EXTENSIVE AND SEMI-INTENSIVE CULTURE OF SUGPO *(Penaeus monodon)* IN THE PHILIPPINES

Florentino D. Apud
Researcher
SEAFDEC Aquaculture Department

INTRODUCTION

The significant events in the history of pond cultivation of jumbo tiger prawns known as ***sugpo*** in the Philippines could be placed within the last three decades. The earliest account regarding its pond culture separately or with milkfish was written by Villadolid and Villaluz (1950). In "Fish Farming in the Philippines," Villaluz (1953) described its morphological characteristics, feeding habits, preparation, stocking and care of fry in nursery pond and preparation of rearing pond.

A study on its growth rate conducted by Delmendo and Rabanal at the Dagatdagatan experimental ponds of the Philippine Bureau of Fisheries was published in 1956. In 196b, Villaluz wrote an information leaflet entitled "General Information on Shrimp ***(Sugpo)*** Cultivation in the Philippines." In a review paper presented at the FAO World Scientific Conference on the Biology and Culture of Shrimps and Prawns, Caces-Borja and Rasalan (1968) discussed sugpo fry collection and marketing, pond culture, and problems associated with its cultivation in monoculture and in polyculture with milkfish.

Feedbacks and lectures given by some fishery officials who had gone abroad to observe prawn culture activities particularly in Japan and Taiwan in the early sixties have intensified interest and enthusiasm in the government and in the private sector to develop the ***sugpo*** industry. The ever increasing demand for said prawns in the international market triggered greater interest.

For many years the industry had suffered major setbacks in pond culture due to inadequate and unreliable supply of prawn fry from the wild (Delmendo and Rabanal 1958; Caces-Borja and Rasalan 1967; Villaluz ***et al*** 1969). The breakthrough in the mass production of prawn fry at MSU-IFRD, Naawan, Misamis Oriental (Villaluz *et al* 1969) under controlled hatchery conditions marked the take off point in the development of the industry. With this achievement, many fishpond operators felt assured of fry supply and were encouraged to go into ***sugpo*** culture.

The 1970s saw more intensified research activities in hatchery and pond culture techniques, training and extension programs, and more involvement by both the government and the private sector in the development of the industry. The MSU-IFRD and SEAFDEC Aquaculture Department spearheaded the research, training and extension activities in collaboration with the Bureau of Fisheries and Aquatic Resources, Philippine Federation of Aquaculturists and some fishfarmers.

PRODUCTION, MARKET DEMAND, AND CULTURE METHODS

a. Production and Market Demand

According to the Market Report Vol. 3 of ADB/FAO Infofish. 1982, the Japanese shrimp consumption in 1981 was 199,000 metric tons. Out of this volume, about 161,700 metric tons were imported from different countries (Japan Finance Ministry and U.S. Dept. of Commerce). The Philippines contributed about 2,700 metric tons or only 1.7% of Japan's total import. This quantity declined considerably from the 1979 record of 3,700 metric tons exported to Japan. About one-half of the export in 1979 was captured from the sea, the rest was pond-grown.

The major cause in the decline of prawn and shrimp export could be attributed to a drastic reduction in the volume of catch. BFAR reports that the catch of prawns and shrimps in 1981 was only 723 metric tons. Based on this figure, it appears that the volume of pond-grown shrimp for export slightly increased from 1,850 metric tons in 1979 to 1,977 metric tons in 1981. Assuming an average production of 250 kg/ha/yr using extensive culture method, such volume could be derived from only 7,600 ha of brackishwater fishponds in the Philippines. If the same farms were used in semi-intensive culture producing a minimum of 750-1,000 kg/ ha/year, output from the same area could be twice or thrice the present volume.

b. Culture Methods

Generally, the fishpond yield per unit area is dependent on the culture method which could be restricted by financial capabilities, pond facilities, level of technical knowhow, and skill. If the culture method does not take into account these factors, failure is highly possible.

The SEAFDEC Aquaculture Department has categorized culture methods into three: extensive, semi-intensive and intensive. The extensive method is commonly practised by fishfarmers and is generally applied in less developed farms or in existing milkfish ponds. These ponds are generally shallow (40-70 cm) with only one gate to serve as supply and drain facility. *P. monodon* under this method are stocked at limited quantities (2,000-3,000 ha) in monoculture or in polyculture with milkfish. The stock are fully dependent on natural food propagated by fertilization. Water management is totally dependent on tidal fluctuation. Efforts are being made to provide a deeper portion that is suitable for prawns by constructing peripheral or diagonal canals. Pests and predators are also eradicated during pond preparation. Their entrance are prevented by providing fine-mesh screen at the gate system during water replenishment.

The semi-intensive culture method has a higher stocking density ranging from 20,000 to 50,000 per ha. Supplemental feed is provided to the stock in addition to natural food. The shallow pond is excavated to attain 70-100 cm water depth, otherwise a trench is constructed to provide a deeper portion of at least 20% of the area. To provide the desired water quality and depth, a water pump is operated especially during neap tide. A number of fishfarmers have shifted to this method to increase yield.

The intensive culture method is basically patterned after that of Taiwan where stocking density has been raised between 100,000 to 200,000/ha. The pond facilities normally include concrete or bricklined dike of small compartments (1/4 to 1 ha); water pumps that provide a pre-filtered mixture of fresh and seawater at appropriate salinity of 10-20 ppt; and aeration devices to provide oxygen, release toxic gases and mix water 24 hours a day. The stock is fully dependent on a high-grade formulated diet. So far very few big investors have adopted this method because of higher capital requirement, higher level of technology, and high risks.

Of the three culture methods, the extensive appears to be most widely practised. The semi-intensive method, however, appears to be the most viable and easily adaptable. The discussion therefore shall be confined to extensive and semi-intensive culture of prawns.

EXTENSIVE AND SEMI-INTENSIVE CULTURE OF PRAWNS

a. Rearing in nursery system

Direct stocking of fry in grow-out ponds, both with extensive and semi-intensive culture of prawns, is considered most convenient by fishpond operators. Results have been unreliable so that an intermediary pond has to be used. At first, the milkfish nursery pond was utilized for prawn fry using the same management method as for milkfish fry culture. This method, however, can hardly achieve acceptable rates of survival. As skill and knowhow developed, different nursery systems were designed to improve prawn fry survival. These include the use of hapa net and the floating cage nursery, the earthen nursery, and the tank system.

(1). Hapa net and floating cage nursery system

The hapa net was introduced in 1975 (Primavera and Apud 1977) primarily as an acclimation facility and secondarily as a nursery system for sugpo fry. The rectangular nylon net (Fig. IA) is similar to an inverted mosquito net set in a pond. It is suspended from bamboo or wooden poles and sometimes enclosed with bamboo screen to protect it from crabs. It is normally installed near the supply gate for better water exchange.

The floating cage as a nursery facility (Fig. 1B) is a recent development initiated by de la Peña and Prospero (1982) at AQD's Batan Station. The floating cage is appropriate in coves with slow currents, protected from big waves, and with minimum fluctuation in salinity, temperature, D.O. and pH. The cage is made of fine mesh net with a coarse outer net or bamboo enclosure for protection. The net is hung on a bamboo or wooden frame provided with floating materials. A 3 x 4 x 1.2 m net cage can accommodate some 25,000 to 30,000 P_4 - P_5 for a rearing period of 30 to 40 days. Feed-

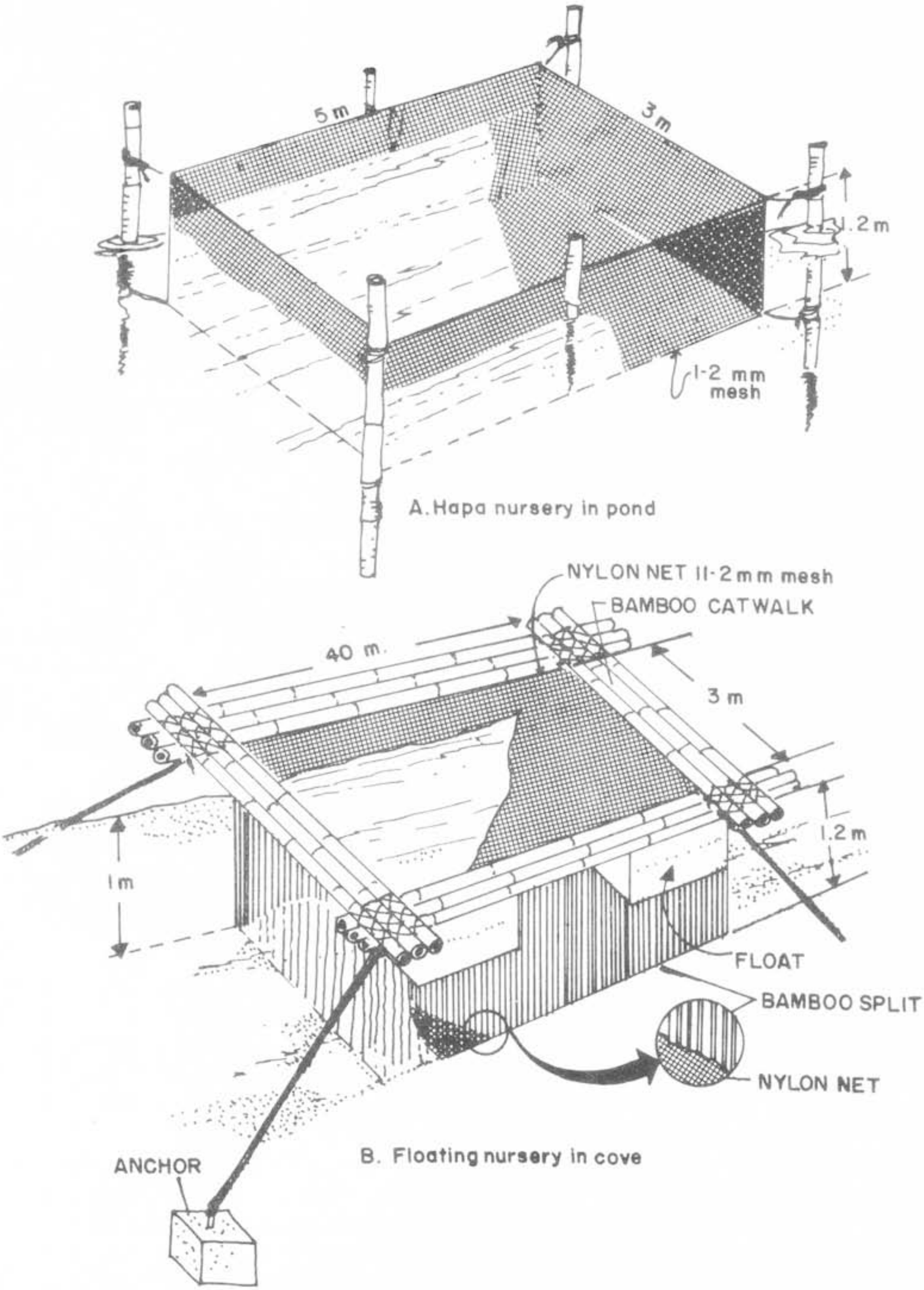

Fig. 1. Floating or hapa net nursery can stock 30,000-40,000 postlarvae/net, is easy to install in a pond (A), or marine cove (B).

ing is done initially by brushing prepared fish paste in a feeding net frame. At the P_4 - P_5 stage, fry tend to cling to any substrate, so that they cling to the feeding frame and feed at the same time. Starting at P_{11}, feeding is shifted to chopped fish or mussel meat attached to a series of hooks hanging from a floating frame. A survival rate of 50 to 70% can be attained.

(2) ***Earthen nursery system***

The earthen prawn nursery system (Fig. 2) was developed at the SEAFDEC Leganes Research Station (Apud and Sheik 1978) to accommodate hatchery-bred fry even at earlier stages (P_4-P_5) and rear them to desirable sizes (0.4-1 g) or stages (P34-P35) suitable for stocking in grow-out ponds. Management of the system aims at controlling excessive fluctuations in temperature, salinity dissolved oxygen, and pH and having a maximum control of pests and predators. These are achieved through a flow-through system with a daily water exchange rate of about 10% and the use of sand filter or fine mesh filter net for water flowing into the ponds.

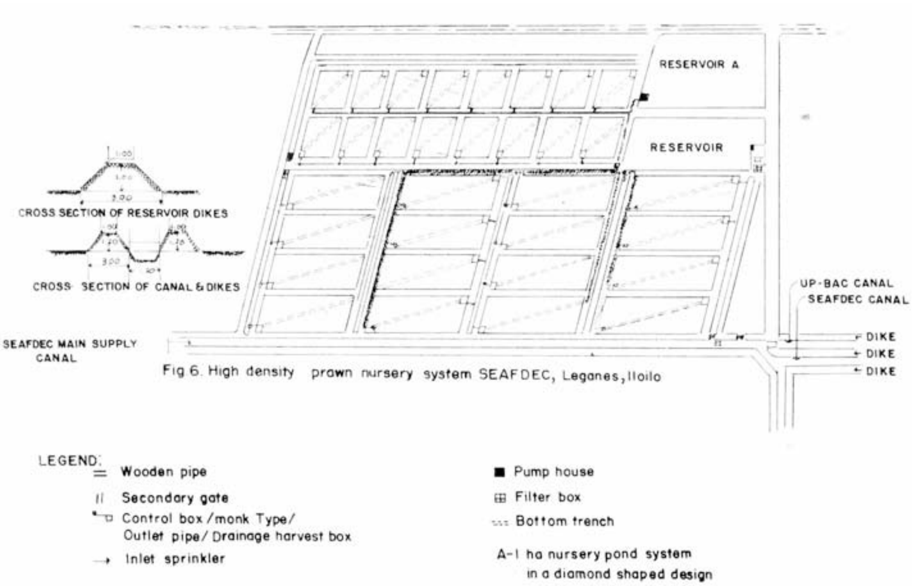

Fig. 2. High density prawn nursery system SEAFDEC, Leganes, Iloilo.

The nursery ponds may be stocked at densities of 50 to 100 per m^2 without supplementary feeding. With supplementary feeding (trash fish, mussel meat, or formulated feeds) the density can be as high as 150 to 200 P_5 per m^2. Acclimation of prawn fry to pond water conditions is necessary during stocking. The proper time for stocking is early in the morning (before 9:00 A.M.) or late in the evening (after 9:00 P.M.). Juveniles at stages

P_{34} - P_{35} weighing about 0.4-1.5 g a piece are harvested after 30 days rearing period. The recommended time of the day for harvest is during the evening or early morning. Survival rates may range from 40 to 80% .

(3) *Tanks or raceways*

Tanks or raceways are practicable in areas with available electric power to drive water pump and blower that provides aeration. The raceway system was tried by Platon (1978) in rearing P_1 - P_2 fry to P_{13}. The raceway is a 1-2 ton oval tank with airlift aeration to circulate the water. Bamboo mattings to serve as shelter are also provided. At stocking density of 5,000/m^3, an average survival rate of 50% is obtained. The fry is fully dependent on supplemental feed.

The use of nursery tanks integrated in hatchery system was initiated by Gabasa (1981). Tanks are usually of concrete and vary in size from 3 to 40 tons. Stocking densities vary from 2,500 to 3,000 per ton with culture period of 30 days from P_1 - P_2 or P_4 - P_5. The tanks are provided with bamboo mattings as shelter. Fry survival has been very much improved (70-90%) with this system. The fry in tanks are highly dependent on supplementary feeding although growth of diatoms is also encouraged.

(4) *Transport of juveniles*

Prawn juveniles harvested from any of the facilities mentioned above may be transported using a continuously aerated transport tank or oxygenated plastic bags. The aerated tank is made of a cylindrical fiber glass, plastic or canvass. The recommended capacity is 30 kg juveniles/ton of water (Mochizuki 1978). For better results, the temperature of transport water is reduced to 22-24 C and maintained at this temperature by adding ice from time to time.

For transport using oxygenated plastic bags, the juveniles are climated gradually to about 20 C using ice mixed with seawater. The temperature of sand-filtered seawater to be used for transport is also reduced to 20°C. The juveniles are packed in plastic bags containing 8-10 liters seawater inflated with oxygen at recommended densities of 1,000 to 2,000 P_{25} - P_{35} per plastic bag. The bags are placed singly or doubly in styrofoam boxes. To maintain temperature at the desired level, packed ice weighing 500 to 600 g is placed on top of each plastic bag.

Yap ***et al*** (1978) tried using different packing densities of juveniles transported in oxygenated plastic bags for a period of 15 hours. The density levels tested were 1,000; 2,000; 3,000; 4,000; and 5,000 P_{26} per bag. A pack of 600 g ice was placed on top of each bag; 400 mg prawns could be packed and transported as much as 3,000/bag for 15 hours. The temperature of transport was maintained at 22-23 C and survival was 95-100% . Packing densities of .4,000 to 5,000 suffered higher mortalities (from 12.5 - 50%). The latter densities could be used only for shorter transport periods.

b. **Culture in Growout Ponds**

The pond culture of ***sugpo*** in the Philippines has evolved slowly through years of experience by fishfarmers. For many years, ***sugpo*** was an incidental harvest from milkfish ponds. Because of the ever increasing demand, more efforts have been directed to develop ***sugpo*** as a major crop in brackishwater ponds. In the process of development, several factors that influence prawn production have been pointed out. These include site suitability, pond design and construction, seed supply, pest and predator control, stocking densities, food supply, diseases and parasites, water management, and harvesting.

(1) Site Suitability

The major factors known to influence prawn production in certain areas include climatic condition, water supply, type of soil, topography, accessibility, availability of labor and material inputs, and support facilities. Better production has been observed in areas with a short and not-so-pronounced dry season with moderate rainfall distributed almost throughout the year. Suitable areas are those having sufficient supply of water that is free from pollutants and with a salinity of 10-20 ppt and those with soil pH between 7-8.5, of either the clay-loam type of soil, silty clay, silt loam that is good for dike construction, or sandy clay that suits the creeping and burrowing habit of ***sugpo***. Pond elevations are within the reach of ordinary high tides where a water depth of 1 meter can be easily attained. Areas with high elevation require considerable expense for excavation or water pumpings. Accessible areas facilitate supervision and delivery of inputs and products. The presence of support facilities such as electric power plant and ice plant would be advantageous.

(2) Design and Construction

The lack of basic knowledge in pond engineering among fishfarmers has impaired prawn production. Generally, farmers utilize fishponds designed for milkfish production which are often unsuitable for prawn production. Pond construction in the Philippines is normally carried out without an engineering plan. Prospected areas are merely cleared and enclosed with peripheral dikes. The division dikes, canal system, and gates are laid out according to the farmer's and his workers' convenience. Fishponds usually turn out to have big and irregular compartments with the canal and gate systems improperly located and constructed, and the desired depth never achieved. Even milkfish production fails due to problems brought about by poor design and construction.

The SEAFDEC Aquaculture Department has come up with a design and layout appropriate for semi-intensive culture of prawn (Fig. 3). Salient features of this design include:

- two canal and gate systems, (the drain canal and gate are from the supply canal and supply gate).

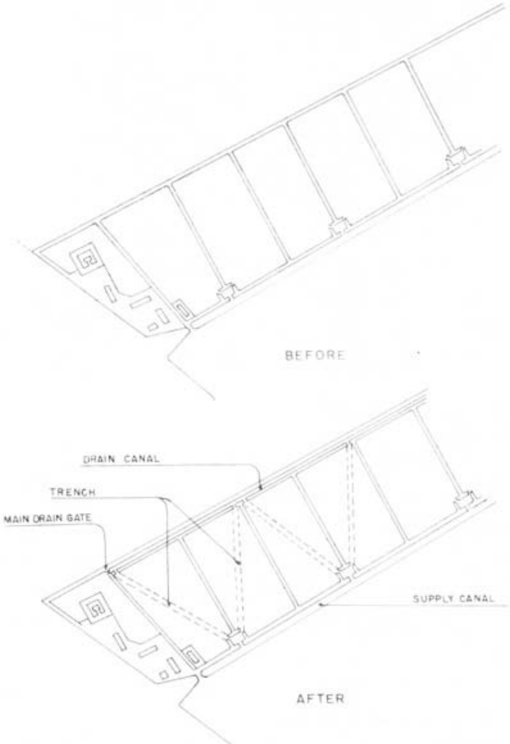

Fig. 3. Milkfish ponds renovated into prawn semi-intensive culture ponds at LRS SEAFDEC AQD. (After Torres 1983)

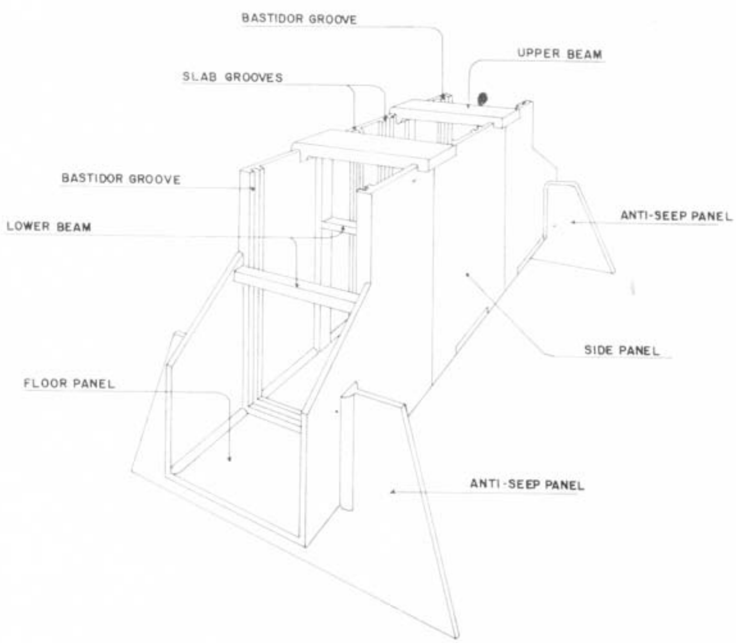

Fig. 4. Ferrocement sluice gate at LRS SEAFDEC AQD. (After Torres 1983)

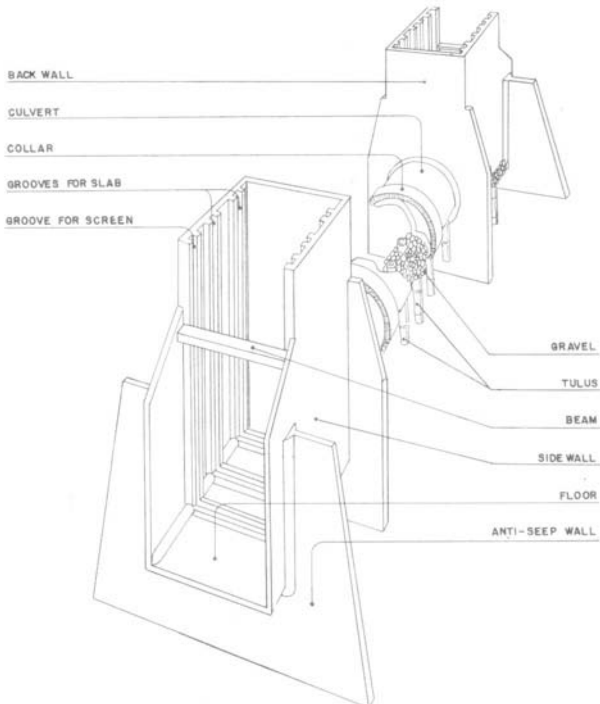

Fig. S. Ferrocement culvert gate at LRS SEAFDEC AQD. (After Torres 1983)

Various gate systems have been developed to suit the requirements of pond systems. The monk type culvert and open sluice gates made of ferrocement materials were introduced (Fig. 4 and 5). These gates are cheaper and more convenient to construct and install. They are normally pre-fabricated at a desired mold before transport to the site and installation. They are effective as tertiary and secondary gates. The use of PVC pipes or elbow standpipe gate systems has been also introduced and is effective in smaller ponds such as nursery ponds (Fig. 6).

In extensive culture method where ponds are dependent on tidal fluctuation and where prawns subsist mainly on natural food propagated by fertilization, it is appropriate to develop a progressive method of culture where stock can be transferred from one pond to another when they grow to a certain size. The layout of the ponds can be so arranged as to enable a series of transfers from nursery to transition to growout pond. The ponds should be adjacent to each other to facilitate transfer. Pond sizes should be progressively increased by 1:2:4 ratio to provide a bigger space for the growing prawns. This idea emanated from various research results at SEAFDEC Leganes Research Station where growth rates of ***P. monodon*** were observed to level off after two months of culture in the same pond. This observation has been confirmed by private operators especially those with stocks dependent on natural food.

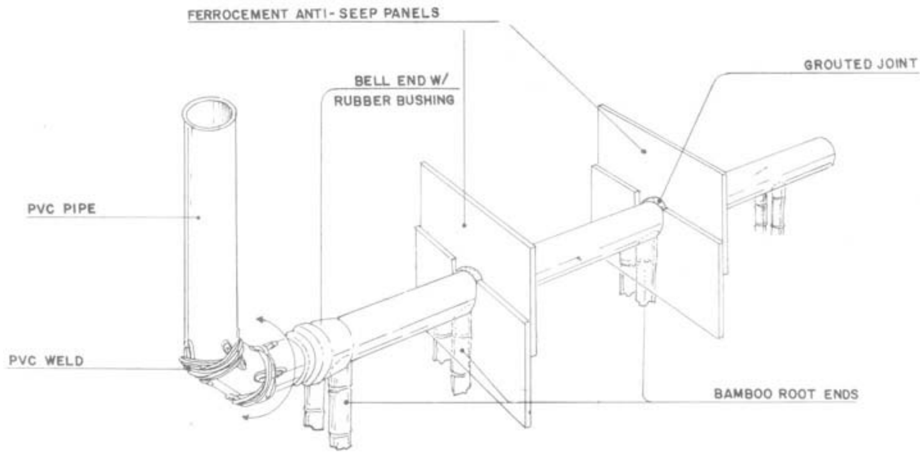

Fig. 6. PVC stand pipe at LRS SEAFDEC AQD. (After Torres 1983)

(3) Seed Supply

Seed supply, handling, storage and transport problems have also affected the development of the industry. Seed coming from the wild initially dominated supply for pond culture. The fry are either allowed to enter the pond during high tide or are collected from fry grounds along the shores and estuaries. Since the occurrence of wild fry is seasonal and the quantity is unreliable, cropping becomes irregular and unpredictable. In addition, identifying and separating the mixed collection of penaeid fry also discourage both collectors and farmers. This problem is aggravated by heavy mortalities, as high as 90%, encountered during handling, storage and transport due to lack of skill and technical knowhow.

The development of hatchery techniques gave an alternative and more reliable source of seed supply for pond culture. Despite uncertainties and failures encountered by hatchery operators and fishfarmers during the first few years, more and more hatcheries have been established and more fishfarmers have shifted to hatchery bred fry. The development of improved techniques in handling and transport of fry at SEAFDEC Aquaculture Department has considerably reduced mortalities.

(4) Pest and Predator Control

The entry of unwanted species is a common problem in pond culture. The damage wrought by pests and predators varies widely depending on the species present in the pond. ***Lates calcarifer (bulgan). Megalops cyprinoides (buan-buan), Elops hawaiiensis (bid-bid)*** are among the most harmful predators in ponds. Other pests and predators include tilapia, gobies, snails, small crabs, water snakes and birds. The modular pond method for milkfish culture has minimized this problem to some extent due to frequent transfer and cleaning of ponds (Abesamis 1980, pers. comm.).

Traditionally, pests and predators are eliminated during pond preparation by the use of inorganic pesticides or insecticides. Since most of these compounds are non-biodegradable, they are known to have a cumulative harmful effect to the pond and to the stock itself. Because of this, researchers have warned fishpond operators of the indiscriminate use of pesticides. Organic pesticides such as tobacco waste and derris root may be utilized instead.

Tobacco dust or waste at 280480 kg/ha or commercial nicotine at 12-15 kg/ha was found effective in eliminating snails (Primavera and Apud 1977). This material also keeps the soil soft and moist. Derris root or tubli, ***Derris elliptica, D. heptaphylls,*** and ***D. philippinassis*** can also be applied at 5-10 ppm in its dried powdered form or as juice extract from 2040 kg raw material per ha. Juice is extracted by pounding and soaking the plant overnight in water and then squeezing it to release the juice.

The bleaching compound sodium hypochlorite (under different brand names like clorox, purex or dulux), at a dose of 20 liters/ha with the water 2 cm deep, can effectively eradicate tilapia and other finfishes. Commercial lime mixed with ammonium sulphate is also effective in eliminating almost all kinds of unwanted species in ponds. The recommended ratio of application is 1:5 ammonium sulphate and lime applied at about 500-600 kg/ha. Pests and predators are readily killed as ammonia becomes toxic when water pH is raised by lime to a level above 9. The advantage of these materials is that after a few hours, toxicity subsides and stocking can be done the following day after admitting new tidal water. Lime also reduces acidity, hastens organic decomposition, and eliminates sulfides while ammonium sulphate is a nitrogenous fertilizer. In other countries the use of saponin from teaseed cake applied at the rate of 10-25 ppm (Cook 1976) and commercial rotenone powder extracted from derris root are reportedly effective in eliminating unwanted species. Extra care however is needed if these materials are applied in ponds with prawn stock. Thorough drying of pond during preparation also eliminates pests and predatory fishes.

Entry of unwanted species is prevented by the use of appropriate screen during water management. The traditional practice is to use bamboo screens (locally called ***bastidor)*** installed at the pond gate. However, this method is not so effective so that other methods have been tried. One of this is the use of window nylon screens on top of the bamboo screen or the ***bastidor.*** However, this requires continuous brushing during water management as it gets clogged easily. A modification introduced at SEAFDEC is the use of the circular netting *(bulon)* in front of the gate or bagnet made of fine mesh nylon screen (0.2 mm) installed in place of the *bastidor* (Fig. 7).

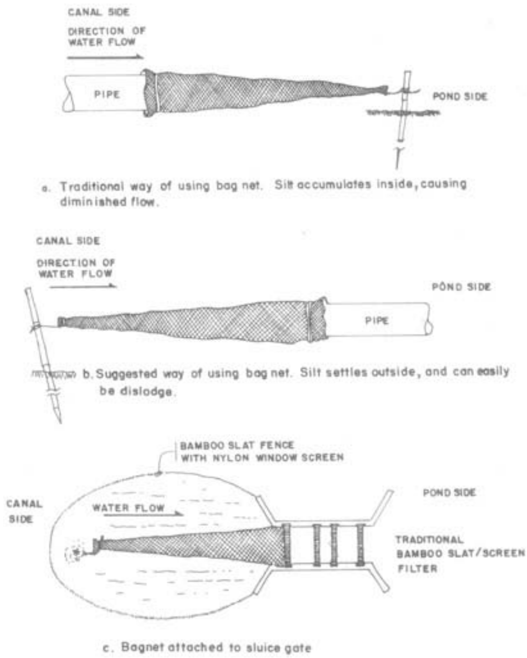

Fig. 7. Different ways of using filter screen and/or bagnet. (After Yap, era/1979)

Stocking Densities

Stocking densities used by fishfarmers in extensive culture method vary from 2,000-6,000/ha with an average of 4,000 ha both in monoculture or in polyculture with milkfish. When natural food is abundant, about 500-2,000 milkfish is added per hectare. The presence of ***sugpo*** at the above density levels together with milkfish was found to be favorable for both species. This was confirmed by results obtained from various studies in a polyculture system of milkfish and ***sugpo*** at Leganes Research Station (Eldani and Primavera 1981; Pudadera 1980; Apud 1981). Eldani and Primavera (1981) pointed out that one of the important benefits of prawn in polyculture with, milkfish is that prawns control the population of chironomid larvae which compete with milkfish for ***lablab***. As a result, growth and production of milkfish in ponds with prawns are higher than those without prawns. Gundermann and Pepper (1977) reported the disappearance of chironomous larvae in Fiji ponds several weeks after stocking with ***P. monodon, P. merguiensis*** and ***P. indicus.***

Stocking densities as high as 10,000-12,000/ha are also practiced by some fishfarmers. These levels require supplementary feeding either during the last two months or last month of culture.

For semi-intensive culture, stocking density may vary from 20,000 to 50,000 individual/ha. These levels were based on the results of various studies on the intensification of prawn grow-out at the SEAFDEC Leganes Research Station (Apud 1978; Destajo 1979; Mochizuki 1979; Norfolk ***et al*** 1980). Apud (1978) observed that survival rates were relatively higher (98.6% and 95.3%) and sizes bigger (23.4 and 18.2 g) in ponds stocked at 25,000 and 50,000/ha as compared with ponds stocked at 100,000 and 200,000/ha (86.4% and 87.6% survival rates and sizes of 11.2 g and 7.3 g, respectively.) The stock was provided with formulated diet in a flow-through system using a water pump within a culture period of 109 days.

(6) Food Supply

The natural food propagated in brackishwater fishponds varies from one pond to another depending upon the pond condition and location. In shallow and higher salinity areas (28 ppt and above) ***lablab*** is dominant over filamentous algae and other higher aquatic plants. In deeper ponds with lower salinity (10-25 ppt) ***Chaetomorpha sp (lumot jusi), Enteromorpha intestinales (bitukang-manok), Rupia maritima (Kusay-kusay),*** and ***Najas graminea (digman)*** are dominant. Diatoms, rotifers, nematodes, ostracod, copepods, and other planktonic organisms good for young ***sugpo*** exist in both environments.

Lablab is composed mainly of benthic blue green algae and diatoms. Many forms of animals and other plants are associated with ***lablab. Lumot, kusay-kusay,*** and ***digman*** are also associated with other organisms that contribute to their nutritive value. The yields of certain ponds dominant with ***kusay-kusay*** and ***digman*** are found to be relatively higher than in the ***lablab*** pond. It is believed that these plants and those organisms associated with them give the appropriate nutritional requirement for prawns. In addition to the shelter effect of these aquatic plants, the higher oxygen production, and the lower salinity for which these forms of plants usually exist also contribute to better prawn production.

Lablab is a natural food preferred by young ***sugpo*** (Villaluz 1953), but its excessive growth can be deleterious once the excess begins to decompose. This retards ***sugpo*** growth usually after the second month of culture.

Marte (1978) identified Crustacea (small crabs and shrimps) and mollusks making up 85% of the ingested food of ***P. monodon*** caught in the wild (Makato River, Aklan). The remaining 15% consisted of fish, polychaetes, ophiuroids, debris, sand, and silt. She noted that feeding activity was high during ebb tide when tidal current brought in a greater volume of food at estuaries and mouth of rivers.

Although the stock in an extensive culture method is mainly dependent on natural food grown in ponds, some farmers provide various kinds of supplementary feeds every now and then depending upon their availability. The most common feeds given are rice bran, trash fish, chicken entrails, cattle hide, mussel meat, toads, and snails.

Studies relating to nutrition have been undertaken at SEAFDEC AQD to gather information regarding the nutritional requirements of ***P. monodon.*** Pond studies using SEAFDEC and commercial diets for semi-intensive culture method include those of Apud 1978; Destajo 1979; Mochizuki 1970; Norfolk 1980; Suemitsu 1981; Tabbu 1982. Despite some encouraging results of these studies the appropriate local commercial feed and feeding techniques are yet to be established. Both researchers and fishfarmers agree that one of the keys to the success of pond culture is food. The economics of feeding should also be looked into. A certain high grade formulated diet with some imported ingredients was found to be efficient with an FCR of 1.5 to 1.7 but costs more than twice that of other commercial products. Research aimed at finding local substitutes with comparable efficiency for less cost must be pursued.

(7) Water Management

Water management in the extensive method of prawn farming is an adaptation of that used in milkfish culture. It is totally dependent on tidal fluctuation. During spring tide, water is replenished by draining a portion of the pond water a few hours before the incoming high tide. At high tide, fresh tidal water is admitted. These activities of draining and flooding are done consecutively everyday during the entire spring tide period. Normally, the first 2 to 3 days are devoted to draining and flooding; in the succeeding days, draining is stopped but flooding is continued until water requirement is satisfied (Primavera and Apud 1977).

For semi-intensive culture water management is a combination of both tidal fluctuation and water pump support. During the first two months of culture, the pond water is replenished during spring tides. This is easily achieved in areas with lower elevations. However, pumping is necessary during neap tides particularly in areas with higher elevations to maintain desired water quality and depth. The accumulation of metabolites at the pond bottom lowers water quality. Organic decomposition depletes dissolved oxygen (to levels below 3 ppm) and prawns cease to eat. Feed thrown into the pond under this condition will only add to pollution.

(8) Diseases and Parasites

Only a few cases of disease problems in ponds have been reported with the extensive method of culture. Among those observed are the "black gill" disease which may be caused by fungus, bacteria or detritus. Necrosis of appendages, which at earlier stages results in browning of the exoskeleton, pleopods, periopods, telson/uropods, spreads towards the base of appendages and leads to erosion of infected areas. The etiology of this disease in ***P. monodon*** has not yet been worked out according to Gacutan (1979). However, shell disease of this nature as in other penaeids can be caused by bacteria such as ***Chitinoclastic, Benechea, Vibrio,*** and ***Pseudomonas*** (Cook and Lofton 1973, as cited by Gacutan 1979). Progressive destruction of the exoskeleton provides places for the entry of secondary infections which may cause death.

Body cramp is another problem which can cause high mortality. This is usually encountered during handling, transfer or harvesting on hot days. The body of cramped shrimp curves and becomes rigid. The cause of this is unknown but according to Liao (1977) this can be avoided by handling shrimps during cool days. Fuzzy growth on the exoskeleton is another disease which can be caused by bacteria, protozoans, or algae. The first two are associated with poor water quality due to high organic matter content. Growth is retarded and molting is inhibited by this fuzzy growth.

The most common complaint of fishfarmers is the occurrence of soft-shelling. In this condition prawns are weak and molting is inhibited so that they stop growing. This disease may be attributed to poor nutrition and poor pond condition. Baticados (pers. comm.) attributed soft shelling to different factors such as microbial, environmental, and nutritional deficiency. She also believes this could be caused by trace amounts of insecticides coming from agricultural areas. This belief is supported by observations that soft shelled prawns are common in areas contaminated with runoffs from rice fields using insecticides. Investigation is being undertaken by SEAFDEC researchers to confirm the hypothesized causes.

(9) Harvesting

In the extensive culture method, harvest takes place after 4 to 6 months culture in ponds. The prawns may attain 20-60 g depending on the salinity, stocking density, feed and water management.

Harvest may be done through different methods depending on whether a partial or a total harvest is desired. Partial harvest may be done with the use of bamboo traps (***bakikong***), pound nets (for selective partial harvest Fig. 8) or cast nets. With traps or pound nets, it is advisable to partially drain water at daytime and re-admit water in the evening to make the prawns move around. This is most effective during spring tide of the new moon. Prawns can be lured into the traps by placing lights over them in the evening. Cast net operation can be efficiently done by placing feed in certain area to gather the prawns before casting the net.

Total harvest is commonly done with the use of a bagnet (***lumpot***) placed at the sluice gate. Just like ***bakikong,*** the pond water is partially drained at daytime and new water admitted to get the prawns moving around. In the evening, the bagnet is installed at the discharge portion of the gate after which the gate is opened. The bagnet must be long enough (8-10m) to make emptying easy. The common practice is to accumulate a big volume in the bagnet before emptying if in big baskets or pails. This lowers the quality of the harvest as the prawns are subjected to too much pressure. A technique of emptying the catch every now and then at limited quantities of about 10 kg to appropriate net bags was introduced recently. The same net bag container is used in washing and immersing the catch in ice water.

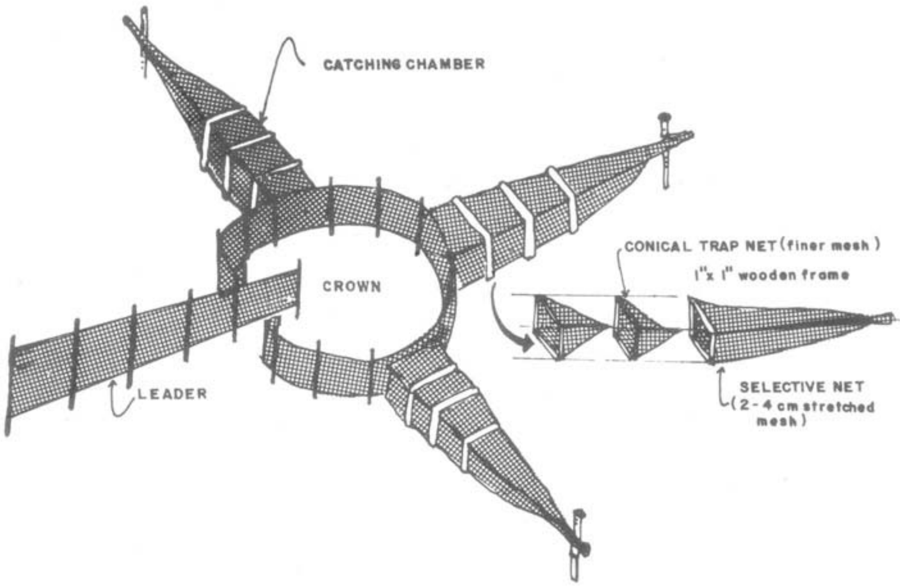

Fig. 8. The selective harvesting net collects only large animals undersized prawns can return to the pond. (After Suemitsu, 1983 and Apud, *et al*. 1983)

Another method applicable for total harvest after some partial harvesting is by the gradual draining of the pond to concentrate the prawns in the pond canals or catching pond. Once the prawns are impounded, a drag net is used to collect them. A bamboo screen can be pushed around the peripheral canal to gather the shrimp in a restricted area where they can be caught with a scoop net.

Some farmers build large barnboo traps in the outlet canal outside the drain gate. As the pond is drained and the gate opened, prawns are carried into the canal and down into the traps. Remaining prawns are picked up after all the water has been drained from the pond.

REFERENCES

Apud, F.D. 1979. Effects of water movement and aeration system on the survival and growth of hatchery-bred sugpo (*P. monodon*) fry reared in earthen nursery ponds. U.P. Visayas, Iloilo, Phils., M.S. thesis (unpublished).

____________1982. Handling and rearing of hatchery produced shrimp postlarvae from small scale hatcheries. FAO/UNDP-SCS, WP/81/SPH/CP 12, 87-93.

Apud, F.D., J.H. Primavera and P.L. Torres, Jr. 1983. Farming of prawns and shrimps. Aqua. Ext. Manual No. 5 Revised 1983. SEAFDEC Aquaculture Department.

Apud, F.D., K. Gonzales and N. Deatras. 1981. Survival, growth and production of *Penaeus monodon* Fab. at different stocking densities in the earthen ponds with flow through system and supplemental feeding. Fish. Res. J. Phils. 6:1-9.

Apud, F.D. and M. Sheik. 1978. Design and construction of prawn nursery pond system. Readings on Pond Management. SEAFDEC Aquaculture Dept.

Apud, F.D., N. Deatras and K. Gonzales. 1981. Feeding behavior and food preference of *Penaeus monodon* Fab. with scrap *Tilapia mossambica.* Fish. Res. J. Phils. 6:27-31.

Caces-Borja, P. and S.B. Rasalan. 1968. A review of the culture of sugpo, *Penaeus monodon* Fabricius in the Philippines. Rome FAO, 2:111-123.

Cook, H.L. 1977. Some aspects of shrimp culture research with particular reference to Philippine species. Fish Res. J. Phils., 2:50-53.

Delmendo, M.N. and N.R. Rabanal. 1955. Rate of growth of the sugpo (jumbo tiger shrimp) *Penaeus monodon* Fab. with notes on its culture in brackishwater ponds. Proc. 2nd Indo-Pacific Coun., 6:424-431.

Delmendo, M.N. and H.R. Rabanal. 1956. Cultivation of "Sugpo" (Jumbo Tiger Shrimp), *Penaeus monodon* Fabricius in the Philippines. IPFC Proc. 6th Session Section 1:424-481.

Eldani, A. and J.H. Primavera. 1981. Effects of different stocking combinations on growth, production and survival of milkfish (*Chanos chanos* Forskal) and prawn (*Penaeus monodon* Fab.) in polyculture in brackishwater ponds. Aquaculture, 417.

Gabasa, P.G., Jr. 1982. Recent development in design and management of small-scale hatchery for *Penaeus monodon* in the Philippines. FAO/UNDP-SCS, UP/81/SPH/CP 11:77-85.

Gacutan, R.Q. 1979. Diseases of prawns. Brief: Technical Consultation, SEAFDEC Aquaculture Dept. 13 pp.

Liao, L.C. 1977. A culture study on grass prawn, ***Penaeus monodon*** in Taiwan-the pattern, the problems and the prospects. J. Fish. Soc. Taiwan, 5(2): 11.-29.

Marte, C.L. 1978. The food and feeding habit of ***Penaeus monodon*** Fab. collected from Makato River, Aklan, Philippines. SEAFDEC Aquaculture Dept., Quarterly Res. Report Vol. 11, No. 1:9-17.

Mochizuki, H. 1979. The present prawn culture in the Philippines. Terminal Report to Aquaculture Dept., SEAFDEC: 1-60 with 33 figs (memeo).

Norfolk, J.R.W. 1981. The use of ammonium sulfate as a pesticide during pond preparation. Asian Aquaculture, 4:7.

Norfolk, J.R.W., J.N. Paul and D.S. Javellana. 1981. A preliminary report on intensification of prawn grow-out at SEAFDEC Leganes Research Station Perspectives, Problems and Prospects. Unpub. report., 10 pp with 4 figs and 7 tables.

Platon, P.R. 1979. Present status of prawn farming in the Philippines. Brief: Technical consultation. SEAFDEC Aquaculture Dept. 22 pp.

Primavera, J.H. 1976. Survival rates of different ***P. monodon*** postlarval stages reared in hapa nets in brackishwater ponds. Phil. Jour. Sci., 105 (3): 103-109.

Primavera, J.H. and F.D. Apud. 1977. Manual of Operations: Sugpo pond culture. Extension Manual, SEAFDEC Aquaculture Dept., No. 2, 18 pp.

Primavera, J.H., F.D. Apud and C. Usigan. 1976. Effects of different stocking densities on survival and growth of sugpo (***Penaeus monodon*** Fab.) in a milkfish rearing pond. Phil Jour. Sci., 105 (3): 193-203.

Pudadera, B., Jr. 1980. Evaluation of milkfish (***Chanos chanos*** Fors.) and prawn (***Penaeus monodon*** Fab.) in polyculture systems. U.P. Visayas, Iloilo, Phils. M.S. thesis.

Tang, Y.A. 1961. The use of saponin to control predaceous fishes in shrimp ponds. The Prog. Fish Cult., 23(1): 43-65.

Torres, P.L., Jr. 1983. Fishpond design and construction. SEAFDEC Aquaculture Dept. 17 pp + 14 figs and 1 table, (mimeo).

Villadolid, V. and D.K. Villaluz. 1951. The cultivation of sugpo (***Penaeus monodon*** Fab.) in the Phils. Phil Fish. J. 1:155-65.

Villaluz, D.K. 1953. The cultivation of sugpo (***Penaeus monodon*** Fab.) Fish Farming in the Philippines, Bookman, Inc., Manila, 137-148.

Villaluz, D.K., A. Villaluz, B. Ladrera, N. Sheik and A. Gonzaga. 1969. Reproduction, larval development and cultivation of sugpo (*Penaeus monodon* fab.) Phil. Jour. Sci., 98(3 & 4): 205-236.

Yap, W.G., H. Mochizuki and F.D. Apud. 1978. Mass transport of sugpo Penaeus monodon juveniles. Unpub. manuscript.

Yap, W.G., F.D. Apud and J.H. Primavera. 1979. Manual on prawn farming. Aquaculture Extension Manual, SEAFDEC Aquaculture Dept. No. 5:46 pp.