ISSN – 0115-5369

Extension Manual No. 5
Third Edition
August 1983

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AQUACULTURE DEPARTMENT
Southeast Asian Fisheries Development Center
Tigbauan, Iloilo, Philippines

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## PREFACE

The culture of prawns and shrimps in brackishwater ponds has evolved from the accidental entry of fry during tidal exchange to deliberate stocking in ponds; from polyculture with milkfish to prawn monoculture; and from dependence on wild fry to acceptance of hatchery-reared fry and juveniles. In particular, the establishment of hatcheries and subsequent availability of prawn fry in greater numbers, has had great impact on local prawn aquaculture.

Milkfish (*Chanos chanos*) farming and sugpo or prawn (*Penaeus monodon*) culture offer an interesting study in contrasts. Already, more than half of all prawn fry stocked in ponds comes from hatcheries whereas milkfish farmers remain totally dependent on wild fry. On the other hand, traditional milkfish pond culture has been perfected by the private sector while sugpo raising is very much in its infancy in this country.

Needless to say, the highly lucrative prices of prawn compared to milkfish added to the greater availability of fry are encouraging fish farmers to shift to prawn. Responding to the need for materials in sugpo grow-up techniques, SEAFDEC AQD produced **Manual of Operations: Sugpo Pond Culture** way back in 1977 followed by the **Manual on Prawn Farming** in 1979. In the span of four years, enough information has been generated, and technology developed, whether by farmers using extensive culture, or by AQD and other research institutions on the semi-intensive method of culture, to merit another revision.

Nevertheless, for every question answered, ten new ones crop up. What causes soft-shelling? Is low salinity essential to sugpo growth? Does molting follow the phase of the moon? These are only a few of the problems that require research efforts of a long-term, basic and multidisciplinary nature.

This manual should also stimulate interest in the culture of *hipong puti* (*P. indicus* and *P. merguiensis*), *hipong suahe* (*Metapenaeus ensis*) and other commercially important prawns and shrimps. Diversification of species leading to diversification of markets (Europe and the U.S.A. in addition to Japan) is merely an application of the principle of not putting all your eggs in one basket. Moreover, the lower prices of these species relative to sugpo places them well within the buying capacity of the Filipino consumer, not to mention their being more suited to such local cuisine as *kinilaw* and *camaron* as well.

Lastly, it is hoped that this manual will be useful and of interest not only to prawn fanners but also to government extension workers, fisheries students and faculty, and other budding aquaculturists.

**F.A.**
**J.H.P.**
**P.L.T.**

August 1983

# FARMING OF PRAWNS AND SHRIMPS

**Florentino Apud, Jurgenne H. Primavera,**
**and Pastor L. Torres, Jr.**

## I. INTRODUCTION

### A. Terminology

There is actually no clear distinction between the terms *shrimp* and *prawn*. They are used interchangeably with emphasis on one or the other in different parts of the world. Shrimps are generally on the small side while prawns, according to a dictionary definition, can range from one inch to the size of a lobster.

Prawns and shrimps may belong to the freshwater, eggbearing Family Palaemonidae (of which *Macrobrachium* or *ulang* are the more popularly cultured species) or the marine, non-eggbearing Family Penaeidae. The U.N. Food and Agriculture Organization has adopted the convention of referring to all palaemonids as prawns and all penaeids as shrimps.

However, both SEAFDEC AQD and local farmers and hatchery operators use prawn to refer to *Penaeus monodon* or *sugpo* and prawn or shrimp interchangeably for the smaller penaeids such as *P. indicus* and *Metapenaeus ensis*. This terminology will be followed for the rest of the manual which deals exclusively with the marine penaeids.

### B. Kinds of prawns and shrimps

There are more than 300 species of penaeid prawns and shrimps recorded worldwide of which around 80 are commercially important in terms of capture fisheries and/or culture. Among the various penaeids found in the Philippines, the following four species are recommended for pond culture:

1. *Penaeus monodon* (Fig. 1) — giant tiger prawn, Eng.; *sugpo*, Tag.; *lukon*, Hil.; *pansat*, Ceb. It is the biggest member of the penaeid group with individuals from offshore catches reportedly reaching 500-600 grams in body weight. Among the characteristics that make it an ideal aquaculture species are high survival rates of up to 90% in grow-out ponds and fast growth rates with sizes of up to 100 grams after 4-5 months at low density culture, although normal harvest size ranges from 15 to 30 pieces to a kilogram (30-60 g). It is extremely hardy and can tolerate being crowded out of water for short periods of time. It can also survive a wide range of temperature and salinity levels although many farmers observe that it grows faster in low salinity ponds (10-25 ppt).

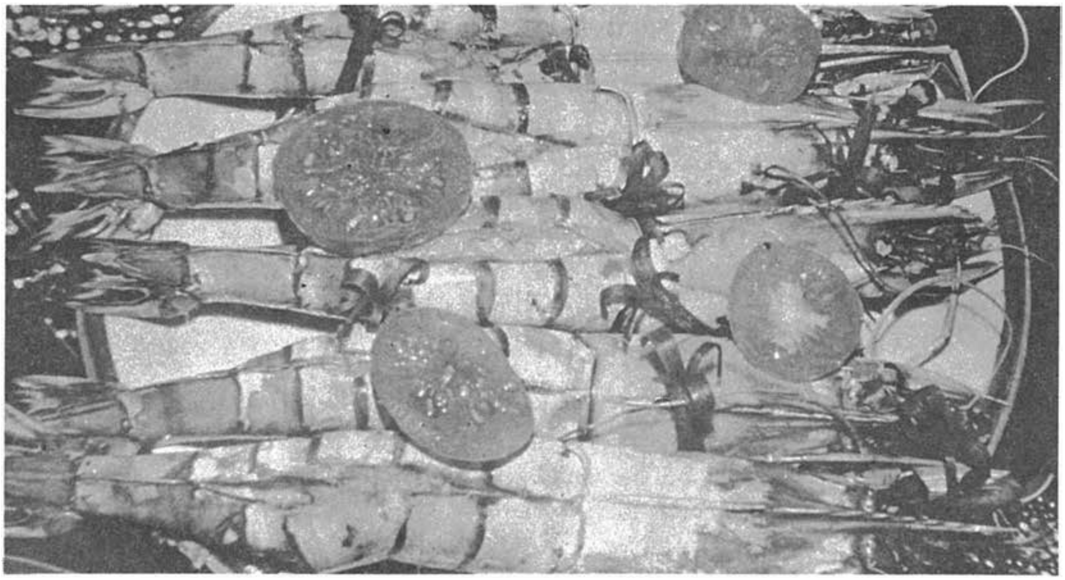


**Fig. 1. The popular sugpo *Penaeus monodon* remains the most important penaeid prawn species in Southeast Asian aquaculture.**

With the basic technology for induced maturation (by eyestalk ablation of females), larval rearing and nursery already available, some 60 hatcheries have been established throughout the country, with majority of them privately-operated. Consequently, around 40% of all *P. monodon* fry stocked in ponds in 1982 came from hatcheries compared to a small fraction from the wild.

2. *Penaeus indicus* and *P. merguiensis* (Fig .2): white shrimp, banana shrimp, Eng.; *hipong puti*, Tag.; *putian*, Hil; *putian* or *lunhan*, Ceb. Fry and adults of these two species resemble each other so that they are discussed as a single group. They are fast-growing and have a quick turnover rate in ponds — sizes of 10-20 g at high density and 20-30 g at low density can be attained after three months with harvests of 300-400 kg/ha/crop. Moreover, both species can tolerate higher pond salinities making either an ideal alternate crop to *P. monodon* during dry months.

A disadvantage, however, is that both species cannot withstand rough handling either for transport of fry or harvest of marketable animals. Direct rearing in ponds without passing through a nursery phase eliminates fry transfer problems whereas efficient postharvest handling and processing minimizes quick deterioration of the flesh that is characteristic of putian.

3. *Metapenaeus ensis* (Fig. 2) — Greasyback shrimp, Eng; *suahe*, Tag.; *pasayan*, Hil. and Ceb. It has a short growing period of 2-3 months in ponds, attaining market sizes of 10-15 g. It is more resistant to handling than putian.

Although wild spawners are available and larval rearing is easier compared to *P. monodon* and even *P. indicus*/*P merguiensis*, commercial hatcheries have not yet

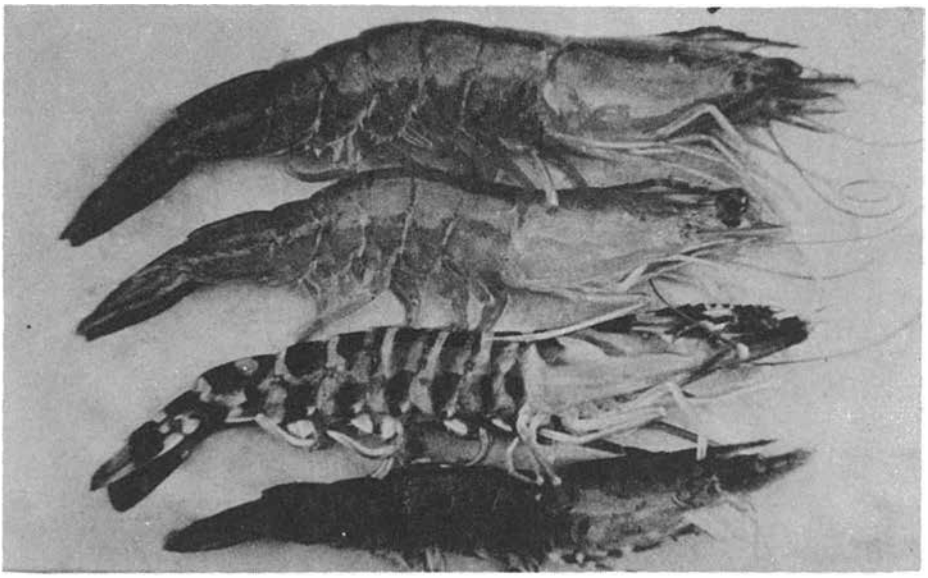


**Fig. 2. Other commercially important penaeids are (from top): a)** *Penaeus merguiensis,* **b)** *P. indicus,* **c)** *P. japonicus* **and, d)** *Metapenaeus ensis.*

tried producing *M. ensis* fry. Suahe harvested together with bangus or even sugpo come from naturally abundant fry that often enter ponds with the incoming tide.

At present, 90% of all our prawn and shrimp exports go to Japan. However, the use of *P. monodon* is limited to weddings and other celebrations partly as a substitute for large sized *kuruma ebi* and the Japanese market has been pegged at 1,500 tons/month. Sooner or later, the Taiwanese monthly production of 500-1,000 tons/ month, coupled with exports from other Asian countries, will saturate the Japanese market. Sugpo prices may suffer the same late 1979 collapse from a high P75/kg to P35/kg.

The instabilities of a single species-single market industry underscore the need to diversify to other species (putian, suahe) in order to diversify to other markets (USA, Europe, Middle East). In fact, the lighter-colored putian and other shrimps are preferred not only for native cuisine but also by European, American, and even Japanese consumers.

Hatcheries can start the ball rolling by selling putian and suahe fry in commercial quantities to farmers for grow-out. While the present attainable market sizes of 10-20 g may not meet export standards, local prices of P20-P40/kg are still more lucrative than those of milkfish. In the meantime, SEAFDEC AQD and other institutions should double their research efforts along nutrition and feeding studies, selective breeding, etc. to achieve the internationally preferred sizes of 20-25 pcs/kg headless (35 g and above heads-on)

## C. Life cycle

The following life cycle of *P. monodon* is typical of other penaeids as well (Fig. 3A).

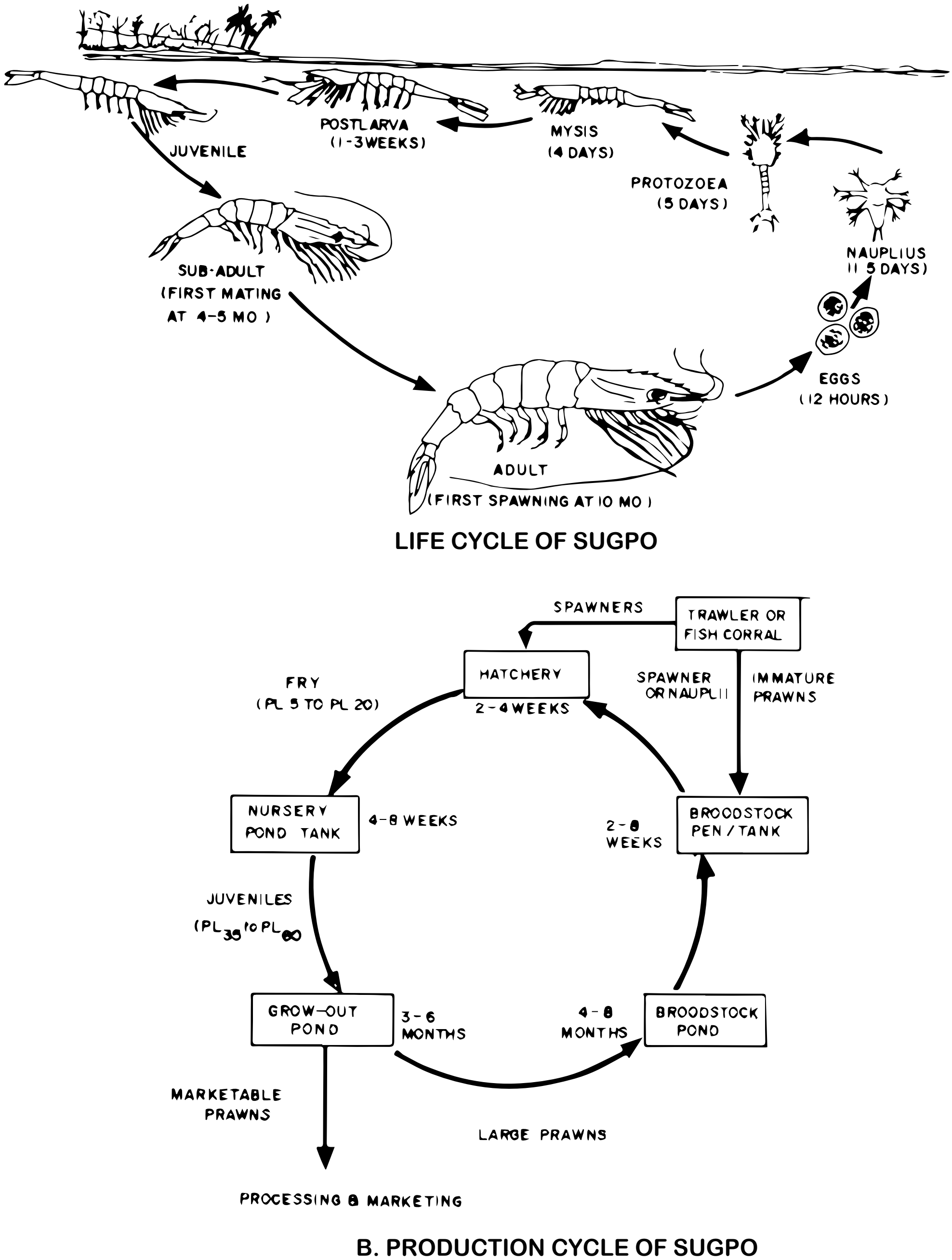



**Fig. 3. Parallels in the (A) life cycle and (B) production cycle of sugpo** ***Penaeus monodon*** **(after Yap, 1980 and Motoh, 1981).**

Adult sugpo are bottom-dwellers in the offshore areas at depths of 20 to 70 meters. The life cycle starts with the spawning or release of approximately 500,000 eggs by a gravid or ripe female. The larvae hatch out 12-15 hours after spawning, looking very different from the adults. After 10-12 days and two more larval stages, the larvae metamorphose into the postlarvae.

The young postlarvae or fry move shorewards and start appearing in coastal waters around two weeks into their postlarval life. They continue migration towards mangrove and other brackishwater areas which serve as their nurseries or feeding grounds, growing to larger juveniles, postjuveniles and subadults. At this stage, *P. monodon* is mainly carnivorous, feeding on slow-moving microscopic animals, small crabs, shrimps, molluscs, marine worms and detritus. The ecologically sound government policy of increasing production from already existing fishponds rather than opening up new mangrove areas has helped preserve wild populations of commercially important crustaceans and finfish by protecting their nurseries.

Although first mating occurs in the estuaries, it is only during or after migration back to the offshore areas that full ripening of the ovaries takes place. First spawning occurs at 10 months of age upon arrival in the offshore areas, followed by 2-3 more consecutive spawnings within a single season. The adults remain in the ocean up to a ripe old age of 3, 4 or 5 years unless they die earlier of predation or disease. However, some *Metapenaeus* species reportedly undergo spawning and the larval stages in brackishwater areas, completing the cycle without returning to the open sea.

It is the production of marketable prawns from postlarvae in brackishwater ponds (Fig. 3B) — parallel to the period of growth from the juveniles to the subadults in the natural cycle — that is the main concern and preoccupation of most prawn aquaculturists in the country.

**D. Culture systems of sugpo**

There are three systems of brackishwater pond culture of prawn in the Philippines based on the major inputs of feeding and water management (Table 1).

1. **Extensive** — At one end of the spectrum is the extensive system which depends completely on natural food propagated in the pond with or without fertilization and on tidal water replenishment. Stocking density is an average of 3,000 postlarvae/ha (range of 1,000 to 10,000/ha) oftentimes in polyculture with milkfish (500-2,000 fingerlings/ha) in already existing ponds. Yearly production is 100-500 kg/ha of prawn and 200-800 kg/ha of bangus.

The two prime prawn-growing areas in the country today are the Northern Panay provinces of Capiz and Aklan with at least 10,000 ha (Fig. 4) and the Bataan-Pampanga-Bulacan areas in Central Luzon with some 5,000 ha all in extensive culture.

Table 1. Culture systems of sugpo *(Penaeus monodon)* in grow-out ponds (Primavera. 1983).

| | Extensive | Semi-Intensive | Intensive |
|---|---|---|---|
| Feed | Natural | Natural + supplementary | Formulated feeds (pellets) |
| Water management | Tidal | Tidal + pump | Pump + aeration |
| Stocking density | 1, 000-10, 000/ha | 10, 000-50, 000/ha | 50, 000-200, 000/ha |
| Pond size | 2-20 ha | 1-5 ha | 1, 000 $m^2$ - 1 ha |
| Pond development costs | Existing milkfish pond | P25,000/ha + existing pond | P500,000/ha |
| Production | 100-500 kg/ha/yr | 500-4, 000 kg/ha/yr | 5, 000-15, 000 kg/ha/yr |

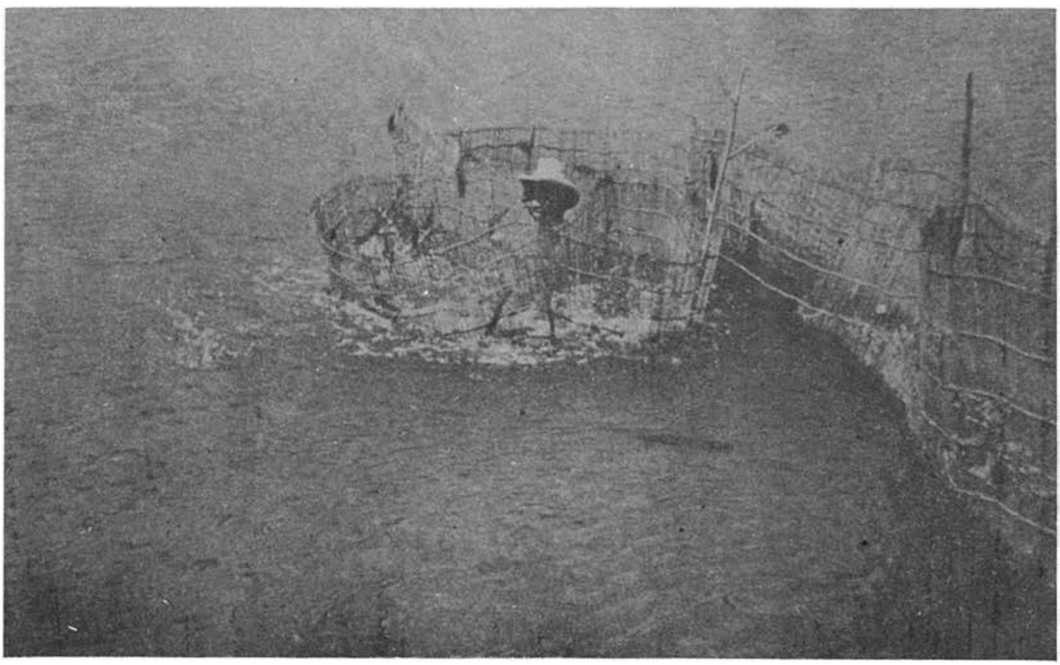


Fig. 4. Partial harvest of sugpo by bakikong in an extensive pond in Pontevedra, Capiz.

2. **Semi-intensive** — The semi-intensive system is on a higher level. It requires the feeding of trash fish, mussel meat, etc. to supplement natural food production and the use of water pumps in addition to tidal water exchange. Stocking density is

higher at 10,000-50,000 prawn juveniles/ha with correspondingly higher annual production of 500-4,000 kg/ha.

Renovation of an existing milkfish pond costs approximately P25,000/ha and includes excavation of peripheral or diagonal canals and installation of drain gates for each compartment, in addition to the supply gate.

3. **Intensive** — Almost completely independent of nature, the intensive system stocks 50,000 fry/ha consequently pushing production to 5,000-15,000 kg/ha/yr. Such high densities can be supported only though major inputs of formulated feeds mostly in the form of pellets, water exchange through pumps and aeration facilities (Fig. 5). Ponds are smaller, 1,000 to 5,000 $m^2$ in size, and are lined with concrete or bricks.

Correspondingly, pond development costs are approximately P500,000/ha whether for a new pond or an already existing pond and annual operating expenses require another P500,000/ha. This system was developed in countries with limited pond areas such as Japan where real estate is expensive and Taiwan where agriculture competes with aquaculture for land use.

This present manual places emphasis on both the extensive system for milkfish farmers who want to shift to prawn monoculture or polyculture and on the semi-intensive system for progressive farmers already practicing the extensive system. This emphasis is due to the relatively lower pond development costs and annual operating expenses for these low- to medium-density culture compared to intensive culture.

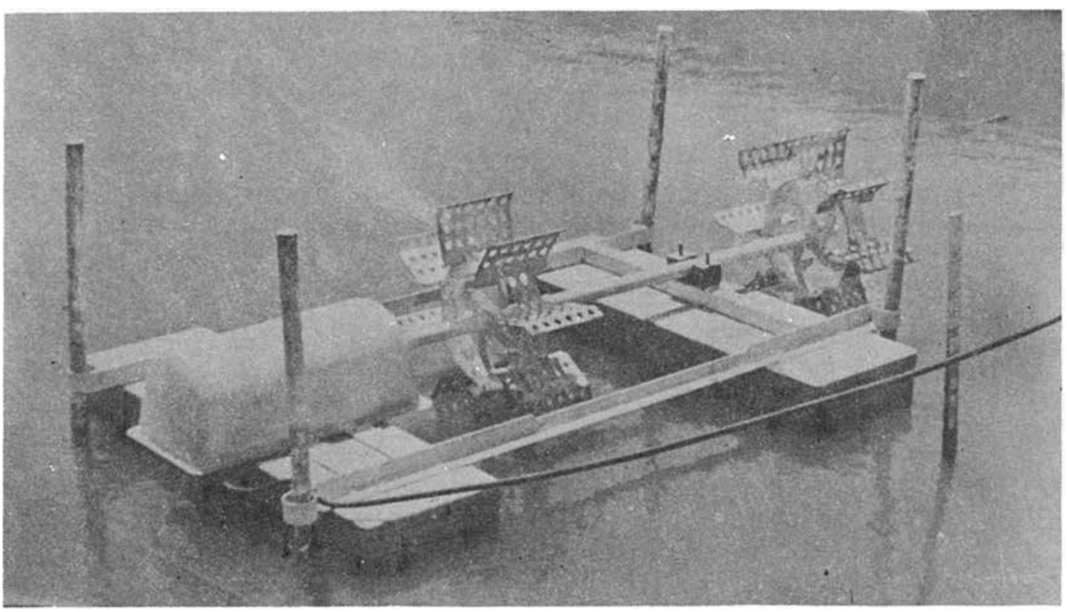


**Fig. 5. Paddlewheels increase oxygen levels in intensive prawn ponds.**

## II. BASIC CONSIDERATIONS

At present, there are approximately 200,000 ha of partially or fully developed brackishwater ponds in the country. Official government policy is to maximize production from these existing ponds rather than to open up new areas. Of the remaining 140,000 ha of mangrove forests, more than half have been designated national preservation and conservation areas and are not available for fishpond development.

### A. Choice of farm site

Although this manual is addressed to farmers who own or lease already developed ponds, the following checklist of site selection criteria may still be useful.

1. **Climate** — The prawn farm should be located in areas with no pronounced dry and wet seasons (Type 2), a short dry season (Type 3), or with evenly distributed rainfall (Type 4) to avoid the risk of stunting or mass mortality of prawns due to excessively high salinity (see Appendix I). In Type 1 areas, sugpo can be reared only during the wet months from June to November; putian may be a suitable crop during the pronounced dry season. Areas exposed to frequent typhoons, floods and strong waves should be avoided.

2. **Elevation** — If water exchange is tidal and no pumps are used, the ideal elevation is 0.5 to 1.0 m above 0 datum to attain water depth of 1.0-1.5 m.

Excessively low areas will be easy to fill but difficult to drain. Conversely, high areas will need extensive pumping or extensive excavation. In the long run, it will be cheaper to pump water out occasionally (during total harvests in low elevation ponds) than to pump water in frequently (regular water admission in high elevation ponds).

3. **Water quality** — Water should be free from agricultural and industrial pollution as well as turbidity due to a high organic load of mud and silt.

4. **Soil** — Clay loam, silty clay, sandy clay, silty loam and sandy loam are suitable soils because they hold water. These are soils which can be shaped into a ball without crumbling even after considerable handling because of the clay content and will have minimum seepage. Sandy and peaty soils are not suitable because they do not hold water and are not good dike materials.

Some coastal areas have accumulations of iron pyrites which form sulfuric acid (as a result of oxidation) when the pond is drained. The resulting acid sulfate soil is reddish in color and has a pH of 4 which can cause prawn mortalities.

5. **Vegetation** — Mangrove vegetation is a good natural indicator of soil type, elevation and salinity. Dominance of *Avicennia (api-api* or *miyapi)* indicates productive

soil suitable for fishpond development. Areas with an extensive growth of *Rhizophora (bakawan, pagatpat)* characterized by above ground prop roots, take longer to condition because of the presence of acid soils. Edges of tidal rivers are characterized by nipa palm stands. Although such areas have clayey soil, low salinity water and are easy to clean, they are also characterized by low pH. Nevertheless, this may be corrected by consistent liming.

6. **Fry supply** — Proximity to sources of wild fry and/or hatcheries reduces transport costs of the farmer as well as transport stress of the fry. The presence of nurseries in the area may be an equally important factor. For example, Cebu and Mindanao hatcheries fly their postlarve ($PL_{10}$ to $PL_{25}$) to nurseries in Roxas City that in turn rear them to juveniles ($PL_{35}$ and above) to supply Capiz farmers.

7. **Support facilities** — The area must be accessible for transport by land or water of equipment, supplies, materials and produce during the construction, operational and harvest phases.

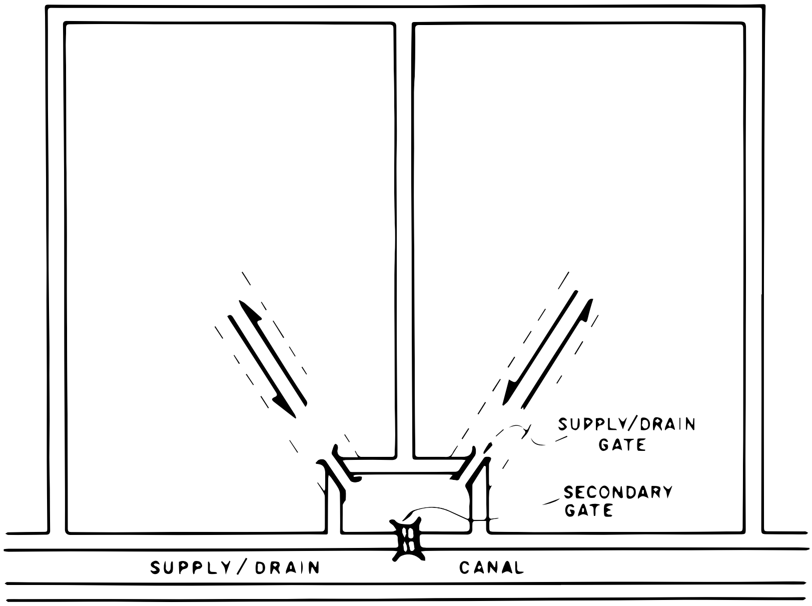
Availability of support facilities such as labor (for construction or daily operations), equipment and supplies (fertilizers, lime, ice), marketing outlets and technical assistance is critical to the commercial success of the venture. The farm should be in proximity to a local market or to a processing plant, harbor or airport if the crop is intended for Metro Manila or the export market.

8. **Legal aspects** — The area should not be in conflict with other uses such as mangrove reserves, navigation, industry and as a source of livelihood of local people (fishing, mussel farming).

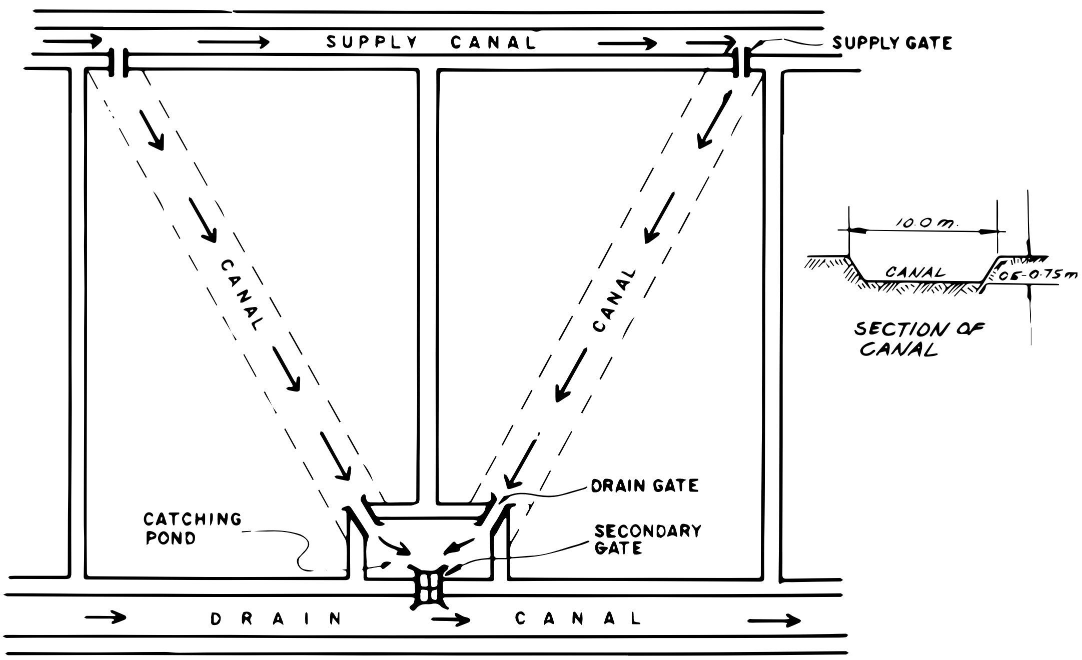
### B. Pond specifications

In line with government policy, this manual concentrates on the renovation of already existing milkfish ponds for prawn extensive or semi-intensive culture, and on proper farming techniques. Moreover, development of completely new areas is too capital-intensive and not feasible, given the present high cost of money (20-24% annual interest on commercial loans). Principles and procedures for pond design and construction have been discussed elsewhere (see References) and will not be covered here.

1. **Nursery pond** - Compartment sizes are small ranging from 100 to 2,000 $m^2$ with an average of 500 $m^2$. The ponds have separate supply and drain gates and canals for easier water management, e.g. a water flowthrough if necessary. Shape is generally rectangular or rhomboid with the acute corners lying along the prevailing wind direction — northeast and southeast monsoons. This way, lablab that accumulates in these corners is easily harvested and does not cause mortality of juveniles trapped in the floating algae. Pond gates may be made of wood because they are cheap or PVC standpipes fitted with an elbow for convenient water control.




A. Extensive Prawn Pond




B. Semi-intensive Prawn Pond

**Fig. 6. Conversion of existing 2-ha milkfish pond into (A) extensive and (B) semi-intensive prawn ponds.**

Aside from nursery ponds, the young prawn fry may be nursed in tanks and hapa net nurseries (section III, C).

2. **Extensive grow-out pond (Fig. 6)** — Existing milkfish ponds that are suitable for prawn culture (section II, C, 3), may be shifted to sugpo with minimal improvements. Although pond compartments may reach a maximum size of 20 ha or more, an area of around 5 ha is more convenient for management purposes.

Ideally, the pond should allow water depth of one m to avoid sudden changes in temperature, salinity, pH, etc. as after a heavy rain. If this is not possible because the pond is elevated or shallow (as with traditional milkfish ponds), a peripheral or diagonal canal will provide the prawns shelter from high temperature, predation and cannibalism. To facilitate drainage, the canal or trench should slope towards the gate and the pond bottom should be flat. Gates and dikes should be strong and free from seepage. The cost for construction of a canal are minimal and may be charged against regular maintenance and operating expenses.

3. **Semi-intensive grow-out ponds (Fig. 6 & 7)** — With a higher stocking density and greater feeding inputs, semi-intensive ponds should be smaller than extensive ponds. Sizes of 1-2 ha are easier to manage in terms of feeding, water management and other pond operations.

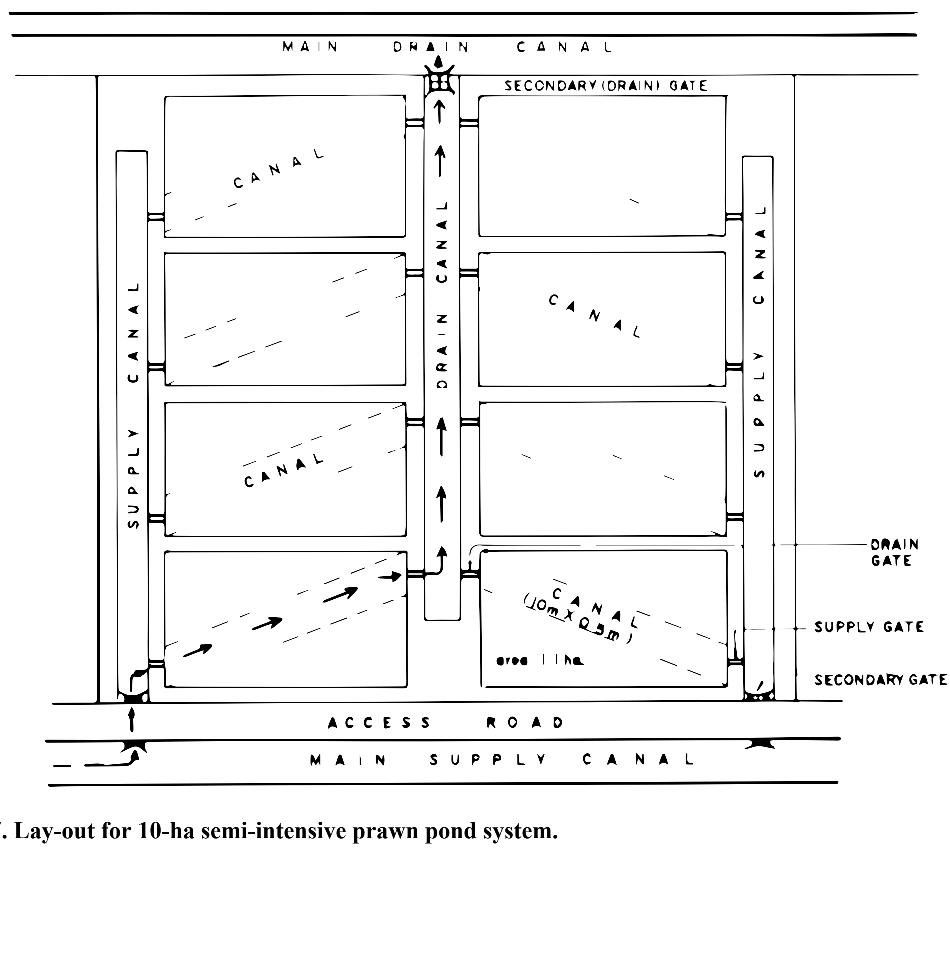



**Fig. 7. Lay-out for 10-ha semi-intensive prawn pond system.**

The maintenance of a one m water depth is much more critical than in extensive ponds but requires costly excavation of traditionally shallow milkfish ponds. For the average farmer with a limited budget however, a compromise would be the construction of a peripheral or diagonal canal 10-15 m wide and 50 cm deep. The excavated soil is used to reinforce the dike. Water depth is then maintained at 70-80 cm at the bottom and 120-130 cm at the canal portion.

A double gate system, one for water supply and the other for drainage, laid out in opposite comers of the pond, is required so water can be changed anytime. Correspondingly, the pond should also be served by independent supply and drain canals (Fig. 8). Gates may be wooden or concrete, depending on available funds. A ferrocement gate prototype (Fig. 9) is presently undergoing refinement studies at the Leganes, Iloilo Station of the Department.

Semi-intensive culture requires daily water change of at least 10% of total pond volume, by tidal flushing or pumping (Fig. 22) during neap tide. Table 2 features the pump capacity needed for each hectare at various percentages of water exchange required.

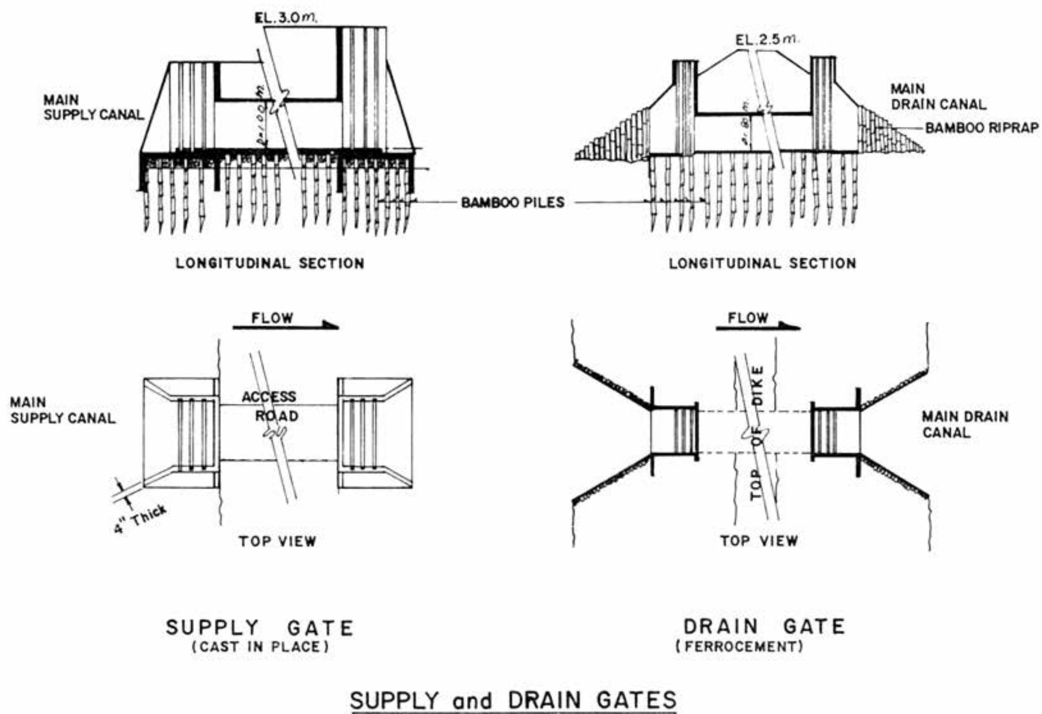



**Fig. 8. Concrete supply and drain gates for a semi-intensive pond.**

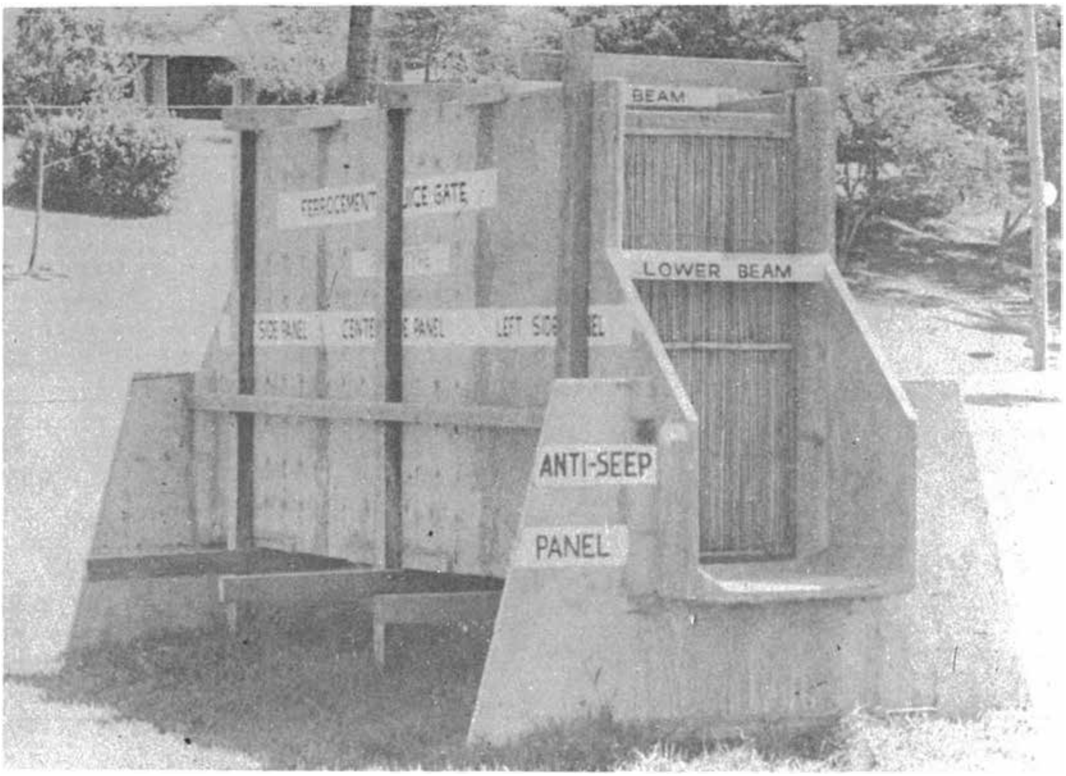



**Fig. 9. The ferrocement gate (display prototype) is cheaper and easier to install compared to a concrete gate.**

Pond bottom should be flat for easier drainage during harvest and pond preparation (for pest control). Moreover, an effective filtering system including a bagnet and/or screens installed at the supply gate will also minimize entry of pests and predators.

Development costs to cover canal excavation, installation of additional gate and a water pump total approximately P15,000-P25,000/ha.

4. **Intensive grow-out pond** — Sizes are generally small (1,000 $m^2$ – 1 ha) with concrete, brick-lined or compacted earthen dikes. Water depth is maintained at 1-1.5 m with premixed seawater of 10-20 ppt salinity delivered through elevated canals and pipes providing a flowthrough water with a daily exchange rate of 3-10%. Water movement or aeration, particularly during the low oxygen hours in the early morning, is provided by means of aquamills or paddlewheels (Fig. 5).

Pond development costs for intensive culture whether for a new pond or an existing pond total roughly P500,000/ha because of the huge volume of earth to be excavated, concrete supply canals and/or dikes, pumps and aquamills or aeration facilities.

**Table 2. Required pump capacity in $m^3$/min* to change water over varying periods in a one-ha fishpond (water depth = 1 m) at varying exchange rates. Ex: A pump capacity of 4.17 $m^3$ /min is required to pump 10% of total water volume over a 4-hour period.**

| Pumping period (hours) \ Exchange rate | 3% | 5% | 10% | 15% |
|---|---|---|---|---|
| 2 | 2.50 | 4.17 | 8.33 | 12.50 |
| 4 | 1.25 | 2.08 | 4.17 | 6.25 |
| 6 | 0.83 | 1.39 | 2.78 | 4.17 |
| 8 | 0.62 | 1.04 | 2.08 | 3.12 |
| 10 | 0.50 | 0.83 | 1.67 | 2.50 |
| 12 | 0.42 | 0.69 | 1.39 | 2.08 |

*$m^3$/min x 264 = gallons/min (gpm)

## C. Pond ecosystem

There is constant interaction among soil, water, air and the various living things in the pond and such interaction is modified to a large extent by the amount of sunlight available, and weather conditions. It is important to understand enough of these processes to enable a fish farmer to manage the pond, not in a mechanical way, but in a manner that will ensure maintenance of conditions conducive to better growth and survival of the prawns and, hence greater production.

### 1. **Living organisms**

a. Assuming no artificial introduction of food materials in the pond, the first or primary production of usable organic material is carried out by plants. This primary production (by photosynthesis) uses water, carbon dioxide, phosphorus and other nutrients dissolved in the water as raw materials in the presence of sunlight as a source of energy to produce organic matter (food) and oxygen.

Only plants produce oxygen whereas both plants and animals respire or breathe using up oxygen (and producing carbon dioxide) in the process.

b. In the daytime, plants produce more oxygen than the amount used up by the respiration of both plants and animals. At night, in the absence of sunlight, plants stop producing oxygen but together with other living things, continue to use it up. Therefore, the oxygen level generally rises to a peak in the early afternoon, decreasing towards sunset to reach its lowest level hours before sunrise (Fig. 10).

c. Plants are consumed by plant-eating animals or herbivores which in turn are consumed or preyed on by other animals or carnivores higher in the food chain. The higher a species is located on the food chain, i.e., top carnivores like sugpo, the more energy and therefore the more expense required to culture the species.

d. Dead plants and animals are eaten by other animals known as scavengers. The uneaten remains are decomposed by bacteria and fungi of decay, thereby releasing nutrients back to the water. All green plants are producers whereas animals may be predators (herbivores or carnivores) or scavengers. Another interaction between animals (and between plants) is the competition for the same food, space, or other resources in the pond.

e. In a natural system, the complex interactions among different species bring about stability because no single species predominates. In contrast, an artificial system be it in agriculture or aquaculture, is simple and therefore unstable because a single species is made to predominate. (An exception is polyculture where more than one compatible species, e.g. sugpo and bangus, whose food and other requirements do not greatly overlap are cropped together in the same pond). This means that in prawn farming, only prawns and the food required to sustain their growth should be allowed to grow in the pond.

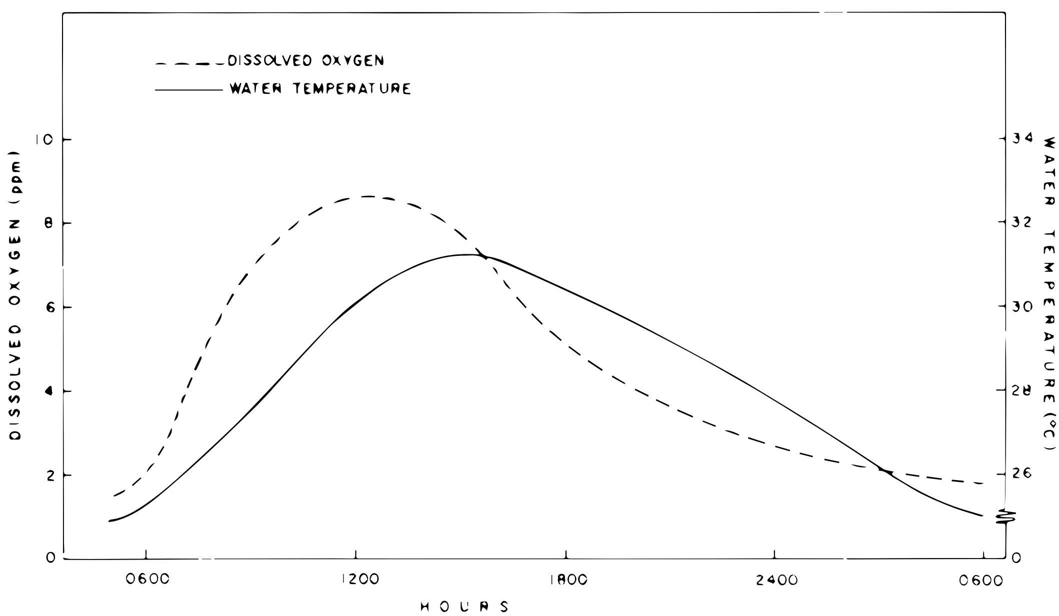



**Fig. 10. Twenty-four-hour profile of water temperature and dissolved oxygen in a brackishwater pond.**

f. Any unwanted species in the pond is considered a pest because it preys on, competes with, or somehow hinders the growth and survival of the cultured species. Common pests and predators in prawn and milkfish ponds are *bidbid (Elops hawaiiensis)*, *buanbuan (Megalops cyprinoides)*, apahap *(Lates calcarifer)*, other fin-fish (Fig. 18), and *snails (suso* and *bagongon)*. A list of the more common pests including crustaceans and shellfish and their local names is found in Appendix II.

2. **Physical and chemical factors**

a. Water, as a universal solvent, can dissolve many substances, whether solids, other liquids or gases. This means water can hold beneficial substances, such as nutrients, as well as harmful substances, such as chemical pollutants and biological wastes.

b. Although water is composed of hydrogen and oxygen, it is not this form of oxygen which is used by aquatic plants and animals for breathing. It is gaseous oxygen dissolved in water which sustains life.

c. The amount of dissolved oxygen (DO) in water is determined by a number of factors. Oxygen is used up by the respiration or breathing of plants and animals and by the decomposition of organic matter. (A study showed that only 15% of total oxygen used was by shrimp and fish stock in a pond. Up to 70% was due to phytoplankton or minute plants, bacteria and decaying matter near or on the pond bottom.)

On the other hand, oxygen is produced by plants together with food. Natural wind action on the water surface, agitation or aeration of the water, and admitting new water into the pond all increase DO levels.

d. Salinity is the amount of salt in water and is expressed in parts per thousand (ppt). Seawater is 30-35 ppt, freshwater is 0 ppt, whereas brackishwater fluctuates between these two levels. The higher the salinity, the denser and heavier the water so that freshwater will float over seawater.

e. Temperature also affects water density. Warm water will float over cold water because the higher the temperature, the lighter the water.

f. Water, to a certain extent, contains dissociated or free hydrogen and hydroxyl ions. The amount of free hydrogen ions is measured in a scale from 1 to 14 known as pH value. Pure water has equal amounts of hydrogen and hydroxyl ions and has a neutral pH of 7. With a pH below 7, water is acidic, while above 7, it is considered alkaline. Water pH is affected by soil pH and the amount of carbon dioxide in the water. Acidic soils have been discussed in section II, A.

g. Water by itself is transparent. It becomes turbid with the presence of non-living particles (soil and organic debris) or tiny living organisms. The more turbid the water, the less the light penetration and therefore the less the food produced by plants.

3. **Environmental requirements of prawn**

a. A salinity range of 10-25 ppt is recommended for sugpo; putian can tolerate higher levels of up to 40 ppt. The common observation that sugpo grows well in low salinity (10-20 ppt) may be due to the biological requirements of *P. monodon*, i.e., it grows best at such salinities. Or it may be indirectly related to the rich growth in low salinity of aquatic plants (section IV, D) associated with good sugpo production. However, other farmers claim comparable production rates of *P. monodon* even in relatively high salinity (30-40 ppt) extensive ponds if they feed occasionally and/or change water regularly.

A hydrometer is a relatively cheap (₱100) calibrated glass tube which measures the weight (or specific gravity) of water and other liquids. The greater the salinity, the heavier the water, the higher the hydrometer will float and vice-versa. Hydrometers are available from laboratory supply and aquarium stores but are breakable, a disadvantage in the field. Imported refractometers are convenient because they give direct salinity readings in ppt but cost ₱1,000 to ₱7,000 apiece.

b. Recommended optimum temperature range for good growth and survival rates of prawn is 25-30°C At lower temperatures, feeding stops and growth is affected whereas mortalities at higher temperature may also be associated with low DO levels.

Water temperature can be measured using a laboratory thermometer which is readily available from pharmacies or laboratory supply stores. The thermometer should be read while it is in the pond water.

c. Minimum acceptable DO level for prawn is 3-4 ppm. Below 2 ppm, prawns exhibit an initial period of hyperactivity with swimming at the surface and jumping followed by mortality.

Portable field DO meters are relatively expensive. A more practical approach is to predict periods of critical oxygen levels such as after a heavy rain, based on past experience (section IV, E).

d. In general, pH does not fluctuate much in natural systems and a range of 7-8.5 is optimal for most plants and animals, including prawns. Although survival remains unaffected at pH below 7, growth may be reduced; pH of 5 and below are lethal to prawns.

Acid sulfate soil (section II, A) leads to low water pH (4 and below) by leaching from the pond bottom or runoff from the dikes after heavy rains. Aside from causing direct prawn mortalities, resulting sulfuric acid also releases iron and aluminum which in turn bind up phosphates and other nutrients needed for the growth of natural food.

pH meters are expensive and pH paper might be more practical for field use provided they are not old stock. Appendix III features commonly available instruments for determining pH, salinity, temperature and turbidity.

e. Hydrogen sulfide ($H_2S$) is a gas produced when oxygen is used up (anaerobic conditions) by the decomposition of excess feed and other organic matter in the pond. The bottom soil turns black with a characteristic foul odor. Because prawns are bottom-dwellers, low DO levels and presence of $H_2S$ can cause "black gill" and other diseases.

Even very low levels (0.1 ppm) of $H_2S$ are detrimental to prawn growth and survival.

f. Most of the ammonia in pond water comes from the nitrogenous waste products of living plants and animals. Ammonia is a poisonous metabolite particularly at higher pH (section IV, B, 3), but in natural systems it is converted into nitrates and nitrites by certain bacteria. Some phytoplankton and larger aquatic plants can utilize nitrogenous wastes directly. This may explain how the presence of *digman kusay-kusay* and other aquatic plants improves water quality and indirectly contributes to good production in extensive sugpo ponds (section VI, D)

g. A rough estimate of total production capacity is around one ton/ha or 100 $g/m^2$ of prawns with supplementary feeding (semi-intensive culture) and 250 kg/ha with natural food alone (extensive culture). This production capacity depends not only on available food but also on soil and water quality, including the presence of ammonia, $H_2S$ and other harmful metabolites.

### D. Differences between prawn and milkfish culture

1. **Supplementary feeding** — In general, food crops such as milkfish are herbivores low on the food chain, cheaper to produce and therefore suitable for the low to middle income bracket. In contrast, sugpo and other cash crops (for export to Metro Manila hotels and restaurants or to foreign countries) are top carnivores that require more inputs and therefore command higher market prices.

A major input is feeding (Fig. 25), particularly at the higher stocking densities of semi-intensive and intensive culture. Even extensive ponds that stock above 5,000 prawns/ha need occasional supplementary feeding.

2. **Pest and predator control** — The maintenance of a pest and predator-free pond (by filtering of water or use of pesticides) is much more critical to prawn culture than to bangus farming. This is because prawns like other crustaceans, regularly shed off their shell in the process of molting, making them vulnerable to predatory fish and to cannibalism by other prawns. Moreover, their weak swimming ability compared to the fast-swimming finfish adds to this vulnerability.

3. **Smaller pond size** — Smaller ponds of 1-2 ha for semi-intensive culture and 5 ha for extensive culture (Fig. 6 & 7) are required for easier water management, feeding and predator control, compared to the large sizes (5-20 ha or more) of milkfish ponds.

4. **Stronger dikes** — Prawn ponds need stronger dikes that are wider at the base and higher compared to bangus ponds.

5. **Double gate systems** — Prawn ponds for semi-intensive culture require separate supply and drain gates (Fig. 8), as well as independent supply and drain canals, compared to a single gate for milkfish ponds. Positioning of the gates opposite each other should allow for maximum replacement of old water by incoming water.

6. **Greater water depth** — Deeper ponds with average water depth of one m or the presence of peripheral/diagonal canals are important in prawn culture. In contrast, bangus ponds hold an average water depth of only 30-50 cm.

7. **Water management** — Prawn ponds are partially (semi-intensive culture) or completely (intensive culture) dependent on water pumps unlike milkfish (and extensive prawn) ponds. Moreover, intensive culture requires water-moving devices such as Paddlewheels or aeration to increase oxygen levels.

## III. SEED SUPPLY

Fry is a general term that applies to both young and older postlarvae from the wild or hatcheries. Prawn juveniles correspond to the milkfish fingerling stage, ready for stocking in grow-out ponds. They must spend at least one month in the nursery and measure the width of a *palito* (matchstick) or more. Therefore juveniles are at least postlarva $(PL)_{35}$, to as old as $PL_{60}$ and may weigh from 0.1 to 3.0 g, depending on conditions in the nursery.

Farmers as well as researchers have commonly observed that stocking of juveniles in extensive and semi-intensive ponds increases survival rate to 80% or better from an average of 50% for younger $PL_{20}$ This is mainly because the sturdier juveniles are less vulnerable to predation and other stresses in the pond environment. (In contrast, intensive ponds which are practically 100% predator-free can be stocked with as young as $PL_{15}$.)

Moreover, the stocking of juveniles shortens the cropping period allowing for a faster turn-over time. A pond can then have three crops lasting 2.5-4 months instead of only two crops lasting 4-5 months within a single growing season.

A. **Wild fry** — If wild sources are abundant and hatcheries are not accessible, it is advisable for a farmer to procure wild fry, particularly for low-density extensive culture.

1. **Collection** — Wild fry may be found in coastal or shore water as $PL_{15}$ to $PL_{25}$ or in mangrove areas and brackishwater rivers as older postlarvae and juveniles. Fry collecting gear are of two kinds:

a. Stationary gear — These are installed in the mouth of rivers to catch the fry as they migrate or are transported by the incoming tide. Ex: Capiz-patterned filter net and fry raft (*saplad*).

b. Mobile gear — These are usually operated along the coastline, especially when the water is turbid during flood tide. Ex: fry seine (*sagap* or *sayod*), scissors net (*sakag*), and fry scare line (*surambaw*).

Appendix IV gives detailed sketches of some of these gear (from SEAFDEC AQD Technical Report No. 5 by H. Motoh, 1980) for adaptation and use by local fishermen in areas rich with fry of sugpo and other prawns. Fry gathering can generate additional income for coastal families.

2. **Identification** — A newcomer may easily confuse postlarvae of penaeids found in wild fry collections with those of other crustacean groups, or with each other. The following criteria are useful in identification.

a. Different crustacean postlarvae (Fig. 11):

1. **Sergestids (including *Acetes* sp.)** — They are easily distinguished by their long, bright orange antennae with a sharp prominent bend and their eyes which extend laterally at a 90° angle. *Acetes* is often found in great abundance and is used in making the familiar *alamang* or *oyap* (Ceb.).

2. **Carideans** — The second abdominal segment overlaps the first and the abdomen is bent more sharply than in penaeid postlarvae.

3. **Mysids** — Unlike penaeids, the uropods (or tail) are pointed posteriorly and held parallel to each other. Also, they have a brood pouch near the head region and statocysts (small bright orange spots) on the tail.

4. **Penaeids** — The second segment does not overlap the first (unlike carideans), they have short, colorless antennae and the eyes do not extend laterally

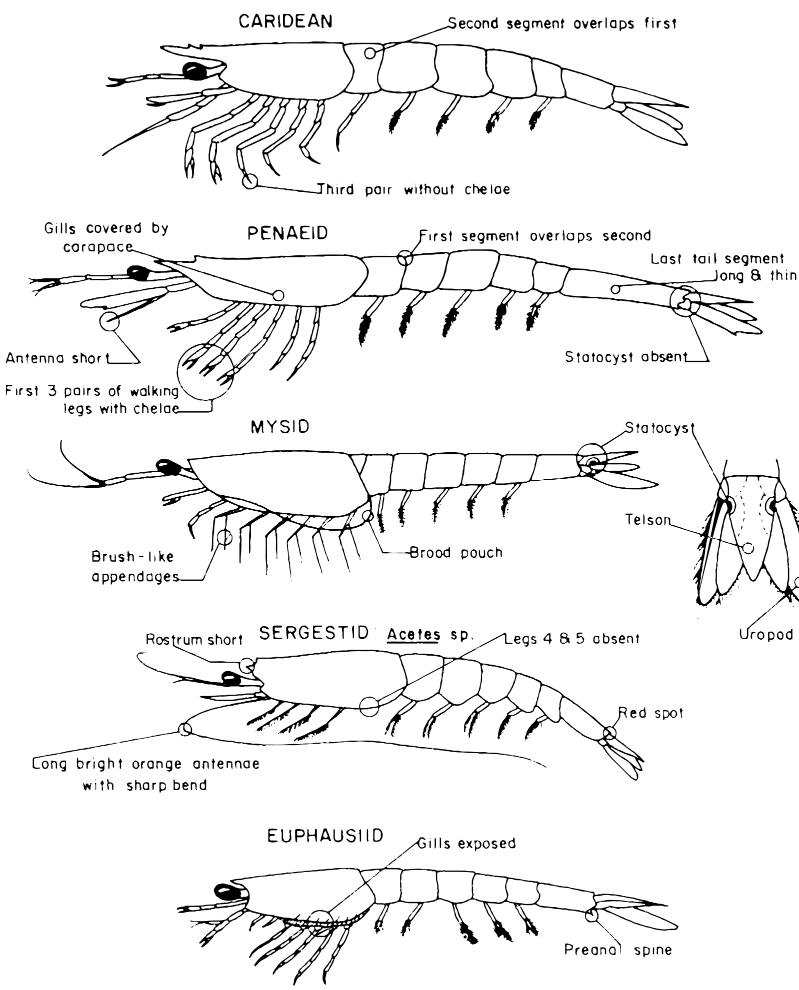



**Fig. 11. Distinguishing characters of crustacean postlarvae and juveniles from wild catches (after ASEAN, 1978).**

at an angle (unlike sergestids). Moreover, they have no statocysts and the uropods are spread fan-like (unlike mysids).

b. Different penaeid postlarvae (Fig. 12):

1. *Metapenaeus* spp. (including *M. ensis* and *M. monoceros*) — Postlarvae are relatively short and stout and generally colored a mottled gray or brown compared to *Penaeus*. Also, the rostrum has no ventral teeth but this needs microscopic examination.

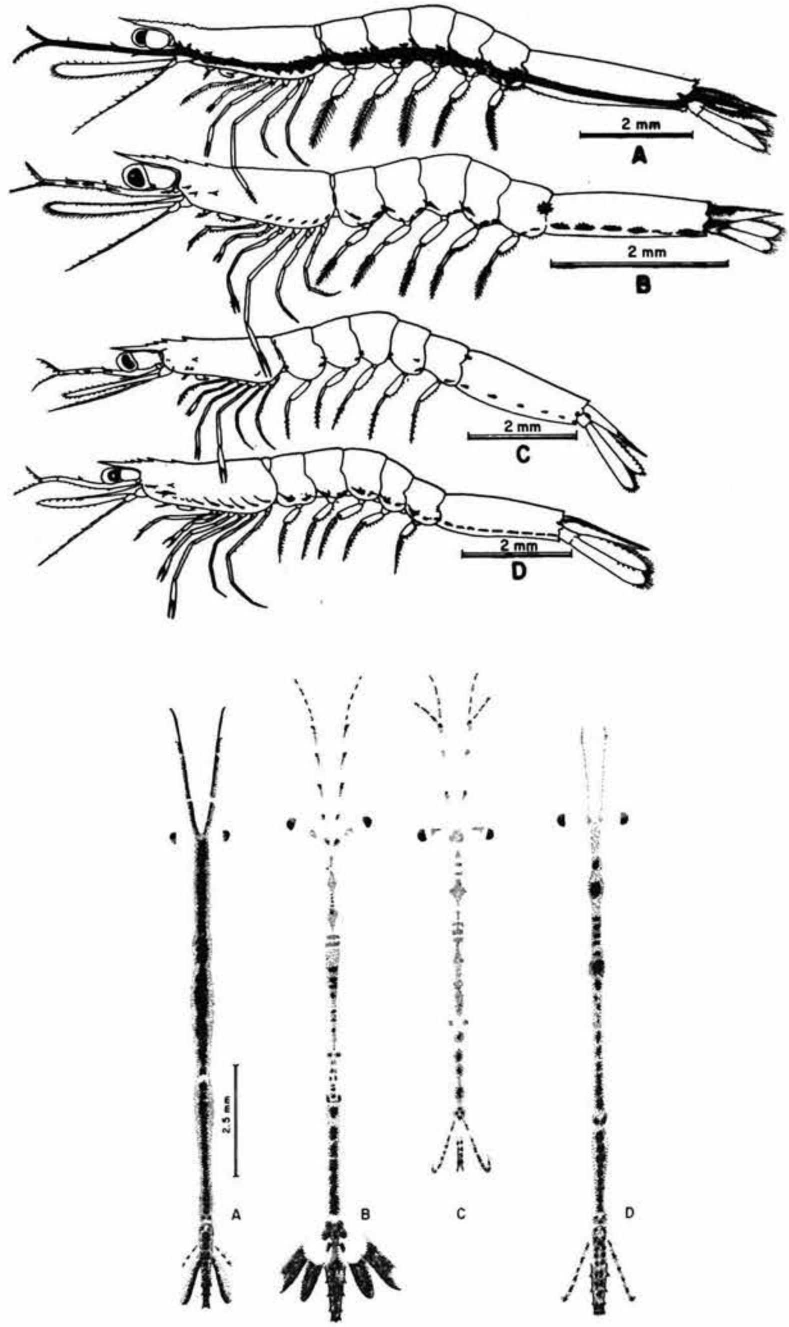



**Fig. 12.** *Penaeus* **postlarvae showing chromatophore pattern laterally (above) and from top view (below). A,** *P. monodon,* **B,** *P. semisulcatus* **or** *bulik,* **C,** *P. merguiensis* **group, and** ***D,*** *P. japonicus* **group (after Motoh, 1981).**

2. *Penaeus monodon* — Postlarvae can be easily identified by the prominent reddish-brown streak on the ventral side of the body formed by dense and continuous chromatophores or pigmented bodies. The last abdominal segment alone has 14-19 chromatophores.

3. *P. semisulcatus* — Among the various penaeid fry caught from the wild, this species is most commonly mistaken for *P. monodon*. However, it is generally shorter than sugpo and the reddish-brown coloration is prominent only on the posterior end of the abdomen (8-11 chromatophores only).

4. *P. merguiensis*/*P. indicus* — The body is much shorter and broader and more transparent (only 5-7 chromatophores on the last abdominal segment) than *P. monodon* and *P. semisulcatus*. Also the eyes are larger than in other penaeid postlarvae. These species constitute the most abundant group in wild fry collections.

5. *P. japonicus* group — The body is also more transparent than *P. monodon* and *P. semisulcatus* but the last abdominal segment has 8-11 separate chromatophores compared to *P. merguiensis*.

**B. Hatchery fry**

The growing preference for hatchery-reared fry over wild fry can be traced to the following advantages: a) greater numbers available at one time, b) more uniform sizes, and c) minimal handling with only 1-2 transfers from hatchery direct to the ponds or through a nursery.

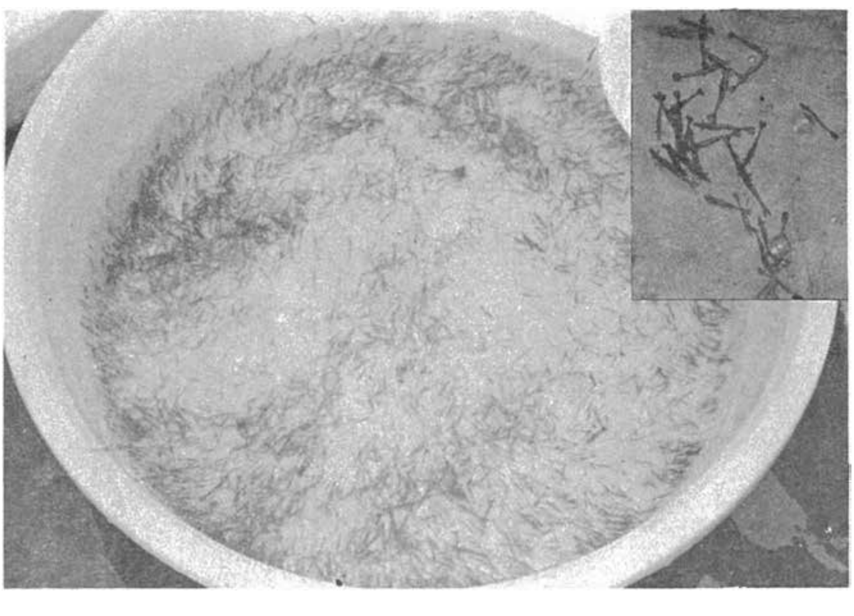


**Fig. 13. Postlarvae of** *P. monodon*; **older juveniles (inset).**

A list of private and government hatcheries (including operator and address) producing sugpo and other prawn fry is found in Appendix V for farmers interested in procuring fry.

**C. Nurseries**

There are three options for nursing the young fry — nursery tanks, nursery ponds or hapa/floating nurseries.

1. **Nursery tank** (Fig. 14) — Fry are stocked at $PL_5$ (from hatcheries) to $PL_{20}$ (wild or from hatcheries) and reared to at least $PL_{35}$ stage. Stocking density ranges from 1,000 to 5,000 PL/$m^3$ although 2,000 PL/$m^3$ is recommended.

Nursery tanks range from 1 to 20 $m^3$ in capacity and can be made of marine plywood, fiberglass or concrete. (Smaller tanks can be moved around and may double as acclimation and chilling tanks during pond operations.)

Substrates provide increased surface area to protect newly-molted animals against cannibalism. In addition to shelter, they also provide food for the growing prawns in the form of benthic algae and associated organisms. Recommended substrates are (conditioned) bamboo slats, polypropylene netting material (mesh of 1-2 cm) and fine nylon material (mesh of 2 mm) which are installed vertically in the tank.

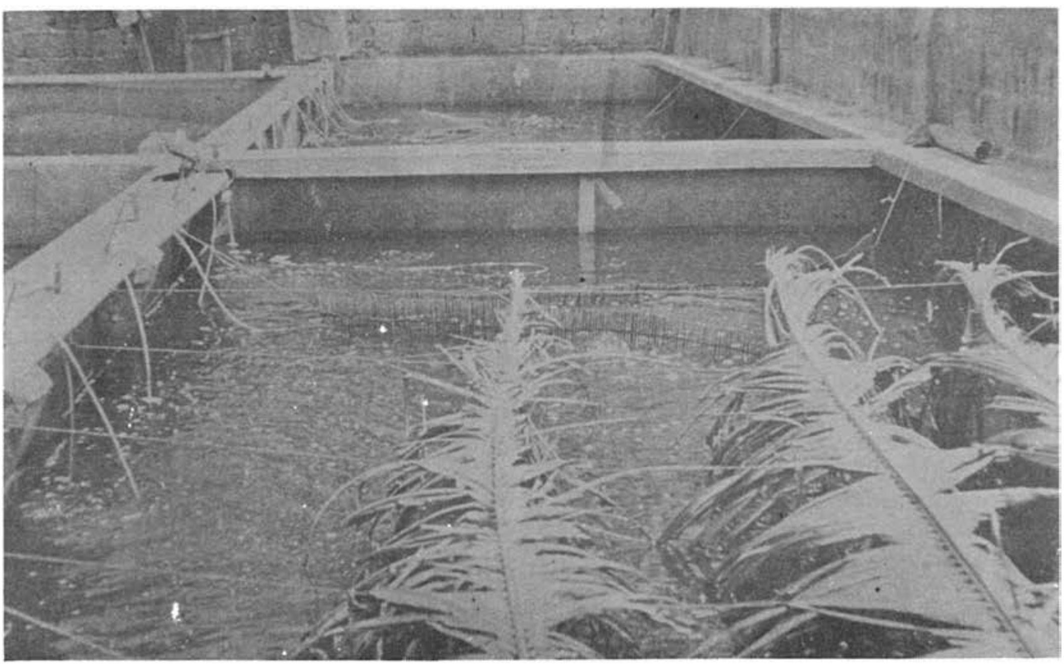


**Fig. 14. Concrete nursery tank with bamboo slat substrates and coconut leaves for shade.**

Aeration is provided by simple air stones. Water depth is 0.5-1.0 m. Water change of 1/3 to 1/2 total water volume is undertaken regularly, depending on the water quality. The postlarvae are fed daily at satiation levels with mussel meat, trash fish or excess *Artemia* (nauplii or adults) singly or in combination. Prior to feeding, excess feeds are siphoned out and water change is undertaken.

Although nursery tanks produce smaller-sized juveniles compared to earthen ponds, they have the advantage of a predator-free environment that accounts for higher survival rates.

2. **Hapa or floating nursery** — The hapa nursery is basically an inverted net set in a cove, river, pond or any other area protected from wave action and not exposed during low tide.

The floating nursery prototype developed at the SEAFDEC AQD station in Batan, Aklan features a 4x3x1.2 m nylon net (mesh size = 1-2 mm) held together by a framework of bamboo slats and catwalks and anchored to the bottom (Fig. 15B). Stocking is at 30,000 $PL_5$/net or 2,500 PL/$m^3$, fry are fed trash fish paste (spread on a separate feeding net) for the first week and mussel meat afterwards. Average survival after 2-4 weeks is around 80%.

Another hapa nursery model is being tested in earthen ponds by both researchers and farmers. Ranging from 2 $m^3$ to 20 $m^3$ in capacity, the rectangular nylon nets are installed in ponds and have no need for a protective bamboo layer (Fig. 15A). However, a minimum water depth of 50 cm should be maintained and the pond should have regular water exchange.

The floating or hapa nursery is cheaper and easier to construct than the nursery tank or pond. Moreover, it is also cheaper and easier to manage than tanks because there are no aeration and pumping costs. Like the nursery tank, it has more effective predator control than the nursery pond. However, sizes of juveniles are larger than in nursery tanks.

3. **Nursery pond** — Earthen nurseries range from 200 to 2,000 $m^2$ in size with fry stocked at 50-100 PL/$m^2$. A detailed discussion of nursery pond design and construction is found in Section II, B. Pond preparation and other management procedures for grow-out (section IV) are applicable to earthen nurseries.

Initial water depth of 30 cm is increased to a maximum 60-70 cm. Regular water exchange is by tidal flushing and/or pumping. Supplementary feeding consists of trash fish, mussel meat, etc. at 100% of estimated total body weight initially gradually decreasing to 25% at the end of a one-month period. Shelters in the form of twigs and dried palm leaves are usually installed inside the pond. Nevertheless, one operator places coconut palm fronds horizontally above the water surface (Fig. 16) to provide protection against high daytime temperatures.

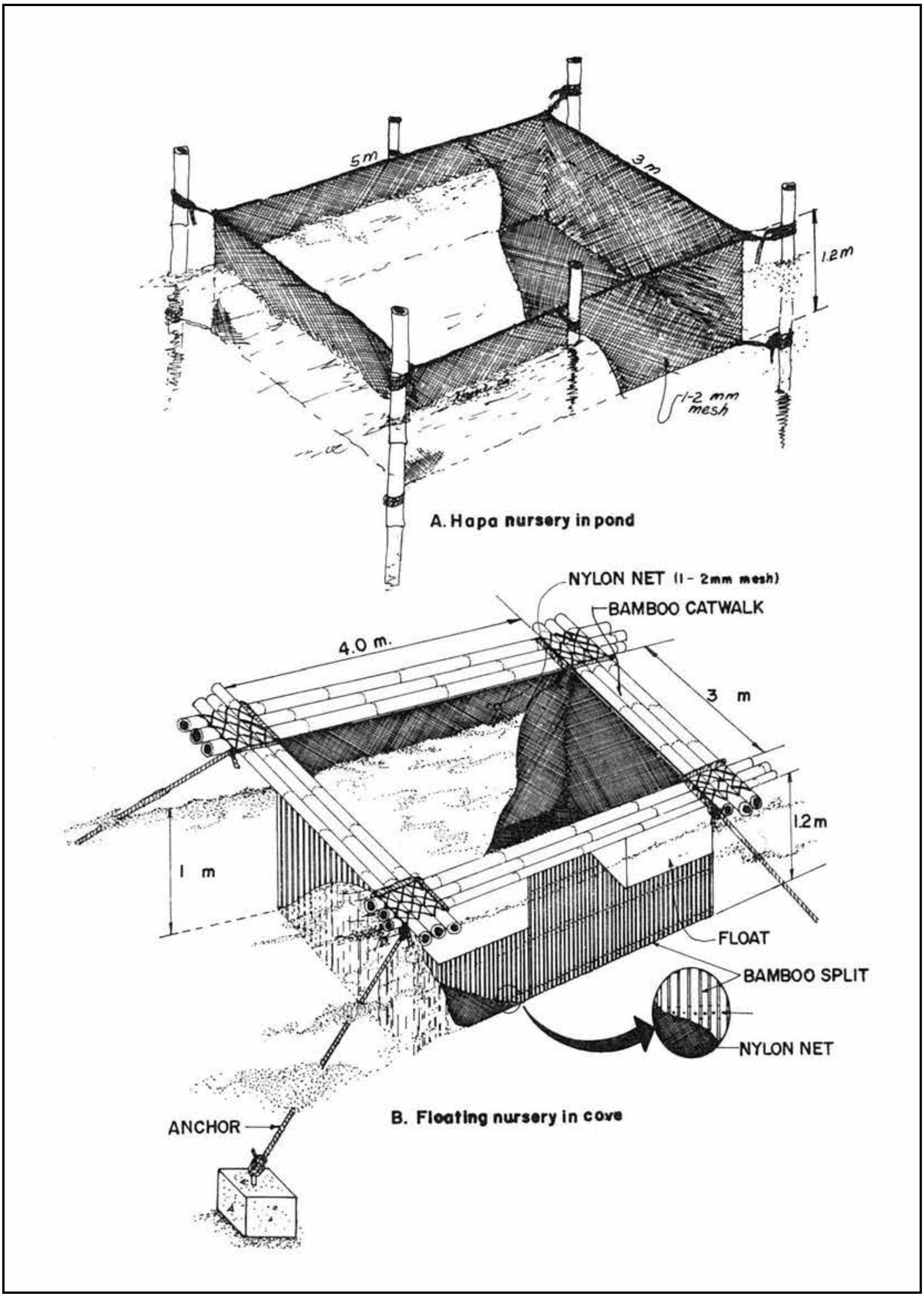



**Fig. 15. Floating or hapa net nursery can stock 30,000-40,000 postlarvae/net, is cheap and easy to install in a pond (A) or marine cove (B).**

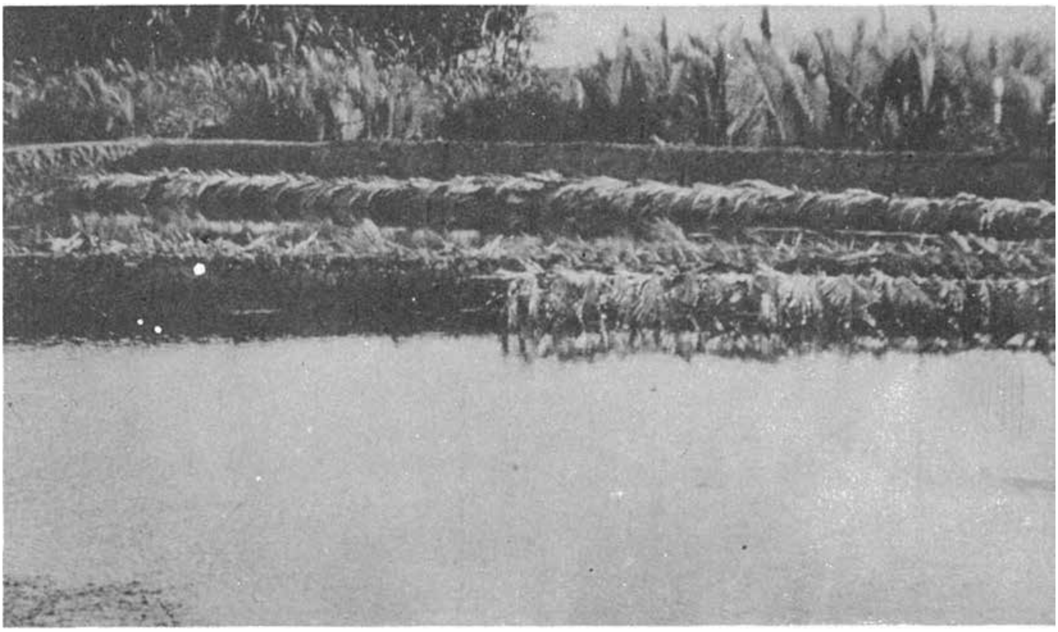


**Fig. 16. Earthen nursery pond in Roxas City also uses dried coconut leaves for shade.**

Harvest is by use of a screen bagnet or *lumpot* (Fig. 20) installed in the drainage gate. As the pond is drained, the juveniles collect inside the bagnet. From time to time, they are removed and transported by buckets to nearby tanks or hapa nets for holding and acclimation prior to restocking or sale to buyers.

The main advantage of nursery ponds is the larger sizes (0.5-2 g) of juveniles at harvest compared to tanks. Although average survival is lower at 50%, a private operator has improved average rates up to 90% with more effective predator control.

4. **Transition (postnursery) pond** - If 250 kg/ha is the production capacity of a pond dependent on natural food (section II, C, 3), the pond is understocked during the earlier months when the prawns are younger with a smaller biomass.

One way of fully exploiting the total pond capacity is to have a transition pond or *bansutan* — a small compartment within a bigger pond or a separate pond adjacent to the grow-out pond — where juveniles can be grown to postjuveniles (10-15 g sizes) prior to release in the grow-out pond.

This modular or transfer method may be a 1-2 system (bansutan to grow-out) or 1-2-3 system (nursery pond to bansutan to grow-out) (Fig. 17) with stocking densities of 250,000-500,000 fry/ha for the nursery, 25,000-50,000 juveniles/ha for the bansutan, and 3,000-5,000 postjuveniles/ha for the grow-out.

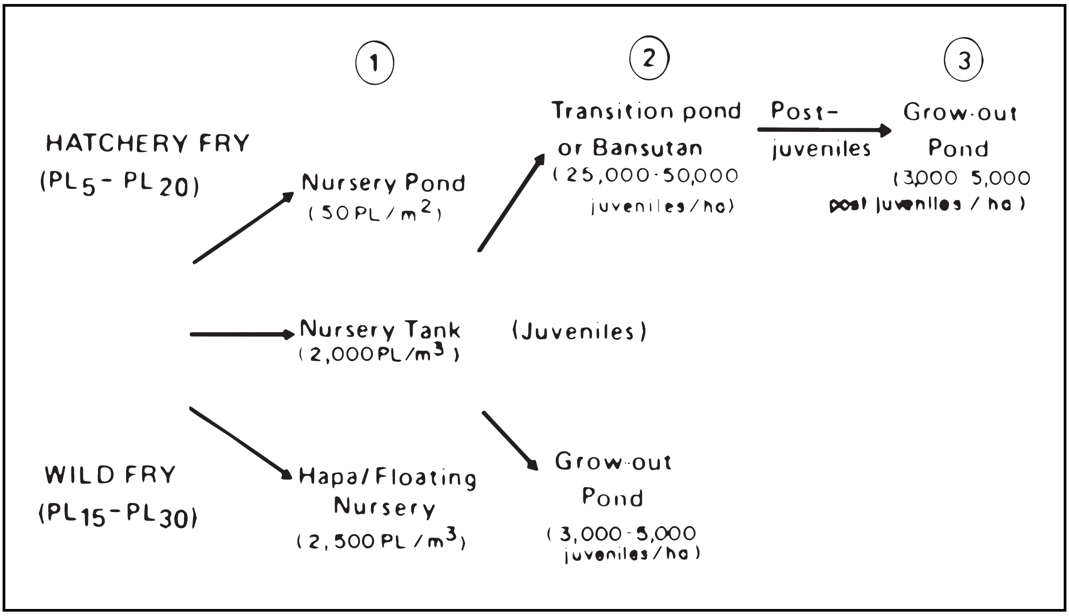



**Fig. 17. The modular or transfer method of extensive sugpo culture using nursery, transition and grow-out ponds.**

### D. Counting, packing and transport

It would be useful for the prawn farmer to be familiar with the following counting, packing and transport techniques:

1. **Counting** — If the fry are harvested from hatchery or nursery tanks, the manner of counting depends mainly on the age. For younger postlarvae ($PL_{10}$-$PL_{25}$), an estimate is made by head counting a given number, say 5,000 pieces, in a white plastic basin with a known volume of water. Water is filled to the same volume in other basins and fry are stocked until the density appears equal to the sample basin. For older juveniles, a headcount is usually done because of their larger sizes and the higher prices they command.

For counting large numbers of juveniles from a nursery pond or hapa nursery, the volumetric method is convenient and avoids unnecessary stress. The harvested juveniles are concentrated in a wooden or fiberglass tank provided with aeration. A plastic sieve (200-500 ml) is used to scoop out juveniles at full capacity. Three to five scoops are taken and the average number of juveniles/scoop is computed. The remaining juveniles in the tank are scooped out and the total number of juveniles determined as follows:

$$\text{Total no. juveniles} = \frac{\text{average no. juveniles}}{\text{scoop}} \times \text{total no. scoops}$$

However, a headcount is in order if the juveniles number a few thousand or if they will be sold to other farmers.

2. **Packing** — Fry are packed in 20-liter plastic (polyethylene) bags placed inside pandan bags, jute sacks or styrofoam boxes (with outer galvanized iron or wooden container). A live tank made of fiberglass or canvas provided with an aerator may be used for overland transport.

The density decreases with older and bigger fry (5,000-10,000 $PL_{10}$/bag vs. 500-2,000 juveniles/bag) and with increasing transport time (20,000 $PL_{10}$/bag for less than 2 hours vs. 5,000 $PL_{10}$/bag for more than 6 hours).

The plastic bags are filled with 5-10 liters of clean seawater with salinity close to that of the receiving pond in order to reduce acclimation time. Water temperature is ambient (26-30°C) if transport to nearby ponds does not exceed one hour. Temperature is decreased to 20-24°C if transport time is more than two hours and also if older juveniles are packed. Placing 500 g of ice chunks wrapped in newspaper in smaller plastic bags on top of the 20-liter plastic bags will help maintain low temperatures.

Oxygen is added for juveniles, regardless of transport time and for long-distance transport, regardless of age or size of fry.

In brief, the factors of size (age), number of fry and duration of transport (distance) all contribute to increased activity thereby requiring corresponding inputs such as oxygen and decreased water temperature. Lower temperature reduces the metabolism or activity of the fry so that they spend less energy, consume less oxygen, do not require feeding, and produce less wastes. If fry are fed, the water becomes polluted and if they are hungry, they cannibalize each other.

3. **Transport** — During transport, containers should be kept in the shade, away from the sun and other sources of heat. Transport should be done late afternoon, at night or early morning to avoid high daytime temperatures, if possible.

## IV. FARM MANAGEMENT PRACTICES

### A. Acclimation and stocking

Prawn fry stocked in extensive and semi-intensive ponds should be of juvenile stage for higher survival rates and a shorter cropping period, as discussed earlier. Juveniles reared in a nursery pond or a hapa nursery adjacent to or within the larger grow-out pond (section III, C) are merely transferred or released without any packing and acclimation necessary. Tank-reared juveniles procured from hatcheries and nurseries are usually packed and transported in plastic bags and therefore need acclimation procedures.

The purpose of acclimation is to make the transport water condition, in terms of temperature and salinity, as close as possible to the pond water condition to minimize stress on the fry. At present, prawn farmers may specify their salinity preference for packing and transport of hatchery/nursery-procured fry based on pond conditions. This practice eliminates the need for salinity adjustment once the postlarvae or juveniles reach the ponds.

1. Stocking should be done in the evening, early morning, during overcast days, or at anytime of the day when the water temperature is low (below 26°C) or new tidal water can be admitted to the pond.

2. If the number is not too many, the juveniles can be acclimated in a tank to which pond water is gradually added before they are released in the pond.

3. A more common practice is to float the plastic bags containing the fry in the pond water for at least 30 minutes to equalize temperature. Once the differences between the transport (plastic bag) water and the pond water are 1-2°C for temperature and 5 ppt or less for salinity, the bags are opened and the fry released.

4. If temperature and salinity differences are great, pond water is introduced very gradually into the plastic bags (up to 2-4 times the original volume of water) before releasing the juveniles into the ponds.

5. The plastic bags or buckets containing the fry or juveniles should be distributed throughout the whole pond as uniformly as possible. Do not crowd the juveniles in only one area to avoid cannibalism. If acclimation and stocking are properly done and fry are healthy, they will swim out in all directions upon release.

6. Stocking rate will depend on the culture system including food availability and water management (Table 1) suitable for the pond. In general, the recommended rates for sugpo are as follows:

a. Extensive monoculture: 2,000-8,000 prawn juveniles/ha

b. Extensive polyculture: 1,000-6,000 prawn juveniles/ha<br>+ 500-2,000 bangus fingerlings/ha

c. Semi-intensive culture: 20,000-50,000 prawn juveniles/ha

Prawn juveniles should be stocked 1-3 weeks ahead of milkfish fingerlings because of the longer growing period required for polyculture.

## B. Pond preparation

In extensive and semi-intensive culture systems, the purpose of pond preparation is the elimination of pests and predators as well as the growth of natural food through fertilization. In contrast, intensive ponds rely almost completely on artificial feeds so that pond preparation concentrates only on pest control and soil conditioning to eliminate harmful metabolites.

1. **Pest and predator control** — The most important preventive action against pests and predators is mechanical — draining and drying of the pond, filtration devices for incoming water, etc. However, even the most levelled pond bottom will have remaining undrainable areas such as water pools near the gate. Here, the use of organic or inorganic pesticides becomes important.

Many pesticides available in the market contain chlorinated hydrocarbons such ad DDT, endrin, etc. which are not biodegradable and therefore may cause soil sterility that hinders the growth of lumut, kusay-kusay and other natural food and leads to stunting of the crop, aside from accumulating in the tissues of the cultured species. In contrast, organic pesticides of plant origin decompose easily, have no negative effect on the soil and may even fertilize the pond.

a. **Mechanical**

1. Complete draining of the pond (with the supply gate soil-sealed) and drying for around one week or until the bottom cracks (Fig. 19) will eliminate most pest and predatory species that burrow in the mud. Drying also mineralizes organic matter making nutrients available and reduces production of H2S and other harmful wastes.

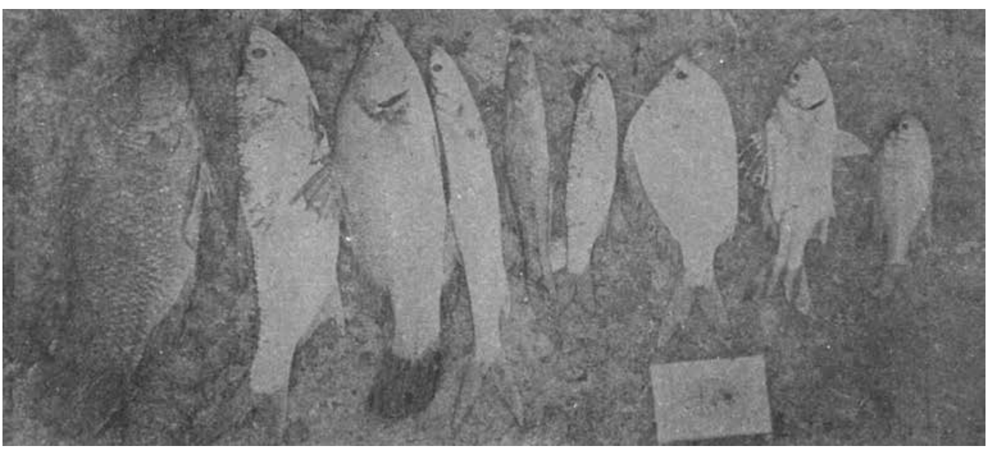


**Fig. 18. Common pond pests and predators (from left):** *Tilapia mossambica*, *Megalops cyprinoides (buanbuan)*, *Lates calcarifer (apahap* **or** *bulgan)*, *Elops hawaiiensis (bidbid)*, *Glossogobius giurus (bagtis), Mugil sp. (gisao or banak)*, *Gerres filamentosus (latab)*, *Therapon jarbua (bugaong)*, **and an Ambasid** *(parangan)*.

**Fig. 19. A completely drained and dried pond bottom is the first step in pest and predator control.**

2. As much water as possible should be removed manually by means of buckets from undrainable pools or areas near the gate.

3. Bagnets, filter box screens and circular screens should be installed separately or in combination at the water supply gate to screen out pests (Fig. 20). Leaks in screens, dikes and gates should be repaired.

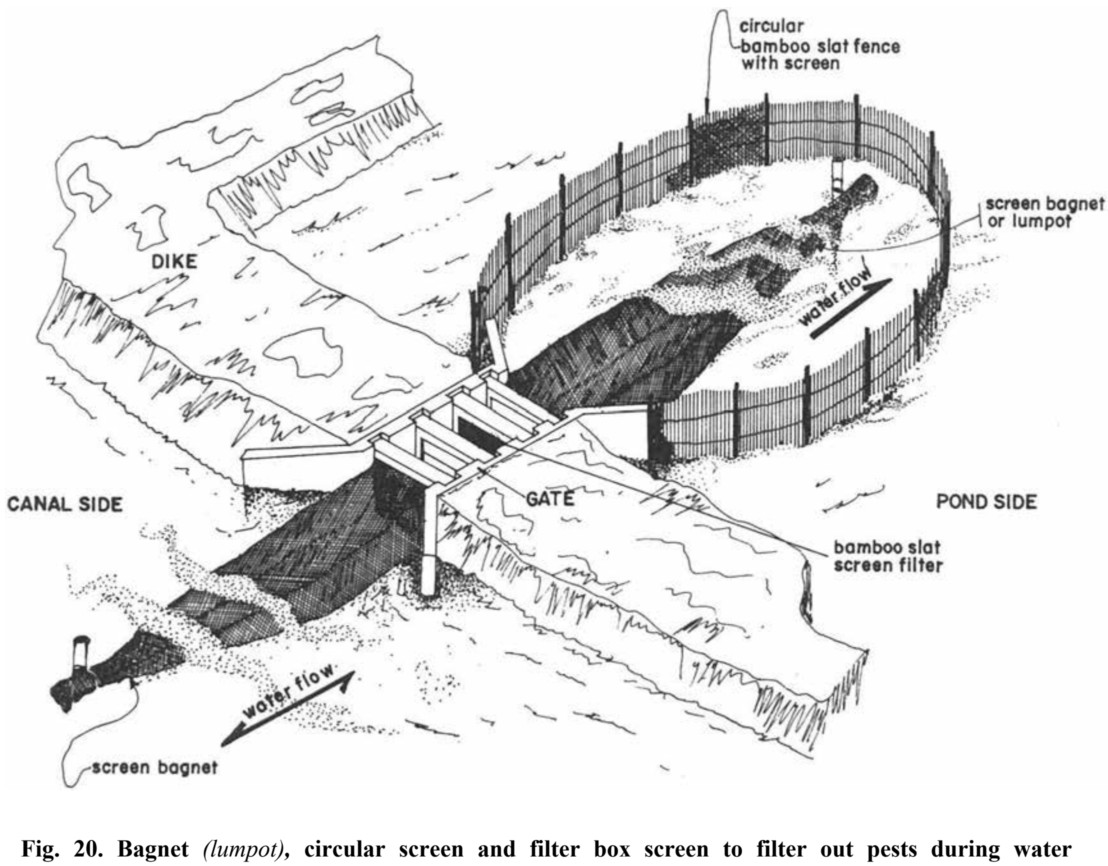



**Fig. 20. Bagnet *(lumpot)*, circular screen and filter box screen to filter out pests during water admission; bagnet is also used for harvest.**

4. *Bagongon*, *suso* and other snails should be manually harvested or collected by shovel as they concentrate around water pools. The larger-sized bagongon may be sold as supplementary feed to prawn farmers and generate additional income for families of pond workers.

5. Tilling of the drained pond bottom and cleaning/deepening of the peripheral or diagonal canals may be undertaken.

b. **Organic pesticides**

1. *Derris* or *tubli* — The active component of derris root powder or solution is rotenone, a white odorless crystalline substance which acts as an inhibitor of cellular respiration in fishes. A selective poison, it is toxic to bidbid, buanbuan and other finfish at levels tolerated by sugpo or putian. The powder preparation (5-8% rotenone) is commercially available in other Asian countries and is applied at 10-20 kg/ha to attain a 5 ppm concentration at 10-20 cm water depth.

If the powder is not available, the root solution can be prepared from local tubli species — *Derris elliptica*, *D. heptaphylla* and *D. philippinensis* — identified as sources of rotenone. *D. elliptica* is a climbing plant found along streams and in secondary forests at low to medium altitude.

The roots of older plants (at least two years old) are washed and cut into small pieces. The stems may be replanted like camote cuttings. The cut roots are soaked in tap water overnight, pounded thoroughly then agitated in the same water to get the rotenone in solution. Alternatively, the roots may also be placed inside a sack cloth, soaked and then squeezed periodically. Effective dosage is around 5 ppm or 20-40 kg/ha of roots at 10 cm water depth to kill pest fish.

The use of noxious substances including derris for marine fishing is prohibited by law (P.D. 704, Section 33). However, there is no prohibition against the use of derris for pest eradication in fishponds nor its interisland transport. This clarification should encourage greater use of this organic pesticide among fishfarmers. Dried tubli roots are reportedly sold in open markets in Cebu City, Samar and other provinces.

2. **Tobacco wastes** — Tobacco dust, shavings, stalks and other wastes serve not only as an effective pesticide (selective for finfish, like tubli) but also as pond fertilizer. These are available from Metro Manila cigar and cigarette factories that use local varieties of tobacco.

To eliminate unwanted fish and snails, apply 200-400 kg/ha. Sacks containing tobacco wastes are soaked overnight in water then spread as uniformly as possible over the drained pond bottom. Soaking prevents the dust from being blown away by the wind. Water is then admitted into the pond and maintained at 10-20 cm depth for 1-2 weeks to kill the pest species. Nicotine is the active ingredient.

3. **Teaseed cake** — A byproduct of tea (*Camellia* sp.), its poison saponin is also selective for finfish. The effective level to eradicate predatory fishes is approximately 1 ppm. Levels up to 10 ppm will not kill prawns, shrimps and crabs.

4. More experimental work is needed on *lagtang* (*Anamirta cocculus*), *casla tuba* (*Croton tiglium*) and other local plants with observed pesticidal properties.

c. **Chemical**

1. **Ammonium sulfate** — To kill pests and predators, this commercial fertilizer is applied at 10-20 $g/m^2$ to watered areas near gates and other undrainable pools or at 100-200 kg/ha to the whole pond at 10 cm water depth. Free ammonia or $NH_3$ in water is toxic. Higher pH increases the proportion of $NH_3$ thereby increasing toxicity. pH can be increased by applying quicklike or burnt lime (CaO) at 50-100 $g/m^2$) just before addition of ammonium sulfate.

Application should be done when it is not windy in order to minimize loss of the chemical. After one day, the pond may be filled and stocked because of the rapid loss of ammonia and the reduction of pH to more normal levels with the introduction of water.

2. **Sodium hypochlorite** — This is widely available as bleaching solution under different brand names (Clorox, Purex, Dulux, etc.). Commercial preparations contain 5% active chlorine and have to be diluted 10,000 times to attain 5 ppm. Twenty liters of bleaching solution/ha of pond area (2 cm of water depth) will be more than sufficient. However, an undesirable side effect is the destruction of microbial and plant communities which are required for ecological balance in the pond. The solution can also be poured undiluted in water pools.

Bleaching preparations often have variable chlorine activity due to improper packaging or prolonged period on the shelf or in storage. A simple test would be to try the solution for the removal of ink stains on a piece of cloth following the instructions on the label. If effective, the chlorine activity is most probably as indicated on the label.

3. **Calcium hypochlorite** — Available as a commercial powder with 75% chlorine activity, this is the same substance used for water purification in water supply systems and swimming pools. Use 1.5 kg powder/ha at 2 cm water depth to attain a 5 ppm concentration. It is best to dissolve the powder in freshwater before application in ponds.

In handling the powder, care should be taken not to inhale any particles as they can irritate the lungs. A filter mask or simply holding one's breath until the container is closed and the powder is safely in the water would be an advisable precaution.

2. **Liming** — For acidic ponds of pH below 5, burnt lime or quicklime is applied at 1,000-2,000 kg/ha. If possible, the lime should be worked into the soil. Lime may be applied before or together with the fertilizer. For long-term pond conditioning, agricultural lime is applied at 2,000-4,000 kg/ha.

3. **Fertilization** — Extensive and semi-intensive culture systems are dependent on natural food which in turn is stimulated by proper fertilization. Chicken dung is applied at 1,000-2,000 kg/ha to maintain an organic matter content of at least 6%. If chicken dung is not available, other organic fertilizers such as pig and carabao manure may be used. Experiments on aerobic and anaerobic decomposition of agricultural and industrial wastes such as rice hulls, rice straw, bagasse and mudpress to lessen fertilizer costs in ponds are underway.

Inorganic fertilizer in the form of a combination of urea (46-0-0) and ammonium phosphate (16-20-0)* at a ratio of 1:3 is initially applied at 50-100 kg/ha. This may be followed by 10-30 kg/ha every two weeks after the regular water change to encourage the growth of phytoplankton and other natural food.

**Fig. 21. Broadcasting of organic fertilizers is undertaken on a drained pond.**

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***The numbering system of an inorganic fertilizer indicates the proportion of primary nutrients in the following order: % N (nitrogen) – %P (available phosphoric acid) – %K (potash).**

Admit water by tidal flooding or pumping to a level of at least 50 cm by the time the juveniles are stocked. Increase water to the maximum the pond can hold and maintain a minimum depth of 60-70 cm.

**C. Water management**

Water exchange is important because it a) replaces oxygen-depleted water with oxygen-rich water, b) dilutes harmful waste products, and c) introduces new food (plankton) organisms to the pond. Extensive culture with low biomass relies wholly on tidal exchange for replenishment.

In high-density semi-intensive (and intensive) culture, greater biomass and decomposition of excess food both require more oxygen. Therefore the ability to change water when necessary (and not only when the tide allows) becomes imperative. According to a veteran pond operator, a fish farmer without a pump is like a farmer without a plow.

The objective of water management is to prevent or control excessive fluctuations in the pond by maintaining physicochemical factors within the recommended ranges (section II, C).

1. Tidal exchange is possible only during spring tides which occur for 5-6 days every two weeks during the New Moon and Full Moon periods. During the neap tides or *aya-ay* (First Quarter and Last Quarter) in between when replenishment is not possible, the gate is soil-sealed if necessary to prevent water seepage.

2. Semi-intensive ponds are drained partially to the level which the high tide of the day is capable of completely replenishing as spring tide approaches. Repeat draining and flooding 2-3 times and follow up with continuous flooding to the desired water depth for the rest of the spring tide period.

3. In extensive ponds, water management may involve only the addition of water up to the maximum level of the pond. Water is not drained to avoid loss of valuable food organisms (plankton).

4. It is desirable to admit new water after midnight (3 a.m. to 6 a.m.) when DO is low and early afternoon (1 p.m. to 4 p.m.) when water temperature is highest. However, avoid draining in the daytime, particularly during warm weather because the decreased water depth and high temperature may endanger your stock.

5. Draining of the pond must always be from the lower layer of water because of the build-up of $H_2S$, ammonia and other metabolites due to decomposing food on the pond bottom.

6. A water pump (Fig. 22) is necessary for regular water exchange during the neap tide in semi-intensive ponds and for emergencies such as low DO, plankton

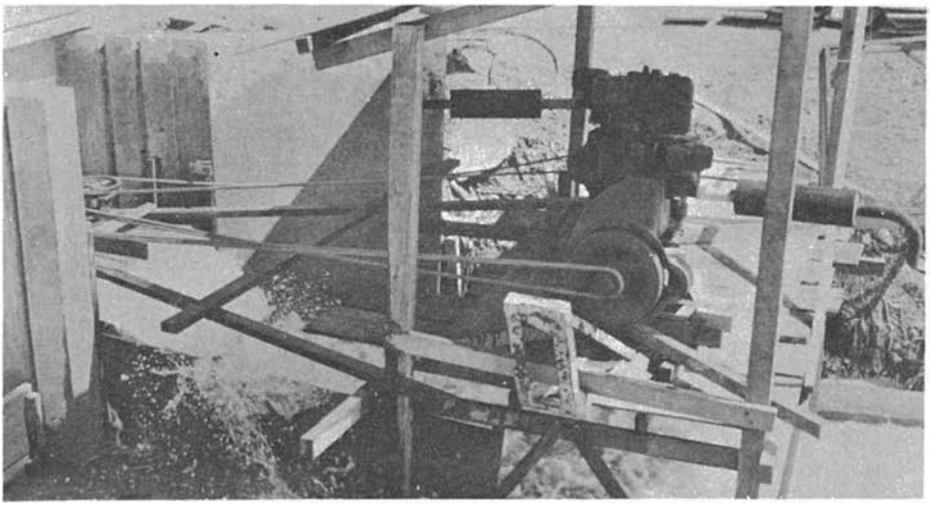

**Fig. 22. A 1,000 gpm vertical flow pump (7 Hp, diesel engine) can be installed in the main supply canal.**

blooms, etc. in both extensive and semi-intensive ponds. A partial water flowthrough (with water from the canal or reservoir entering through one gate and pond water simultaneously draining through the opposite gate) is recommended for semi-intensive ponds.

7. Examination of pond gates for immediate repair to prevent unnecessary seepage of water and cleaning of gate screens should be done daily (section IV, B, 1).

D. **Foods and feeding**

The extensive system of culturing sugpo relies almost completely on natural foods that grow in the pond. Occasional supplementary feeding may be needed when natural food production is low in extensive ponds particularly when stocked with 5,000/ha or more. As the stocking rate or biomass increases, the amount of supplementary feeding also increases to 50-80% (semi-intensive culture) and more than 90% (intensive culture) of the total food requirement of the prawns.

1. **Natural food**

a. **Higher aquatic plants** — Extensive culture as practised in Pontevedra, Capiz (which accounted for 50% of all total prawn production in ponds in 1981) and other Northern Panay towns depends to a great extent on aquatic plants. The two most important species are *digman* (*Najas graminea*, Family Nadjaceae) and *kusay-kusay* (*Ruppia maritima*, Family Potamogetonaceae). Kusay-kusay is bright green, with straight leaves, grows up to 30-60 cm long and has 15% protein content (dry weight) whereas digman is dark green with finely toothed leaves and is shorter (Fig. 23). Both plants may be found in the same pond during the rainy season but only kusay-kusay grows during the dry season.

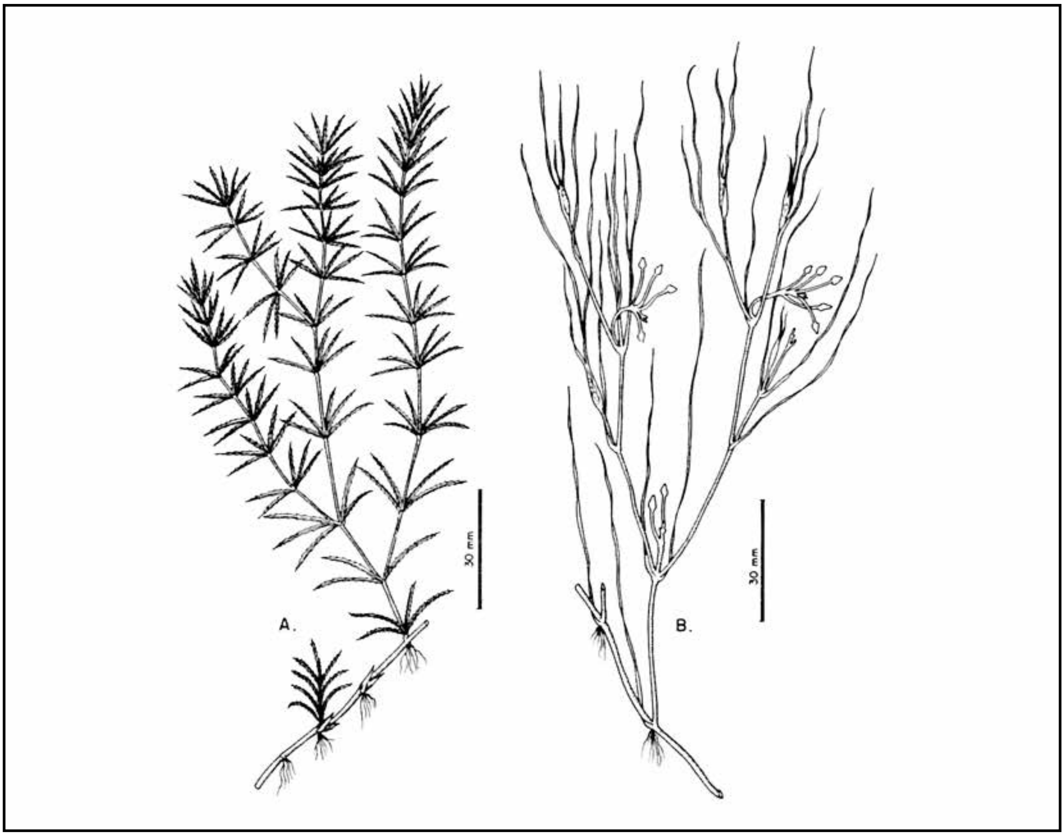


**Fig. 23. Aquatic plants common in extensive prawn ponds: A)** *Najas graminea (digman)*, **and B)** *Ruppia maritima (kusay-kusay)*.

Sugpo and other prawns graze on the soft part of the plants and the small animals (copepods, mosquito and other insect larvae, nematodes, snails, etc.) associated with both the live kusay-kusay and digman and their decaying remains on the pond bottom.

Aside from food, these plants also provide shelter from cannibalism, predation and high daytime temperature, through the presence of extensive mats of floating kusay-kusay on the pond surface. Thirdly, the presence of these aquatic plants improves water quality in the pond as silt and other particles are collected on their leaves and stems and the possible direct absorption and utilization of nitrogenous waste products by the plants.

These plants grow best in deep ponds of at least 70 cm water depth and 10-25 ppt salinity. Seeds or stem fragments on the pond bottom left over from the last cropping may give rise to new plants. A growing practice among some Capiz and Masbate farmers is to gather kusay-kusay seeds after a pond harvest and sell them in dried form at ₱60-80/ganta (Fig. 24).

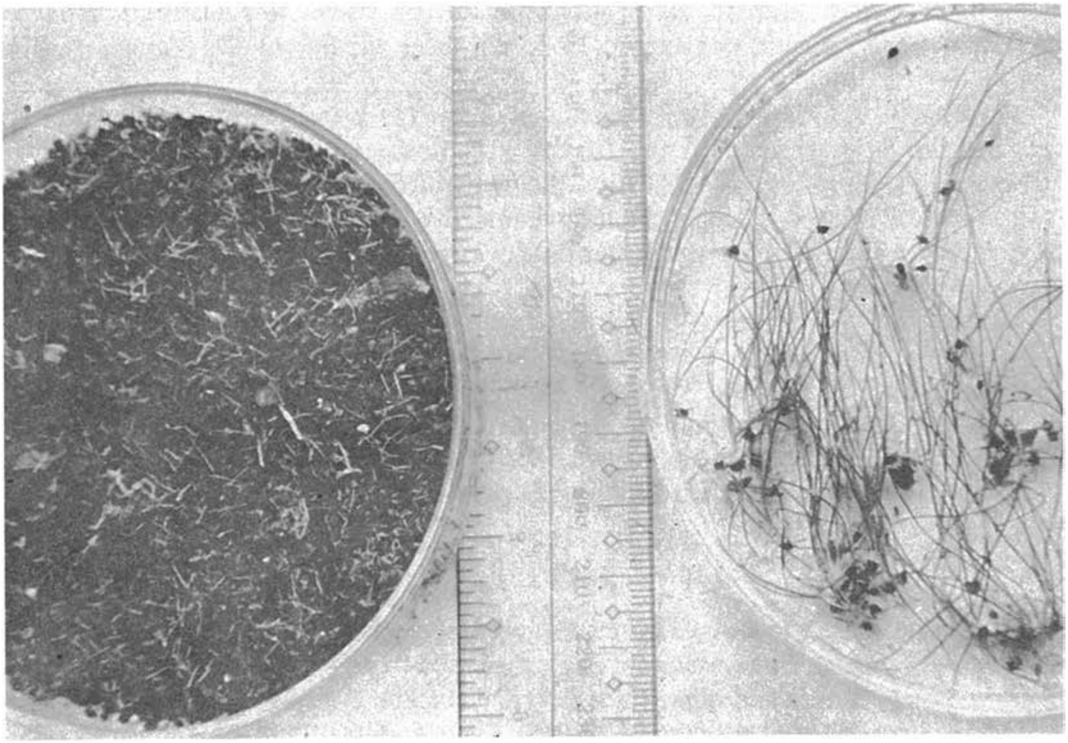

**Fig. 24. Newly-germinated seedlings and dried seeds of kusay-kusay (*R. maritima*).**

The dry seeds are first soaked in pond water overnight or broadcast directly on a moist pond bottom at the rate of 5-10 kg/ha during pond preparation. After a few days the seeds germinate and take root and water is allowed to a depth of 50 cm in the pond. The water depth is gradually increased to a maximum of one meter or more.

b. **Lumut** — Composed mainly of filamentous green algae such as *Chaeto-morpha*, lumut (13.4% protein content) grows well in deep water (60 cm and above) with low salinity, conditions which are compatible with sugpo culture. Other living organisms, particularly animals associated with lumut, may be eaten by prawns but excessive growth can cause harm by entangling young prawns. When this happens, milkfish stocked at the recommended polyculture rates (section IV, A, 6) control the lumut by feeding on it. Fertilization at the prescribed rates (section IV, B, 5) maintains the growth of lumut.

c. **Phytoplankton** — These are microscopic plants suspended in the water that form the base of a food chain wherein they are eaten by progressively larger animals which in turn are preyed on by sugpo. Deep ponds at low to medium salinity (10-30 ppt) are generally available for phytoplankton growth. Yellow-green or brownish pond water indicates the presence of plankton species favorable for sugpo. Reddish or bright green water which may be due to overfertilization should be avoided because this may lead to mass mortality of the stock. For plankton growth, turbidity reading should not exceed 25-35 cm using the Secchi disc (Appendix III).

Growth of phytoplankton is maintained by the use of inorganic fertilizer in combination with organic fertilizer initially at dosages prescribed earlier. Because nitrogen and phosphorus are lost from the water after a short while (by being bound to the soil or utilized by living plants and animals), fertilization should be frequent, e.g. every two weeks and in small amounts.

d. **Lablab** — Composed of a microbenthic complex of bottom-growing blue-green algae, diatoms and other microscopic plants and animals, lablab grows well in salinities above 30 ppt and shallow water (40 cm and below). In contrast, sugpo grow best in deep ponds with low salinities. Lablab is therefore not the best natural food for sugpo culture, unlike bangus. Should excessive lablab appear, stocking a few hundred pieces of milkfish will provide control.

2. **Supplemental feeding**

a. **Unprocessed feeds** — Commonly used feeds are shellfish (*tahong* in Capiz and Aklan; *gasang* from Manilay Bay); *bagongon* (*Telescopium*) and other snail pests in ponds; tilapia and other trash fish; and chicken entrails, hides from slaughter-houses and toads (*Bufo marinus*) (Fig. 25). Choice of feed will depend on availability (toads are rare during the dry season) and price (trash fish is cheaper than mussel in Capiz).

b. **Preparation** — Feed preparation varies with the item. Trash fish may be blanched and chopped prior to feeding. If procured in semi-dried or dried form, it is first moistened. Slaughterhouse hides and toads also need to be chopped. If large amounts of mussels are fed, it is better to remove shells to avoid build-up on pond bottom. Bagongon and other hardshelled univalves need to be crushed and the meat extracted. Already shelled mussel meat or bagongon and other shellfish may be bought by the kerosene can (and provide additional income to families of pond workers).

Other feed items that have been tried in cooked or uncooked forms singly or in combination are rice bran, sorghum and shrimp heads (from processing plants). There is no single preferred item — use whatever is economical and readily available.

c. **Artificial (formulated) diets** — Unlike unprocessed feeds which are fed as single items, formulated diets combine a number of ingredients in one single preparation. The nutrition and feeding of sugpo with emphasis on artificial diets is discussed extensively in another SEAFDEC AQD extension manual (Pascual, 1983).

There are a number of commercial prawn feeds available in the market — Universal Robina (Crustacean Pellet), Vitarich, Techno Dynamics, Int'l. (Dyna Mix)

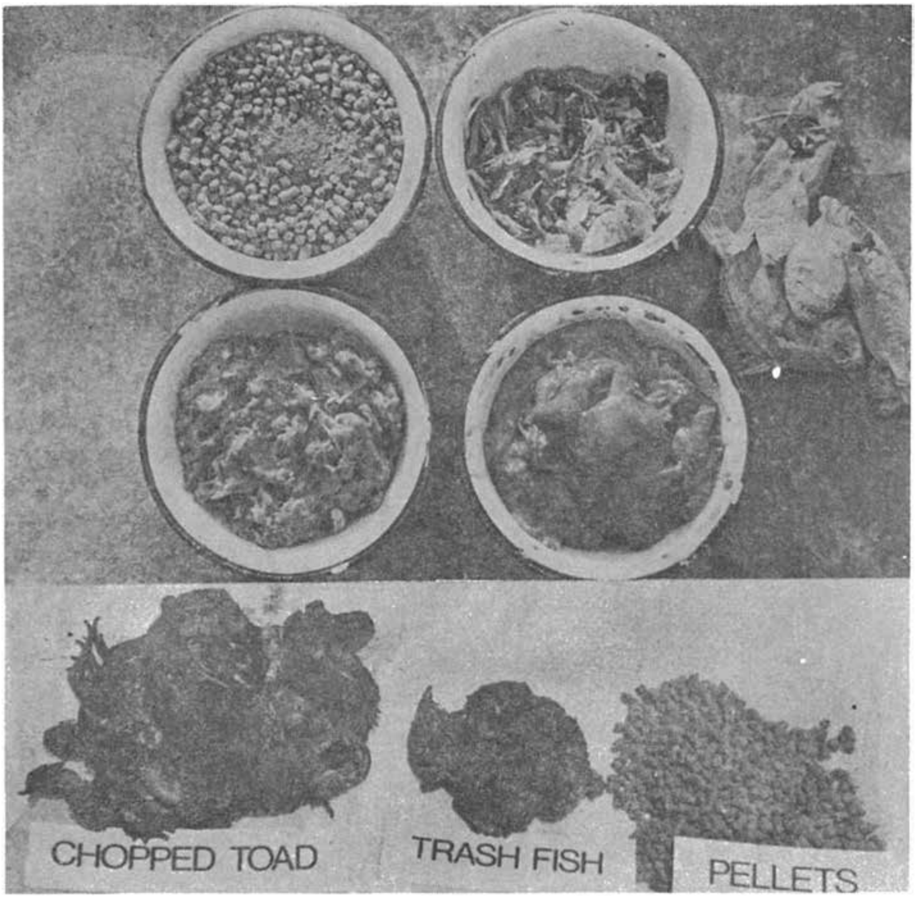


**Fig. 25. Commonly used supplementary feeds include pellets, dried trash fish, mussel meat and chicken entrails (top).**

— with varying market prices. SEAFDEC AQD is testing a number of formulations with 35-40% protein. Results in experimental and demonstration growout ponds have shown survival of up to 90% with FCR (see below) as low as 1.5.

d. **Feeding rate and sampling** — For semi-intensive culture, the recommended feeding rates (decreasing with time) are as follows:

| | |
|---|---|
| Wet feed: | 15-10% estimated total weight of prawns |
| Pellets: | 10-6% estimated total weight, 1st-2nd month<br>5-3% estimated total weight, 3rd-4th month |

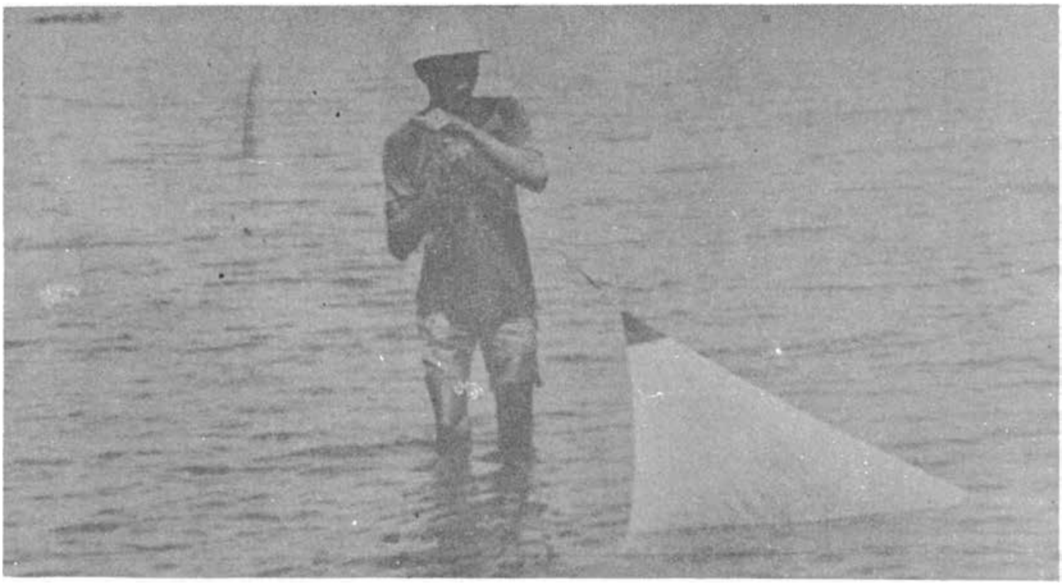

**Fig. 26. Sampling by cast net helps estimate prawn population in the pond.**

The prawn population can be sampled using a cast net or *laya* measuring 3 m in diameter with stretched mesh of 2-4 cm (Fig. 26). The best time to sample is at night or early morning when the prawns are active and uniformly dispersed in the pond. If possible, prawns from the cast net sample should be weighed individually. Otherwise, they can be weighed together as a group.

The total prawn biomass in the pond is estimated as follows:

$$\text{Area of net} = \pi r^2$$

$$= 3.1416 \times \text{radius of net}^2$$

$$\text{Total weight} = \frac{\text{total sample wt (g or kg)}}{\text{area of net (m}^2\text{)}} \times \text{total pond area (m}^2\text{)}$$

The typical growth curves of sugpo and putian are still in the exponential phase at the time of harvest at 3-6 months (Fig. 27). Therefore most of the food intake is converted into flesh or body weight (rising curve) rather than used up as energy (stable curve) which means maximum profits for the farmer.

e. **Feeding trays**

The use of feeding trays is desirable, even necessary, in semi-intensive culture which depends mainly on supplementary feeding. Simple trays measuring 0.5 x 0.5 m, made of nylon screen, bamboo strips and weighted down by sinkers (Fig. 28) may cost no more than ₱5-10 apiece.

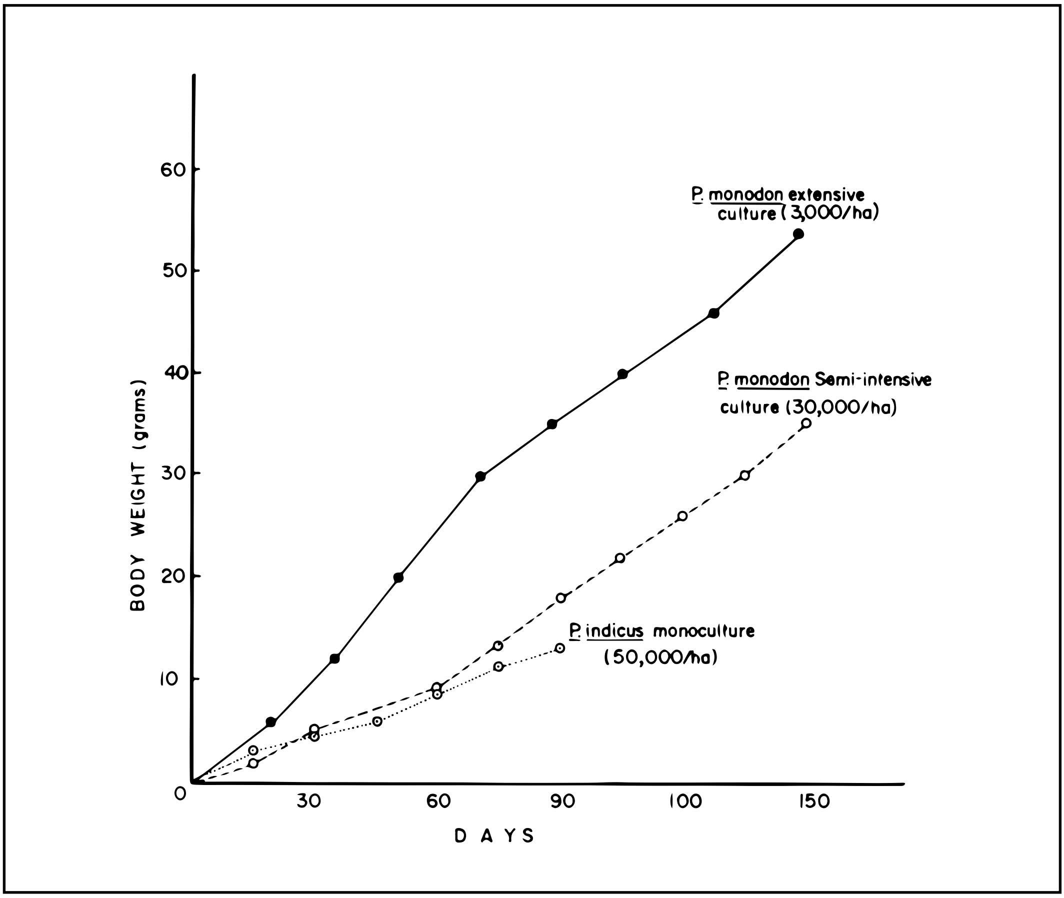


**Fig. 27. Average growth rates of** ***Penaeus monodon*** **and** ***P. indicus*** **in different culture systems.**

After blanching, cooling, chopping or soaking in water, some of the wet or dry feed is placed in feeding trays at the rate of 8-10 trays/ha alongside the dikes. The rest of the food may be broadcast directly to the pond. Feeding should be undertaken twice (8 a.m., 4 p.m.) or thrice (8 a.m., 4 p.m. and 10 p.m.) a day. Division of the feeding ration for the day should be such that the greater portion is given at night when the animals are actively feeding.

The trays are inspected daily to check for overfeeding (which may lead to pollution and mass kills) or underfeeding. An added advantage of the trays is monitoring of the stock — healthy animals readily come to the tray. When they look sluggish or do not appear at all on the trays, this means trouble — poor water quality, disease outbreak, etc. — which needs immediate checking. Monitoring of daily feeding level may also be done by going into the pond and examining the bottom.

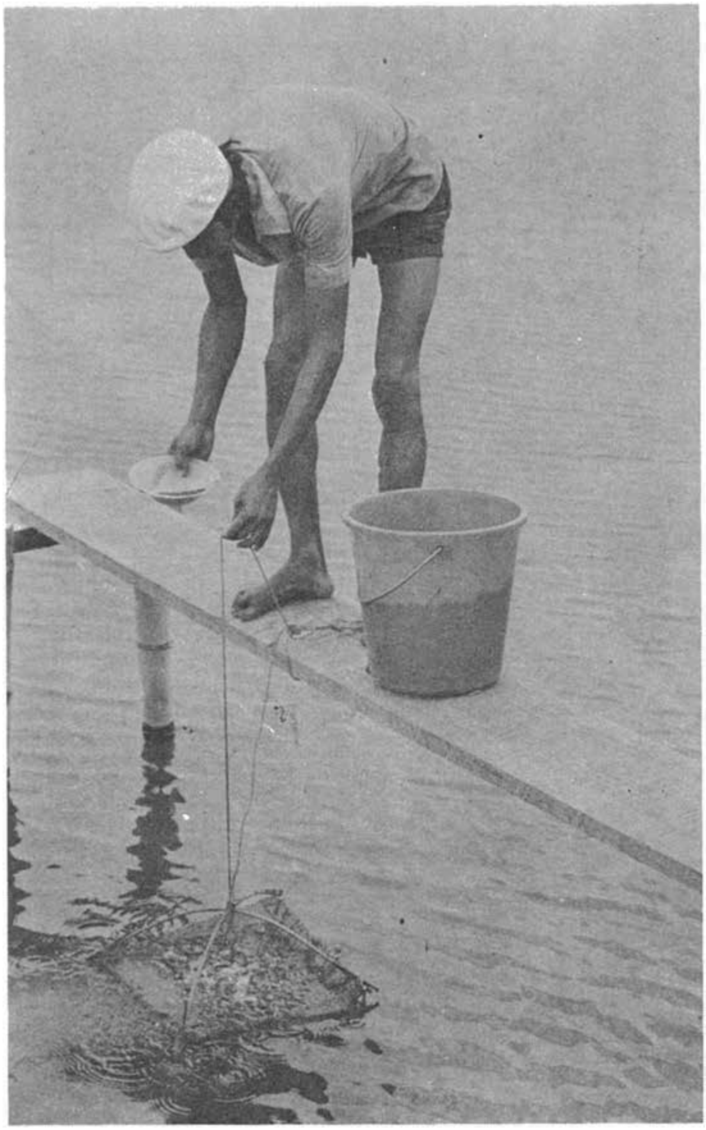

**Fig. 28. The use of a feeding tray is helpful in monitoring feeding rate and health of prawn stock.**

f. **Food Conversion Rate (FCR)** — This is the amount of food needed to produce a given amount of prawns. An FCR of 2 means that 2 kg of feed are needed to produce 1 kg of prawns. Obviously, the lower the FCR, the better (because of greater profits) for the farmer, although the cost of the feed will also affect the margin of profit.

In general, an FCR of 3-5 for fish, mussel and other unprocessed feeds and 1.5-2.5 for artificial diets (by dry weight) is acceptable.

## E. Detecting and solving pond problems

The farmer (or his caretaker) can minimize mass mortalities or low production if he diligently visits and observes his ponds for any sign of trouble.

### 1. Problems and their signs

a. Dead or dying prawns and fish in the pond. Only dead prawns at the sides near the dikes can be observed because they sink to the bottom (unlike dead fish which float due to the presence of an air bladder). This may be caused by low DO, high temperature etc.

b. Actively swimming prawns at the surface of the water during the daytime due to low DO, high temperature, etc.

c. Stunted growth of prawns, based on successive sampling of stock (section IV, D. 2) could be due to lack of food or high salinity and other unfavorable environmental conditions.

d. Black gills or black spots on the body (due to bacteria) are diseases in prawns caused by a polluted pond bottom with excess feed and other decaying organic matter.

e. Decomposing algae, particularly lablab, produces $H_2S$ (which may release a foul odor) and other harmful metabolites.

f. Overgrowth of lablab or lumut may trap or entangle younger prawns.

g. Bloom (or excessive growth) of phytoplankton may lead to low oxygen levels.

h. The DO level a few hours before sunrise may become critically low (Fig. 10) and lead to stress in semi-intensive ponds.

i. Heavy rain can cause a sudden lowering of salinity. A layer of freshwater over saltier waters can prevent the interchange of gases between the air and water and cause oxygen depletion especially when the air is perfectly still. Run-off from the dikes in ponds with acidic soil will cause the pH of the pond water to drop from 8 to less than 4 in a short time and cause mortalities.

j. Another commonly observed mass mortality in fishponds (called *hangla* in Hiligaynon) occurs towards the end of a dry season. The early morning mortalities can be traced to the convergence of a number of events — hot, humid weather and still air with no wind action the preceding day, progressively higher salinities with the absence of rain, and no water exchange due to the neap tide, all contributing to critically low DO levels. Moreover, hangla is more commonly observed in deep ponds than in shallow ponds where atmospheric diffusion and wind action can increase DO levels.

2. **Solutions**

a. Immediate water exchange (tidal or by pumping) solves many of the problems listed above. It increases oxygen levels, adds new food organisms and eliminates $H_2S$ and other harmful waste products.

The water must be drained and replenished from the bottom layer where low DO and build-up of metabolites commonly occur (section IV, C, 5). On the other hand, a pond must be drained from the top to remove a layer of freshwater after a heavy rain and replenished from the bottom.

b. Decomposing algae or lablab should be removed to prevent further deterioration of pond conditions.

c. If the prawns are stunted due to lack of food, the pond should be fertilized to induce growth of natural food (extensive culture) or additional food should be given (semi-intensive culture).

d. If natural food has been depleted from an extensive pond, the stock may be transferred to newly prepared ponds with abundant food. This is the principle of the modular or transfer method of rearing (Fig. 17).

### F. Harvest and postharvest handling

Sugpo are harvested after 2.5 months (if postjuveniles from a bansutan are stocked) up to 4-6 months (if juveniles or younger fry are stocked) of culture at sizes of 15-30 pcs/kg (35-70 g each).

1. **Factors to consider** — Like other crustaceans, prawns are more active at night than during the daytime, particularly when they feed. They also become active when new water is admitted and can even be seen swimming towards the gate (or source of new water). At night, prawns will swim towards a source of light.

Inasmuch as soft-shelled prawns command a lower market price, harvesting should be timed when the stock are hard-shelled. Soft-shelling may be due to normal molting or may be chronic and related to a nutritional deficiency. Taking a sample by bakilong or cast net (section IV, D, 2) will help a farmer determine whether his prawns are hard-shelled.

In extensive and semi-intensive ponds which are dependent on tidal exchange, harvest has to be synchronized with the spring tide, either New Moon or Full Moon, so long as the prawns are not molting. Some farmers claim that 50% or more of their stock are soft-shelled if they harvest after the neap tide whereas only a few are soft if harvest is after New Moon or Full Moon.

2. **Partial or selective harvesting** — This is recommended when there is a wide range of sizes in both extensive and semi-intensive ponds, particularly for sugpo. Cropping the bigger prawns reduces competition and allows the remaining stock to increase their growth rates.

Partial harvest is also convenient for small quotas of 20-50 kg and for undrainable ponds. In polyculture ponds, prawns may be harvested ahead of milkfish.

a. **Bamboo trap** (*bakikong* or *aguila*) (Fig. 29) — Made of bamboo slats, it is usually set perpendicular to the dike. It consists of a leader, a crown and 1-2 catching chambers. The pond water is drained to about 20-30 cm depth and new water is admitted to make the prawns active. As the prawns come in contact with the leader, they enter the crown and are trapped in the catching chamber. They are then scooped out.

b. **Bagnet** (*lumpot*) (Fig. 20) - The bagnet (stretched mesh = 3-4 cm) is at least 3 m long and is mounted on a wooden frame or *bastidor* which fits into special grooves in the gate. The pond is drained late in the afternoon and new water is admitted to stimulate the prawns. In the evening, the prawns are carried along with the current and caught in the lumpot as water is drained from the pond. Lights placed near the gate will also attract the prawns. Draining is stopped when the required quantity has been harvested. The pond is then refilled with water.

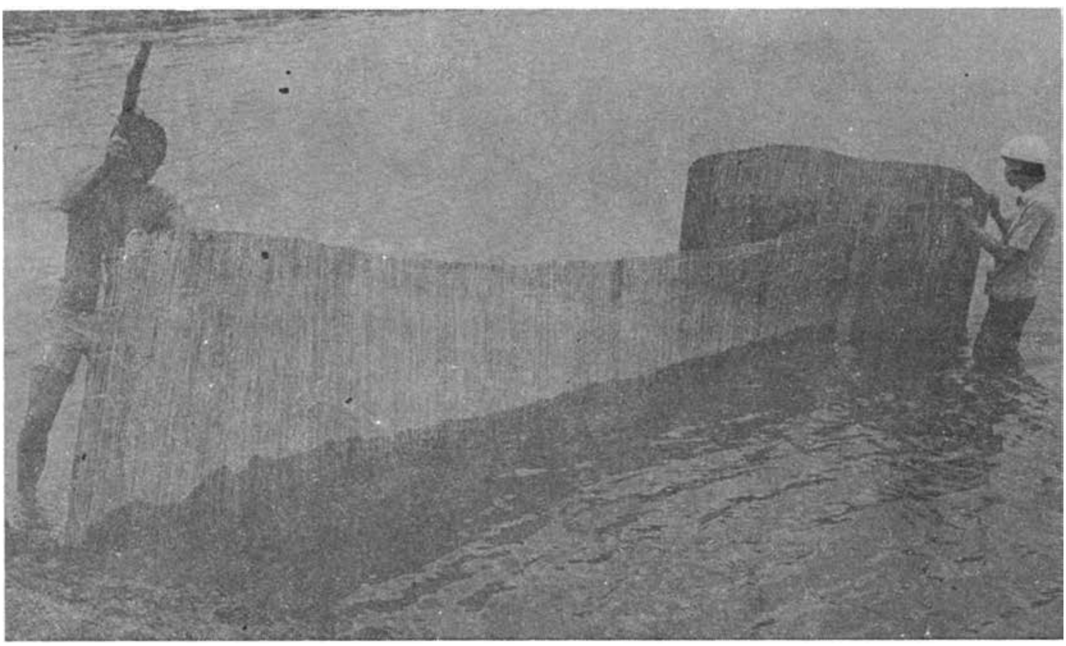

**Fig. 29. The traditional bakikong for partial harvesting consists of a leader, crown and catching chamber.**

Some Bataan and Pampanga farmers partially harvest their extensive ponds by lumpot to meet daily prawn quotas for Metro Manila markets.

c. **Selective harvesting net** (Fig. 30) — Like the bakikong, this consists of a leader, a crown and three collecting or catching chambers. It costs ₱400/net and is made of nylon material (stretched mesh = 5 cm) attached to a bamboo and wooden frame.

With the admission of new water into the pond, the actively moving prawns get trapped in a series of nets. However, the smaller animals escape through the large meshes of the collecting bags and only the big prawns are caught. In contrast, the smaller prawns caught in a bakikong become stressed if they remain in the catching chamber the whole night.

A second advantage of this net is that collection of the prawns can be made from a boat. A person has to go down into the pond, to scoop prawns out of a bakikong.

The selective harvesting net can be operated after 2.5 months of culture and every two weeks thereafter. Experiments at the SEAFDEC AQD Leganes, Iloilo Station show a production of 640 kg/ha/crop using selective harvest compared to only 500 kg/ha/crop with a single harvest, both after a 4.5 month culture period.

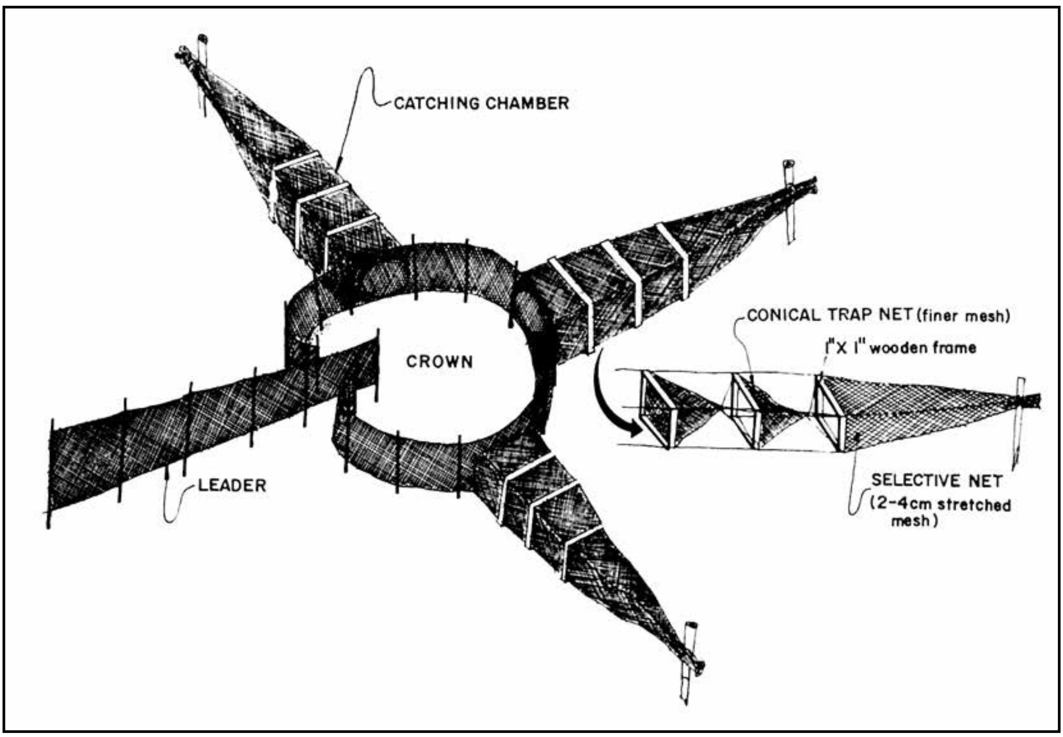


**Fig. 30. The selective harvesting net collects only large animals; undersized prawns can return to the pond.**

d. **Seine net** — Seining of prawns is practised in undrainable ponds and in watered canals of a drained pond.

3. **Complete or total harvest** — Many extensive ponds are too large (5-20 ha) to be harvested in a single night. The ponds are first harvested up to 50-80% of total stock by bakikong or lumpot over a period of 1-2 weeks. Harvest of remaining prawns is done by complete draining of the pond.

All screens and flushboards are removed from the pond gate. Water is drained to half depth in the late afternoon or evening followed by admission of new water.

a. **Bagnet or lumpot** — Operation is the same as during partial harvest (see above). The lumpot is attached to the gate and may be installed in a catching pond or directly in the water supply canal.

b. **Suspension or hapa net** — The hapa net is installed directly outside the pond gate (in the catching pond or supply canal) and collects the prawns as the water is drained.

c. **Manual harvest** — After the pond has been drained, the remaining prawns that burrow in the mud should be handpicked.

4. **Postharvest handling** — A prawn farm should have a roofed area with a concrete floor provided with running water, weighing scale, drainage and other facilities for handling and processing of the harvested animals.

a. If needed, the prawns are first washed carefully to remove mud and debris. Otherwise, they are immersed in chilled freshwater for 5-10 minutes, weighed and packed in alternate layers with crushed ice inside styrofoam containers.

b. Depending on the requirements of the buyer, quality control at the farm site generally means excluding prawns that are soft-shelled, diseased (blackened legs, tails, etc.) and undersized. The prawns may be classified into sizes at the pond but the finer grading is done at the processing site. The commonly accepted size ranges are 6-18, 19-25, 26-40 and 41-45 pcs/kg.

c. The packed prawns are picked up at the farm site either by middlemen,/ dealers (for local or Metro Manila markets) or by representatives of processing plants. Prawns for local markets are sold whole because consumers consider the head a delicacy.

d. In the processing plant, the prawns are graded, beheaded, shelled and deveined to meet the specific requirements of the export market. They are then quick frozen (in blast or contact freezers), placed inside plastic bags then packed in carton boxes ready for shipment.

e. Prawn heads and other byproducts are sold separately to buyers who use them for shrimp meal (an important ingredient in prawn pellets) or for making sauce.

## V. Economic aspects

Table 3 compares the three sugpo pond culture systems based on stocking rates of 4,000/ha in polyculture with bangus for an extensive farm, 30,000/ha for a semi-intensive farm, and 150,000/ha for an intensive farm. Although the assumptions are based on information from private farmers and data from available literature, the analysis can be further refined. Nevertheless, it remains useful in giving a general idea of how the three systems compare with each other in terms of profitability.

An existing fishpond using the extensive system (in polyculture with milkfish) requires yearly operating expenses of ₱8,700/ha. With a gross income ₱11,500/ha and no pond development costs, this means a net income of ₱2,000/ha, internal rate of return of 47% and payback period of two years.

The semi-intensive system has development costs of P25,000/ha for an existing pond. Given yearly operating expenses of ₱56,850/ha and net income of around ₱21,000/ha, this gives an internal rate of return of 44% and payback period of 2.2 years.

Development costs per ha for intensive culture is around ₱500,000 with yearly operating expenses of ₱467,000, gross income of ₱648,000, for a net income of ₱95,400, internal rate of return of 18% and payback period of 4.5 years.

Therefore the extensive and semi-intensive systems are more attractive to the average farmer because they require relatively lower investment and give relatively higher rates of return compared to the intensive system.

## VI. Culture of putian

Enterprising farmers in Western Visayas and Northern Mindanao have tried culturing putian with encouraging results. Pond operators in Dipolog, Zamboanga stock wild *P. indicus* and *P. merguiensis* fry bought from coastal gatherers, harvest after 2.5-3 months and sell their produce in local markets or Metro Manila at ₱20-30/kg.

Pond specifications, preparation and other management procedures for sugpo apply to putian as well.

**Table 3. Comparison of three pond culture systems for sugpo (per hectare per year).**

| | Extensive | Semi-Intensive | Intensive |
|---|---|---|---|
| **A. Assumptions** | | | |
| 1. Culture method | polyculture with milkfish | monoculture | monoculture |
| 2. Pond development cost per hectare | (existing pond) | ₱25,000 (existing pond) | ₱500,000 (new pond) |
| 3. Prawn | | | |
| a. Stocking density | 4,000/ha | 30,000/ha | 150,000/ha |
| b. Fry age | juveniles | juveniles | $PL_{20}$ |
| c. Fry cost | ₱0.40 | ₱0.40 | ₱0.20 |
| d. Survival rate | 50% | 70% | 80% |
| e. Ave. size at harvest | 40 g | 35 g | 30 g |
| 4. Milkfish | | | |
| a. Stocking density | 600/ha | | |
| b. Fry age | fingerlings | | |
| c. Fry cost | ₱0.35 | | |
| d. Survival rate | 90% | | |
| e. Ave. size at harvest | 250 g | | |
| 5. Water management | tidal | tidal + pump | pump + paddlewheels |
| 6. Feed | | | |
| a. Type | natural + minimal supplementary | natural + supplementary | pellets |
| b. Cost | ₱1,000/year | ₱4/kg | ₱13/kg |
| c. FCR | | 3:1 | 1.7:1 |
| 7. No. crops/year | 2 | 2 | 3 |
| 8. Production (kg/ha/yr) | | | |
| a. Prawn | 160 kg | 1,470 kg | 10,800 kg |
| b. Milkfish | 270 kg | | |

| | Extensive | Semi-Intensive | Intensive |
|---|---|---|---|
| **B. Financial Analysis** | | | |
| 1. Gross Income | | | |
| a. Prawn (₱60/kg) | ₱ 9,600 | ₱ 88,200 | ₱ 648,000 |
| b. Milkfish (7/kg) | 1,890 | | |
| Total | ₱ 11,490 | ₱ 88,200 | ₱ 648,000 |
| 2. Operating Expenses | | | |
| a. Fry | | | |
| 1. Prawn | 3,200 | 24,000 | 90,000 |
| 2. Milkfish | 420 | – | – |
| b. Feeds | 1,000 | 17,640 | 238,680 |
| c. Fertilizers and lime | 2,000 | 7,600 | – |
| d. Labor | 500 | 800 | 14,450 |
| e. Power | – | 900 | 91,120 |
| f. Pond maintenance | 1,000 | 1,500 | – |
| g. Overhead (5% of gross income) | 575 | 4,410 | 32,400 |
| h. Marketing cost[1] | – | – | – |
| Total | ₱ 8,695 | ₱ 56,850 | ₱ 466,650 |
| 3. Net Operating Income before Depreciation | ₱ 2,795 | ₱ 31,350 | ₱ 181,350 |
| 4. Income | | | |
| a. Depreciation expense[2] | – | 2,500 | 50,000 |
| b. Net income before tax | ₱ 2,795 | ₱ 28,850 | ₱ 131,350 |
| c. Income tax[3] | 698 | 7,212 | 35,973 |
| d. Net income | ₱ 2,097 | ₱ 21,638 | ₱ 95,377 |

[1]Marketing cost is nil as the quoted selling prices are ex-pond rates.

[2]Depreciation is on straight-line basis for 10 years.

[3]Income tax rates for corporations are used.

| | Extensive | Semi-Intensive | Intensive |
|---|---|---|---|
| **C. Investment** | | | |
| 1. Development cost | | ₱25,000 | ₱500,000 |
| 2. Initial working capital[1] | 4,348 | 28,425 | 155,550 |
| Total | ₱4,348 | ₱53,425 | ₱655,550 |
| **D. Profitability Indicators** | | | |
| 1. Average rate of return | 96% | 81% | 29% |
| 2. Internal rate of return | 47% | 44% | 18% |
| 3. Payback period (years) | 2.1 | 2.2 | 4.5 |

[1]Initial working capital represents the required outlay for one cropping.

## A. Stocking density

Wild putian fry or hatchery-reared $PL_{15}$ to $PL_{20}$ can be stocked directly in the grow-out pond without passing through a nursery phase. Direct stocking avoids unnecessary mortality in these species which are not so resistant to handling. Stocking density is 50,000-100,000 fry/ha for monoculture and 10,000-12,000 fry/ha of putian with 3,000 fingerlings/ha of bangus for polyculture. (One farmer discourages stocking of milkfish because they destroy screens as they flock towards the gate during tidal admission of water thereby allowing pests to enter.)

## B. Feeding

For the first month, the crop can subsist wholly on natural food. Once this is depleted, feeding of pellets, trash fish, mussel meat and other supplementary feeds is given twice (8 a.m. and 4 p.m.) or thrice (8 a.m., 4 p.m. and 10 p.m.) daily. Feeding rate is 12-10% for the second month and 8-6% for the third month, of estimated prawn biomass in the pond.

## C. Management

Regular water exchange is by tidal fluctuation over a cropping period of three months. Putian can tolerate a salinity range of 20-40 ppt, making it an ideal dry season crop.

### D. Harvesting

Partial harvest is by bakikong or lumpot followed by a complete draining of the pond. Expected survival rates and harvest sizes of putian are 70-80% at 8-12 g each (80-120 pcs/kg) for monoculture and 15-20 g each (50-65 pcs/kg) for polyculture. The sizes of putian at harvest are much more uniform compared to sugpo.

Larger sizes of 30 g or more (for the export market) may be obtained with better nutrition or if the stock is transferred to another pond for extended rearing. However, the additional handling required may pose problems. Also, it has been commonly observed that putian disappear if kept beyond 3-4 months in the ponds. The mortalities causing this disappearance may be related to salinity and other environmental changes in the ponds.

## ACKNOWLEDGEMENTS

The authors would like to acknowledge the help of colleagues in the Department and insights shared by friends from the private sector in the writing and preparation of this manual: a) Tito Angudong, Jon Arcenas, Dam Arches, Atty. Ed Azarraga, Nilda Bermejo, Ben Deocampo, Mac Hormillosa, Atty. Tony Ortiz, Mayor Serafin Roman, Raffy del Rosario, Hernan Viterbo and other fish farmers; b) Roger Gacutan, Masanori Suemitsu, Jun de la Peña, Edgar Reyes, Romy Mesa, and other co-researchers at SEAFDEC AQD; and c) Alex Dormitorio, Ching Cansancio, Esther Cang, Nani Juntaria, Jojo Legaspi, Roland Rudio, Auggi Surtida and other production staff.

Special thanks are due Fred Yap, formerly of SEAFDEC who contributed many ideas to the immediate predecessor of this manual; BFAR Director Jose Garrido for legal information and fish identification; Dr. Paciente Cordero, Jr. for plant identification; Alex Lim, Jr. for the economic analysis; Nick Primavera, Jr. for encouragement; and to Dr. Alfredo Santiago, Jr., Dr. Yasuhiko Taki, and Engr. Rolando Platon, Department Chief, Deputy Chief, and Research Division Head, respectively, for providing the suitable environment for aquaculture research.

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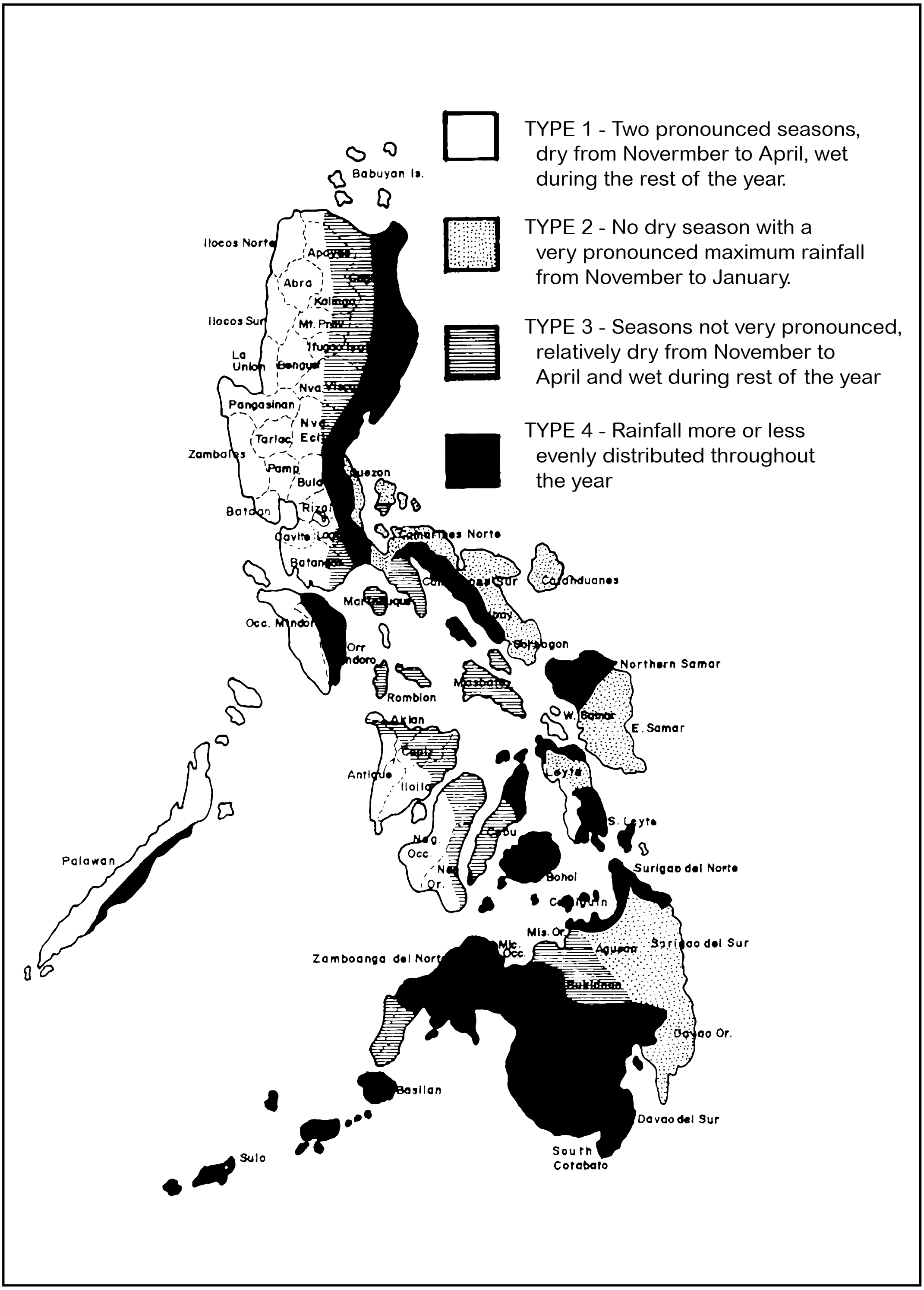
## APPENDIX I CLIMATIC TYPES OF THE PHILIPPINES



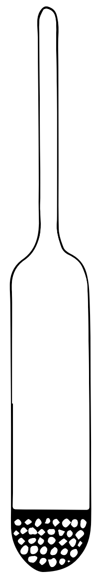
## APPENDIX II

## COMMON PESTS AND PREDATORS IN BRACKISHWATER PONDS

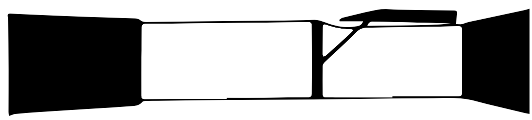
| Scientific Name | Common Name: English | Common Name: Tagalog | Common Name: Visayan/Others | Remarks |
|---|---|---|---|---|
| **A. Finfish** | | | | |
| 1. *Elops hawaiiensis* | ten-pounder | bidbid | bidbid | predator |
| 2. *Megalops cyprinoides* | tarpon | buanbuan | bulanbulan | predator |
| 3. *Tilapia mossambica* | tilapia | tilapia | tilapia | predator |
| 4. *Therapon jarbua*, *T. puta* | | ayungin | bugaong | scavenger |
| 5. *Glossogobius giurus*, other Gobiidae | gobies | biang puti bia | bia | predator |
| 6. *Moelenesia latipana* | molly, guppy | bubuntis | buntitan, paitan | competitor |
| 7. *Liza* spp., *Mugil* spp. | mullet | banak | gisao, banak | competitor |
| 8. *Lates calcarifer* | sea perch | apahap | bulgan | predator |
| 9. *Epinephelus* spp. | grouper | lapulapu | lapulapu | predator |
| 10. *Caranx* spp. | | talakitok | talakitok | predator |
| 11. *Lutjanus* spp. | snapper | mayamaya | mayamaya | predator |
| 12. *Arius* spp. | | kandule | | predator |
| **B. Crustaceans** | | | | |
| 1. *Scylla serrata* | mud or mangrove crab | alimango | alimango | destroys dikes |
| 2. *Varuna litterata* | | talangka | kalampay | competitor |
| 3. *Uca* spp. | fiddler crab | | | competitor |
| 4. *Macrobrachium* spp. | freshwater prawn | ulang | ulang | |
| **C. Molluscs** | | | | |
| 1. *Cerithideopsilla cingulata* | snail | suso | suso | competitor |
| 2. *Telescopium* sp. | snail | bagongon | bagongon | competitor |

## APPENDIX III INSTRUMENTS FOR MEASURING PHYSICO-CHEMICAL PARAMETERS

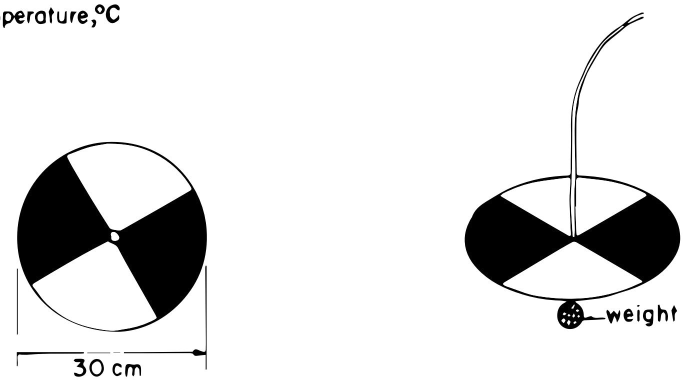
THERMOMETER -
air and water temperature,°C



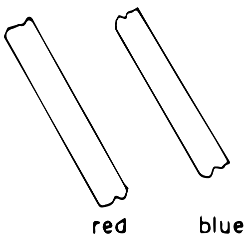
2) HYDROMETER — Specific gravity
(indirectly measures salinity)



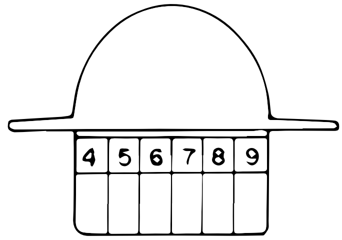
3)REFRACTOMETER, Salinity, ppt.




4) SECCHI DISC - Turbidity, cm



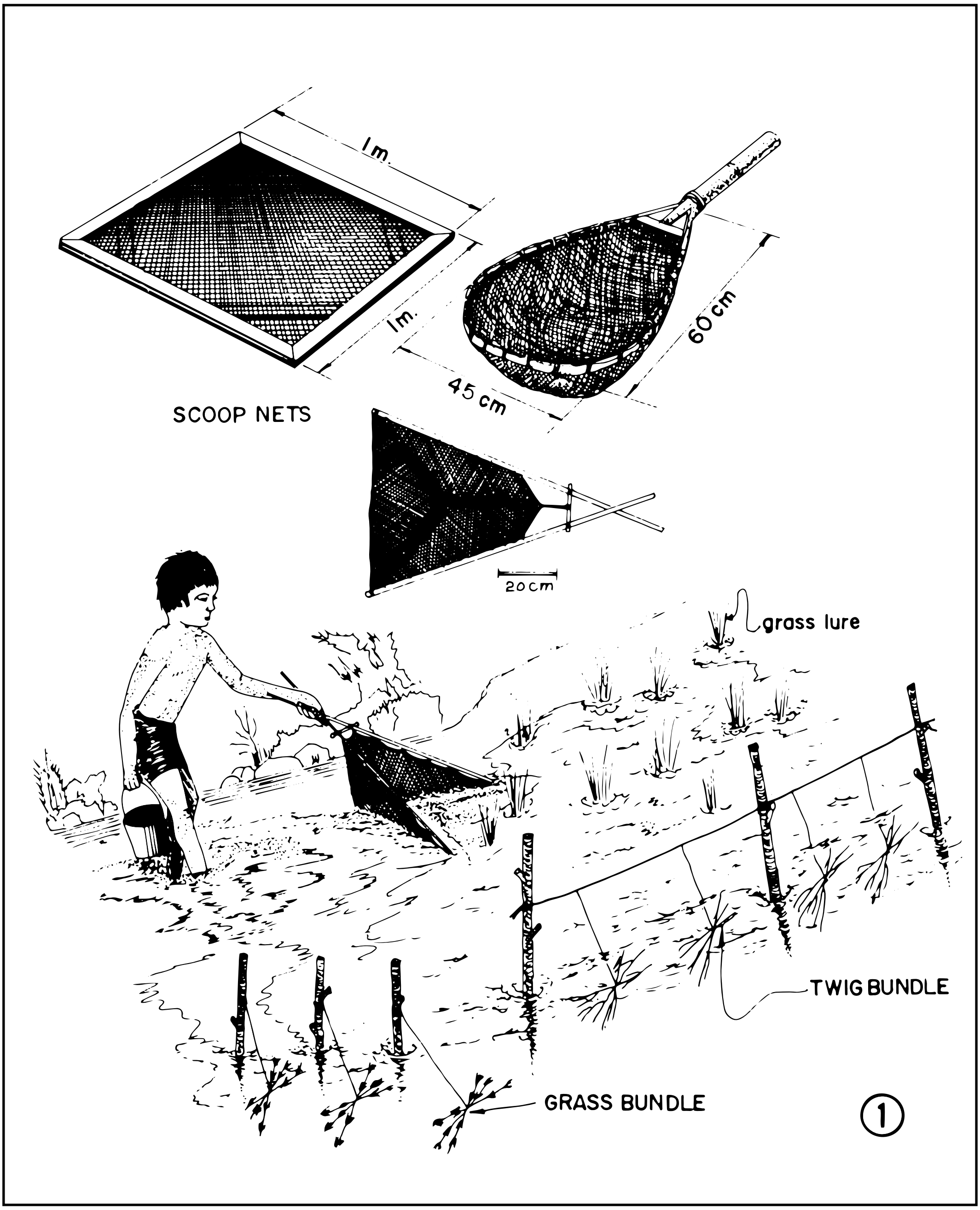

5) LITMUS PAPER



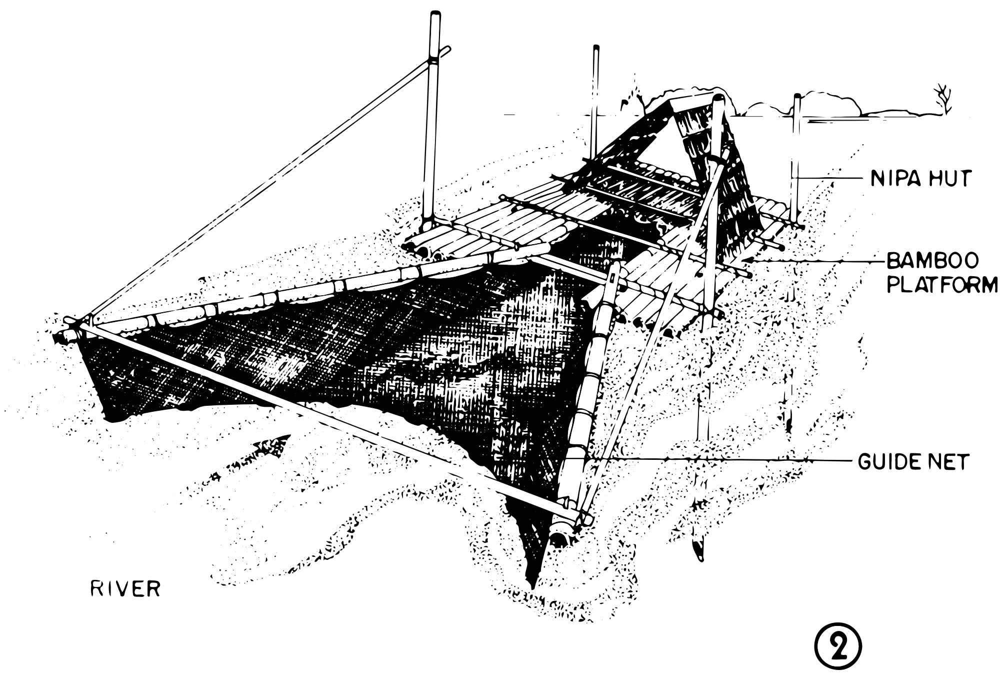

6) HYDRION PAPER - pH

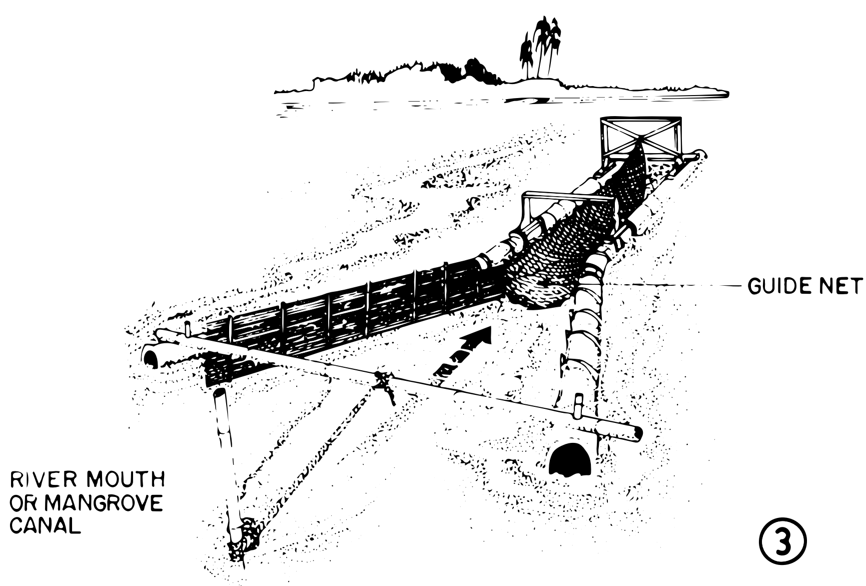
## APPENDIX IV COLLECTING GEAR FOR PRAWN FRY

**(After Motoh, 1980)**



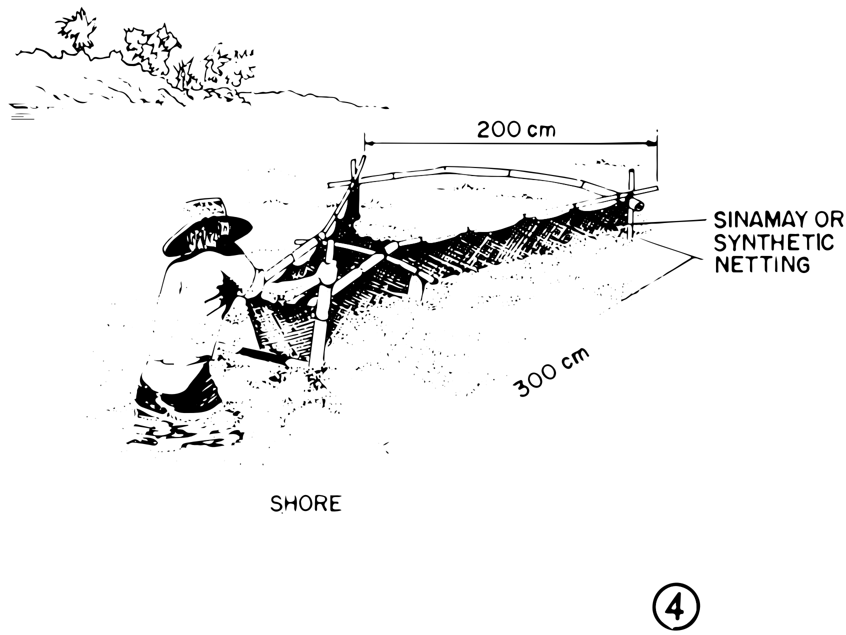

1. Fry lures made of grass and twigs are set in mangroves and brackishwater rivers. Fry clinging to the lures are collected by scoop nets.

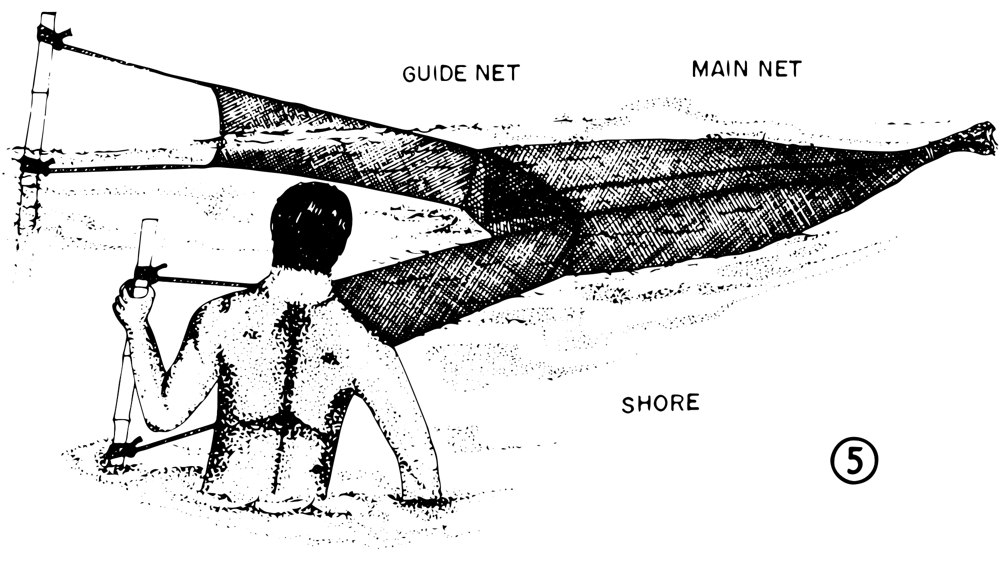



2. Capiz-patterned fry filter net set in rivers collects fry migrating from offshore areas to brackishwater grounds during incoming tide.

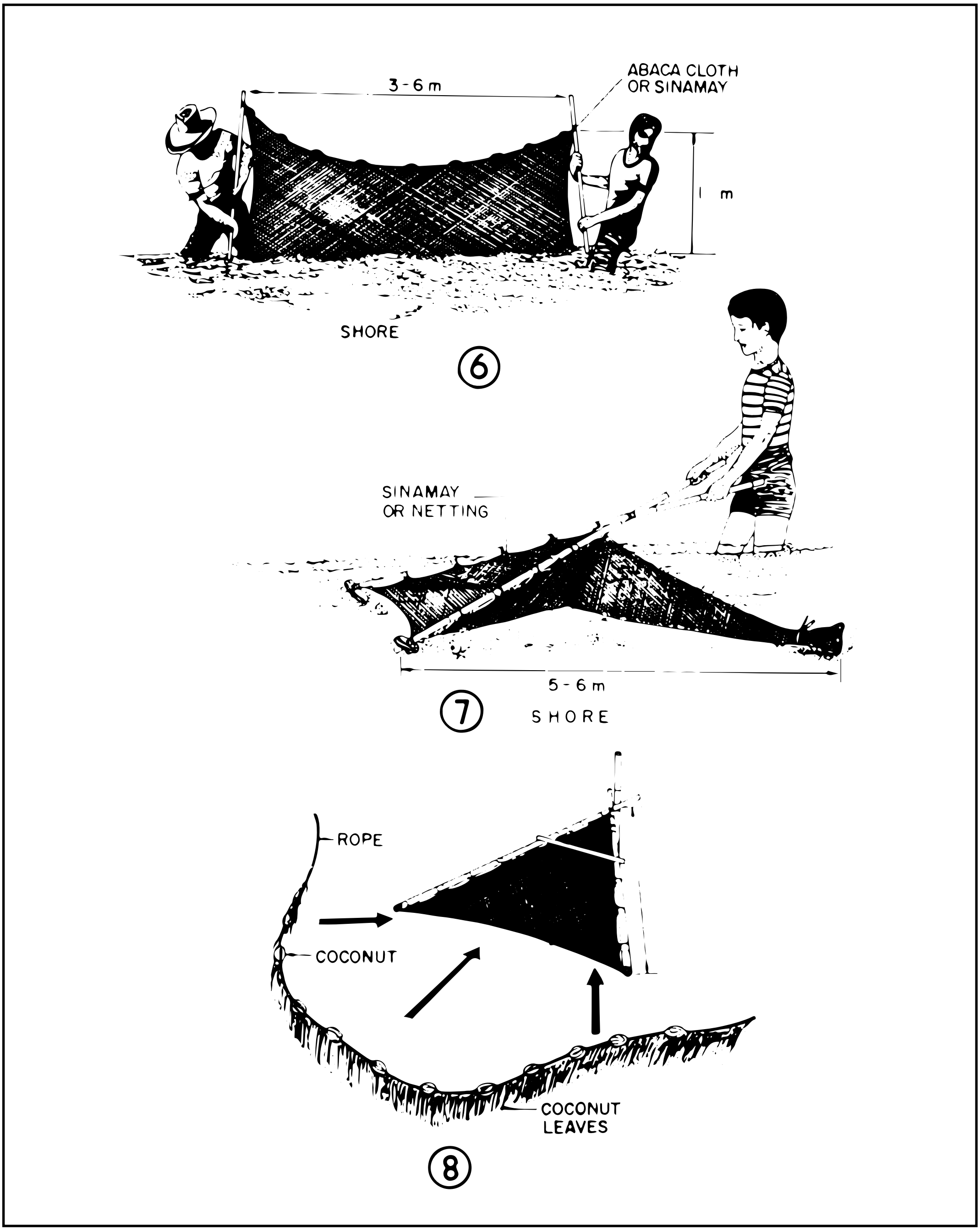
3. Fry raft (*saplad*) collects migrating fry near mouth of brackishwater rivers during incoming tide.




4. Fry bulldozer (*baka-baka*) pushed by 1-2 persons parallel to shoreline is a more efficient collector of bangus rather than prawn fry.

5. Fry filter net (*tangab*) installed oblique to shoreline collects fry as they migrate or are transported by the current.




6. Fry seine (*sagap*, sayod, or *sibut-sibot*) made of woven abaca or *sinamay* collects fry as it is dragged slowly in waist-deep waters parallel to the shore.

7. Triangular or scissors net (*sakag*) is operated in waist-deep waters parallel to the shoreline.

8. Fry scare line (*surambaw*) used in shallow shore waters is more effective for bangus rather than prawn fry.

## APPENDIX V

## LIST OF PENAEID PRAWN HATCHERIES AND NURSERIES IN THE PHILIPPINES*

### A. Government

1. SEAFDEC Aquaculture Department — Tigbauan, Iloilo; Leganes, Iloilo and Batan, Aklan (3 hatcheries)

2. Masaganang Sakahan, Inc. (Land Bank) — Magsaysay, Mindoro Occidental

3. Ministry of Human Settlements — Mamburao, Mindoro Occidental

4. MSU — Southern Philippines Development Authority — Naawan, Misamis Oriental

5. Zamboanga Regional Institute of Fisheries Technology — Zamboanga City

### B. Private

1. Tagat Industries, Inc./Mr. Alfonso Lim — Tagat, Claveria, Cagayan

2. Mascariñas Hatchery/Mr. Romualdo Mascariñas — Orani, Batan

3. Mr. Earl Kennedy — Sunset Village, Parañaque, Metro Manila

4. San Jose Aquaculture Dev. Corp./Mr. Alfonso Lim — San Jose, Mindoro Occidental

5. Aquaphil (Tabacalera) — San Jose, Mindoro Occidental

6. Suarez Agro Industrial Corporation/Mr. Danilo Suarez — San Isidro, Catanawan, Quezon

7. Aquamarin Hatchery Co. — Dumaguit, Aklan

8. Rojas Prawn Hatchery/Mr. Luis Rojas, Jr. - Batan, Aklan (2 hatcheries)

*The remaining hatcheries (out of a total of around 60) are either not operational or not enough information is available.

9. Mega Hatchery - Batan, Aklan
10. Pacific Aqua Development Corp./Mr. Mike Ho — Makato, Aklan
11. AA Export-Import Corp. — Culasi, Roxas City
12. Shrimpy's Hatchery/Ms. Nilda Bermejo - Baybay, Roxas City
13. Mr. Victoriano Andaya — Baybay, Roxas City
14. San Rafael Aquaculture, Inc./Atty. Rafael Dinglasan — Baybay, Roxas City
15. Mercury Hatchery/Mr. Dam Arches — Dumolog, Roxas City
16. Venus Hatchery/Mr. Dam Arches — Cogon, Roxas City
17. Cogon Aquafarms, Inc. - Cogon, Roxas City
18. Mr. Antonio Ortiz — Baybay, Roxas City
19. EN Prawn Nursery/Mr. Edmundo Bermejo — Baybay, Roxas City
20. Mr. Santiago Bermejo, Jr. Nursery - Roxas City
21. TV Fish Marketing Nursery/Bingbing Tan — Roxas City
22. RJG Industries/Mr. R.J. Gullanes — Dumangas, Iloilo
23. Ms. Dawn Jamandre — Oton, Iloilo
24. Mr. Nelson Jamandre — Tigbauan, Iloilo
25. Seascapes Hatchery — Villa, Iloilo
26. Philippine Marisco Corporation — Bacolod City, Negros Occidental
27. San Miguel Corporation Hatchery — Calatrava, Negros Occidental
28. Pioneer Hatchery/Mr. Franklin Young — Calumangan, Bago City
29. HJR Fishing Industries/Mr. Jerry Lim — Banilad, Cebu City and Liloan, Cebu (2 hatcheries)

30. Premier Hatchery/Mr. Jimmy Uy — Talisay, Cebu

31. Traders Marketing/Mr. Joaquin Ang — Talisay, Cebu

32. Pedrito Bombeo/SPDA Hatchery — Panaon, Misamis Occidental

33. Mr. Luciano Puyod — Davao City

**Produced by the Information Services Office**

**AQUACULTURE DEPARTMENT**
**Southeast Asian Fisheries Development Center**
**Tigbauan, Iloilo, Philippines**