorption Spectrophotometer
- 2. Chemicals and Reagents
- 3. Personnel Requirements

FLORIAN MAGNO OREJANA

TILAPIA

# Title

- Field Testing of Tilapia Culture Technologies in Brackishwater Fishfarms
- Cage Culture of <u>Tilapia mossambica/</u>
   nilotica
- 3. Mass Production of <u>T</u>. <u>nilotica</u> fry in the Pilot Hatchery
- 4. Socio-Economic Aspects of Aquaculture Technology
- 5. Field Testing on the Use of Tarpon as Biological Control for Tilapia Production
- 6. Pilot Small-Scale Tilapia Hatchery in Brackishwater
- 7. Field Trials of Fish Cage Culture in Running Water (5 kph current or more) in Cagayan River
- 8. Tilapia Sex Reversed Fry

# Proponent

Dr. Rafael D. Guerrero III CLSU

Dr. Hiralal Chaudhuri SEAFDEC

Dr. Hiralal Chaudhuri SEAFDEC

Dr. Aida R. Librero PCARR-SEAFDEC

Prof. Romeo D. Fortes UP-BAC

Ms. Lourdes A. Dureza UP-BAC

Mr. Primitivo O. Clave BFAR

Mr. Ruperto Angodung, Jr. Fishpond Operator

TITLE: Pilot Commercial Tilapia Hatchery

### **OBJECTIVES:**

- 1. To demonstrate economic feasibility of mass producing tilapia fingerlings on a commercial basis.
- 2. To determine effectiveness of tilapia hatchery technologies under fishfarm conditions.

### SIGNIFICANCE:

The lack of tilapia fingerlings for culture in ponds and cages is a major contraint in commercial production. Demonstration of technical and economic feasibility of tilapia hatchery technologies will encourage the private sector to invest in the enterprise.

### PROPOSED METHODOLOGY:

Developed technologies for the hatchery of tilapia species in great demand for pond and cage culture will be applied in the pilot hatchery. An evaluation of the effectiveness and economics of these technologies will be done.

## BUDGETARY REQUIREMENT:

\$200,000- For pond facilities and operation.

RAFAEL D. GUERRERO III

TITLE: Cage Culture of Tilapia mossambica/T. nilotica

#### **OBJECTIVES:**

- 1. To verify available technology on the high yield of tilapia obtained by cage culture in different lakes.
- 2. To study economic feasibility of tilapia cage culture and make the technology available to fish farmers in areas where tilapia is popular.

### SIGNIFICANCE:

Though introduced in 1950, tilapia did not become popular because overpopulation stunted its growth. With improvement in population control techniques and with floating cage culture in lakes rich in natural food obtaining high production, fresh impetus has been generated in the tilapia industry.

### PROPOSED METHODOLOGY:

Floating cages will be established in fertile natural bodies of waters on a pilot scale and tilapia will be stocked at suitable stocking rates. Supplementary feeding will be provided when natural food is depleted. The reproduction usually will be restricted to floating cages of large-size meshes. The seed will be produced in the same body of water either by fencing the fringe shallow areas or by using hapa nets.

BUDGETARY REQUIREMENT: 1/200,000.00

TITLE: Field-Testing the Use of Tarpon as Biological Control for Tilapia Reproduction

## OBJECTIVES:

To verify, in commercial scale, the use of tarpon as biological control for tilapia reproduction in a milkfish - mixed sexes tilapia population.

# SIGNIFICANCE:

The benefits of the use of tarpon as biological control for tilapia reproduction have already been shown. Because of the need to thin down the population of undesirable sized tilapia from milkfish-tilapia polyculture, the use of tarpon could increase pond productivity in a polyculture system.

## PROPOSED METHODOLOGY:

The established 1:10 ratio of tarpon-tilapia combination shall be tested in ponds stocked with milkfish and mixed sexes tilapia population.

## BUDGETARY REQUIREMENT:

Approximately \$50,000

R. D. FORTES

TITLE: Field Trials of Fish Cage Culture in Running Water (5 kph current or more) in Cagayan River

### **OBJECTIVES:**

- 1. To develop technology for fish cage culture in running water.
- 2. To test applicability of the technology.

## SIGNIFICANCE:

The development of technology for fish cage culture in Cagayan river will enhance fish production in Region 2.

# PROPOSED METHODOLOGY:

Construct and set a series of fish cages in Cagayan River and determine its technical and economic feasibility using technology developed at CLSU.

# BUDGETARY REQUIREMENT:

1150,000 for 3 cages

PRIMITIVO O. CLAVE

TITLE: Mass Production of <u>Tilapia nilotica</u> Fry in Pilot Hatchery

### **OBJECTIVES:**

- 1. To test the efficacy of the technique of <u>T</u>. <u>nilotica</u> seed production under fish farm conditions.
- 2. To demonstrate large-scale production of <u>T</u>. <u>nilotica</u> in a pilot hatchery.

### SIGNIFICANCE:

Tilapia culture has gained much popularity in the Philippines in recent years because of the introduction of the more efficient <u>T. nilotica</u> species. But shortage of seed is the big constraint of the industry. Demonstration of seed production techniques will enable fishfarmers to produce the seed themselves.

# PROPOSED METHODOLOGY:

Technology developed in mass production of tilapia will be demonstrated under farm conditions in different regions where tilapia is popular. Stocking at proper spawner sex ratio and improved methodology to obtain maximum fry survival in the hatchery will be demonstrated.

## BUDGETARY REQUIREMENT:

Total initial budget of #180,000 may be required. With selection of more sites, additional funding may be required.

TITLE: Pilot Small-Scale Tilapia Hatchery in Brackishwater

### **OBJECTIVES:**

To demonstrate the technical and economic feasibility of mass producing all male tilapia in brackishwater.

# SIGNIFICANCE:

Due to the abundance of brackishwater compared to freshwater, the former could be tapped as water supply for a pilot small-scale hatchery facility for the production of desired tilapia fingerlings.

# PROPOSED METHODOLOGY:

Improved techniques of mass production tilapia fingerlings of good quality (as to sex and size) and of the desired quantity in brackishwater will be used. Appropriate aquaculture systems will be evaluated.

BUDGETARY REQUIREMENT: \$100,000

LOURDES A. DUREZA

TITLE: Large-Scale Production of Sex-Reversed Tilapia Fry

# OBJECTIVES:

To provide suitable tilapia fry in quantities enough to meet fry needs of brackishwater ponds.

## SIGNIFICANCE:

Existing brackishwater ponds can be rendered productive if stocked with tilapia fry while milkfish fry is in short supply.

# PROPOSED METHODOLOGY:

Fry will be stocked in transition ponds and fertilizer requirements for natural feed production will be undertaken. Sex-reversal studies will be accelerated.

RUPERTO ANGODUNG

ALL TECHNOLOGIES

TITLE: Rationalization of Verification Studies' Methodologies for Various Aquaculture Technologies

## **OBJECTIVES:**

- 1. To determine the optimum aquaculture technologies in terms of maximizing effectiveness and efficiency, with the least amount of costs, inputs and effort.
- 2. To verify the most feasible technologies according to location and situation.

### SIGNIFICANCE:

Verification studies refine technology to a form that is relevant and applicable to farmers' settings. Methods adopted in these studies need to be rationalized to maximize efficiency and effect at the least cost.

### PROPOSED METHODOLOGY:

- Identify the variables: degree of mechanization, degree of task complexity, workflow integration, complexity of technological process, socio-cultural acceptance, variances or volatility of performance, degree of labor intensiveness, usage of locally available materials, other organizational variables, etc.
- 2. Survey the present practices on available technologies.
- 3. Prepare empirical studies on each technology using the multivariate technique of multi-dimentional scaling and cluster analysis.

# BUDGETARY REQUIREMENT:

The project should be conducted by SEAFDEC-AIA or any other interested organization. The budget would depend on the extent of use of each technology.

EMMANUEL ENCARNACION

TITLE: Study of Factors that Help or Hinder Acceptance/Adoption or Non-Acceptance/Non-Adoption of Improved Aquaculture Technology

# **OBJECTIVES:**

To find the factors that influence farmers' decision to accept, adopt or reject introduced aquaculture technology.

## SIGNIFICANCE:

Since the ultimate target of improved technology is the farmer himself, more information must be known about him so that strategies for technology transfer may be developed.

### PROPOSED METHODOLOGY:

This study may be conducted by the unit of the University of the Philippines System which has the expertise and experience in this type of study.

J. A. AGBAYANI, JR.

#### **PARTICIPANTS**

- I. University of the Philippines System
  - 1. Arsenio S. Camacho
  - 2. Jose Carreon
  - 3. Virgilio A. Dureza
  - 4. Romeo D. Fortes
  - 5. Florian M. Orejana
  - 6. Neon C. Rossell
  - 7. Carmen Velasquez
- II. Central Luzon State University
  - 1. Emmanuel M. Cruz
  - 2. Rafael D. Guerrero III
- III. Bureau of Fisheries and Aquatic Resources
  - 1. Primitivo Clave
  - 2. Hermenigildo Magsuci
- IV. Fishfarmers' Associations
  - 1. Saturnino Abesamis
  - 2. Ruperto Angodung, Jr.
  - 3. Carlos David
  - 4. Arnolo Goco
  - 5. Concordia P. Goco
  - 6. Ernesto V. Jamandre
  - 7. Tirso Jamandre, Jr.
  - 8. Benjamin E. Lerma
  - 9. Antonio Ortiz
  - 10. Ceferino de los Santos, Jr.
- V. Philippine Council for Agriculture and Resources Research
  - 1. Dolly de Guzman
  - 2. Aida R. Librero
  - 3. Elizabeth Nicolas
  - 4. Elvira O. Tan
- VI. Southeast Asian Regional Center for Graduate Study and Research in Agriculture
  - 1. Billy P. Blanco
- VII. National Institute of Science and Technology
  - 1. Katherine Apolinario

# VIII. Fishery Industry Development Council

## 1. Elizabeth D. Samson

# IX. Southeast Asian Fisheries Development Council

- 1. Jose A. Agbayani, Jr.
- 2. Lita V. Benitez
- 3. Artemio Bernardino
- 4. Priscilla Borja
- 5. Napthali Carandang
- 6. Hiralal Chaudhuri
- 7. Rufil Cuevas
- 8. Emmanuel Encarnacion
- 9. Ricardo Esquerra
- 10. Jose A. Eusebio
- 11. Thomas G. Flores
- 12. Benjamin Cer Gabriel
- 13. Rogelio Gacutan
- 14. Shiro Hara
- 15. Noburo Hoshino
- 16. Julie Ann Jaranilla
- 17. Jesus V. Juario
- 18. Yong Chan Kim
- 19. Shiqeru Kumagai
- 20. Flor Lacanilao
- 21. Melchor Lijauco
- 22. Chhorn Lim
- 23. Joseph C. Madamba
- 24. Porfirio Manacop
- 25. Clarissa Marte
- 26. Hideo Mochizuki
- 27. Julia Pantastico
- 28. Felicitas Pascual
- 29. Luis M. Rodriguez
- 30. Hermenigildo Sitoy
- 31. Noel Solis
- 32. Rodolfo T. Tolosa
- 33. Cesar Villegas
- 34. Robert Wear
- 35. Adam Young
- 36. Hiroshi Motoh

# OBSERVERS

- 1. Ponciano Batugal, PCARR
- 2. Emeterio Borlongan, SEAFDEC
- 3. Morena Bucu, PCARR
- 4. Herminio Catahan, Jr., SEAFDEC-SEARCA IFCD Project
- 5. Steve Robles, SEAFDEC-SEARCA IFCD Project
- 6. Bernardita A. Q-impo, Farming Today Magazine