Chapter Four

PRAWN GROW-OUT PRACTICES IN THE PHILIPPINES

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Prawn farming in the Philippines is generally classified into three: extensive, semi-intensive, and intensive (Apud et al 1983, Apud 1985). While intensive farming is gaining rapid development in marginal and elevated areas along the shoreline, extensive and semi-intensive farming is done mainly in former for milkfish culture areas.

Regardless of the type of farming being practiced, most farmers are usually confronted with the problem of standardizing their operation. Production can vary from one crop to another or from one pond to another and even from one individual, site, and/or facility to another. In effect, there is a need to standardize prawn farming practices for consistent reference. Presently, prawn farming is viewed more as an art rather than as exact science.

This paper deals mainly with the state of the art of prawn pond culture, specifically with pond management practices, including site suitability, engineering design, and harvest and post-harvest handling. For added insight, problems and prospects in the industry are briefly discussed with some recommendations.

SITE SUITABILITY

The major environmental factors generally observed to have great influence on prawn production are climatic conditions and water and soil quality. Better production is observed in areas having short and not so pronounced dry season with moderate rainfall distributed almost throughout the year. A pronounced long dry season can affect production because of increasing temperature and salinity. High temperature (31-33°C) and high salinity (28-33 ppt) promote excessive growth of benthic algae in nutrient-rich water. Overgrowth of benthic algae disturbs the ecological pond

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condition by having extreme fluctuations in dissolved oxygen (Subosa, pers. comm.). In daytime, dissolved oxygen is usually high due to rapid photosynthetic activity while from midnight to early morning, oxygen is depleted due to respiration of all plants and animals including plankton (Apud et al 1983).

To remedy the situation, some farmers particularly those engaged in intensive farming select areas with adequate source of good seawater and freshwater quality that can be manipulated to maintain desirable levels of temperature and salinity. Fish farmers are also concerned with water pH. At a reading below 6.5, the condition tends to become acidic; hence, production is poor. At pH 9.0 and above, ammonia in water becomes toxic to animals (Norfolk et al 1981). The water pH is usually influenced by soil pH; hence, knowledgeable fishpond operators avoid areas with potential high acidity.

The bottom elevation easily reached by ordinary high tides is preferred for extensive culture ponds in order to enhance water management by gravity flow. Higher elevation is chosen for intensive and semi-intensive ponds to easily achieve complete draining and better exposure of pond bottom during drying period.

Accessibility of the project to land transport is also preferred by prospective operators to facilitate supervision and transport of input materials and products. Availability of cheap power source and ice is also beneficial to the operation, especially for the intensive culture system.

ENGINEERING DESIGN

Prawn farmers in extensive and semi-intensive culture systems usually utilize ponds originally designed for milkfish culture. Minimal improvements are introduced depending on the existing conditions of milkfish ponds for extensive system, while more improvements are made for semi-intensive culture in terms of depth, and gate and canal system. In contrast, the intensive culture ponds are so designed following the standard requirements in terms of pond elevation, size of compartments, gates and canal system, access road, and provisions for pumps, electrical, and aeration system. A typical design of intensive and semi-intensive culture ponds is shown in Figure 1.

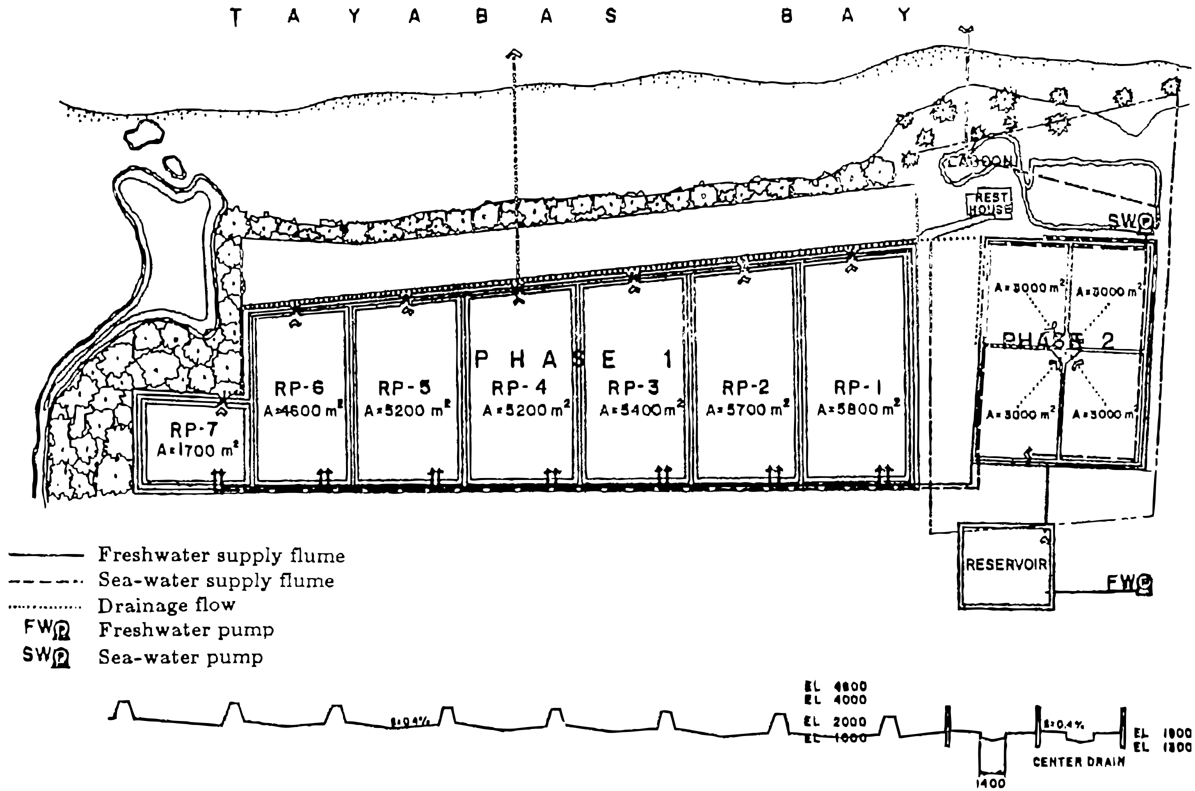

Fig. 1. A typical design of semi-intensive (Phase 1) and intensive (Phase 2) culture ponds (Inland Resources Development Corporation 1988)

The improvements in pond engineering design have contributed a lot to the success of the prawn grow-out operation. An improved design can effectively provide the best environmental conditions for prawns in terms of good water quality through efficient pumps, supply canal, drain canal, water gates, and filtration system at lesser efforts. The design using ferrocement gates (Figure 2) and dikes developed at SEAFDEC Aquaculture Department has reduced cost, minimized routine maintenance work, and provided safety to the stock. Standard shape for intensive ponds is either circular, octagonal, rectangular, or square with a manageable size of no more than 0.7 ha per pond. The pond bottom has a slope of 0.4-0.5 percent from the side towards the center. The circular movement of

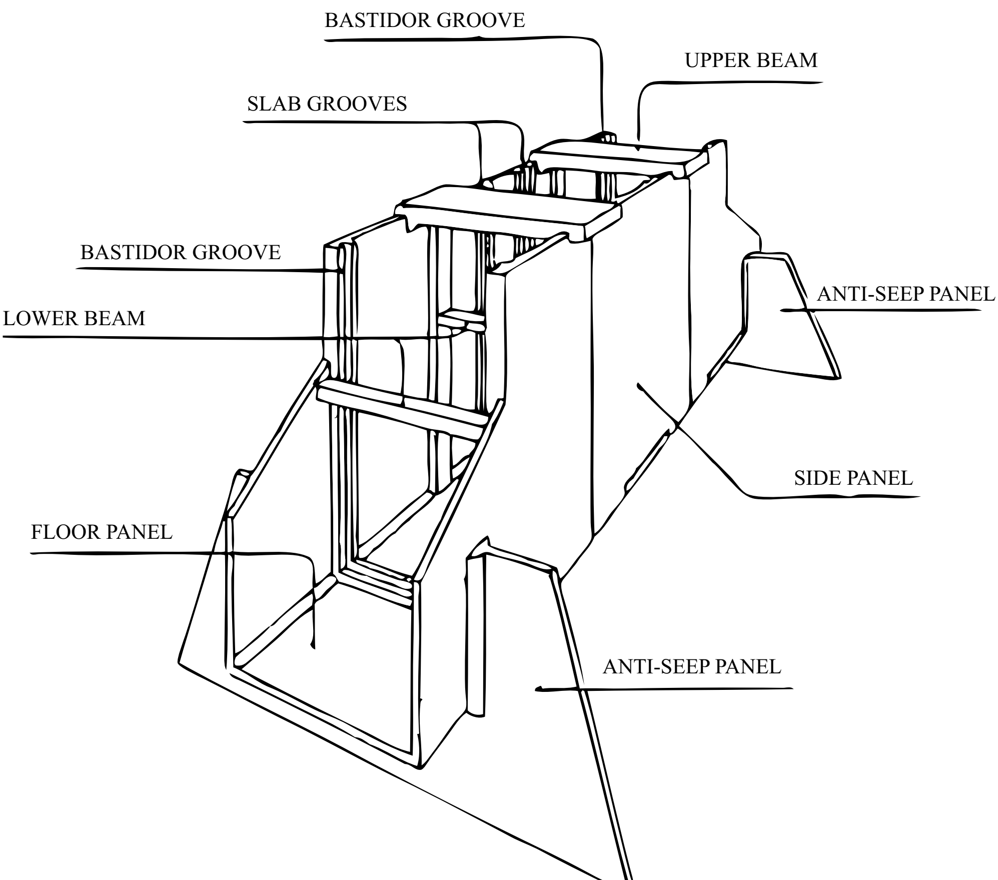

Fig. 2. Ferrocement sluice gate at LRS SEAFDEC AQD (Torres 1983)

water created by paddlewheels concentrates wastes products toward the center drain. These wastes are in turn flushed out daily or every other day as the need arises.

POND MANAGEMENT PRACTICES

Pond management practices among prawn farmers vary according to culture system and style. Some farmers prefer to stock their fry directly in grow-out ponds while others choose to stock them first in a nursery pond, *hapa* nets, or net enclosure. The management practices considered seriously by prawn farmers regardless of the culture system being used are the following: adequate pond preparation, appropriate size of stock and stocking procedure, feed and feeding management, water management, control of pests and predators, harvest and post-harvest procedures, and marketing strategies.

Pond Preparation

Just like in agriculture, farms are adequately and properly prepared prior to planting. Success in rice production, for example, depends on how adequate the paddies are tilled and cleaned. In prawn farms, progressive farmers are very particular with drying of the pond bed. This practice eliminates pests and predators, releases toxic gases, disinfects harmful wastes, and mineralizes part of the organic matter making nutrients available (Apud et al 1983).

Pond conditioning. Most farmers engaged in intensive culture till the pond bed for better sunlight penetration and to loosen the soil. Treatment of lime is also done to sterilize the soil and control diseases and also to neutralize acidic conditions. According to Subosa (1986), lime stimulates the growth of nitrogen-fixing bacteria and other heterotrophic soil organisms, and therefore promotes bacterial breakdown of waste materials including green manure, waste food, and organic fertilizers. It also decreases the concentration of hydrogen ions and solubility of iron, aluminum, and manganese while increasing the availability of phosphates, molybdates, and exchangeable calcium and magnesium. Further, lime generally improves water quality.

Lime requirement is usually based on the pH of the soil. Experience in SEAFDEC AQD's Leganes Research Station and from the industry shows that a newly developed pond with pH of 4-5 may require a sizeable amount of lime to raise its pH to the desirable level of at least 7. For conditioning or prophylactic purposes, a rate of 1-2 tons hydrated lime per ha is applied. Ammonium sulphate (21-0-0) can be added to lime at a ratio of 1:5 in the watered portion of the ponds to eradicate remaining pests and predators during pond preparation (Norfolk et al 1981).

For convenience, some fishpond operators engaged in extensive and semi-intensive culture use certain chemicals to eradicate pests and predators. According to Villaluz et al (1969), this practice should not only be discouraged but totally eliminated in prawn farms to avoid residual effects. The use of organic pesticides such as derris root, teaseed cake, and tobacco dust has been encouraged by SEAFDEC AQD (Apud et al 1983).

Pond fertilization. Fertilization is another standard practice in pond preparation particularly for extensive and semi-intensive culture systems. Prawn farmers normally apply organic manure at 1-2 tons per ha. Usually inorganic fertilizers such as ammonium phosphate (16-20-0) and urea (46-0-0) at 75-150 and 25-50 kg per ha are added to enhance the growth of natural food.

This application is not needed for intensive culture except when there is very poor growth of plankton during initial cropping. Subosa (1986) has demonstrated the feasibility of producing prawn stocked at 7500 per ha reaching marketable size in 120 days through fertilization of organic manure and inorganic fertilizers at 1 ton chicken manure and 15 kg N + 30 kg P, respectively, per ha. The above amount was divided into eight equal parts and applied at two-week intervals starting two weeks before stocking until two weeks before harvest.

Gate screen or filter system. Proper screening or water filtration is one pond management practice that has been improved recently. Traditionally, the gate screen as utilized in milkfish ponds is made of bamboo slats with wooden frames. This allows a lot of unwanted species to enter the pond at egg or larval stages which in due time compete with cultured species. A modification was made earlier by placing a finer nylon screen over the bamboo slats. Although this was helpful, the flow of water was very much interrupted. To improve the situation, the use of circular screening or "bulon" and bag net or "lumpot" was developed at SEAFDEC AQD (Primavera and Apud 1977). Eventually the use has spread among prawn farmers particularly those who are engaged in extensive and semi-intensive culture.

The filtration system for intensive culture is more effective and varies from one farm to another. The common practice is to use a fine bag net at the discharge or a series of screens at the concrete supply canal. Screening materials vary from the locally made to the expensive imported ones. These are usually made of strong materials with varying mesh sizes. A number of intensive farms in Negros are using imported perforated stainless sheets in the supply canal. This is quite expensive but durable and effective in preventing entrance of unwanted species.

Fry Stages at Stocking, Stocking Density, and Stocking Procedures

With the proliferation of hatcheries all over the country, a grow-out pond operator can avail of good quality fry throughout most of the year. Stages of fry usually produced in the hatchery range from PL_4 to PL_{25}. Fry gathered from the wild may range from PL_{15} to PL_{30}. Regardless of source, prawn operators prefer older stages of fry for stocking in grow-out ponds. Ideally PL_{30} to PL_{35} give good results. The demand for older stages of fry has paved the way for a series of studies on the development of the nursery system (Apud and Sheik 1978, Cholik 1978, Apud 1979, Fernandez 1979, and Gabasa 1982).

Development of nursery system. Work on nursery systems was mainly concentrated on earthen nursery ponds except that of Gabasa (1982) who developed the tank system attached to the hatchery tank system. In 1983, the floating cage nursery system (Figure 3) was developed at SEAFDEC AQD Batan Station (De la Pena and Prospero 1984). The common objective of most studies on the nursery system is to be able to produce juvenile stages (PL_{30} to PL_{35}) suitable for stocking in grow-out ponds from the earlier stages of PL_4 to PL_{10}. In due time, nursery techniques spread to the private sector. A number of investors in Roxas City put up nurseries to accommodate earlier stages of

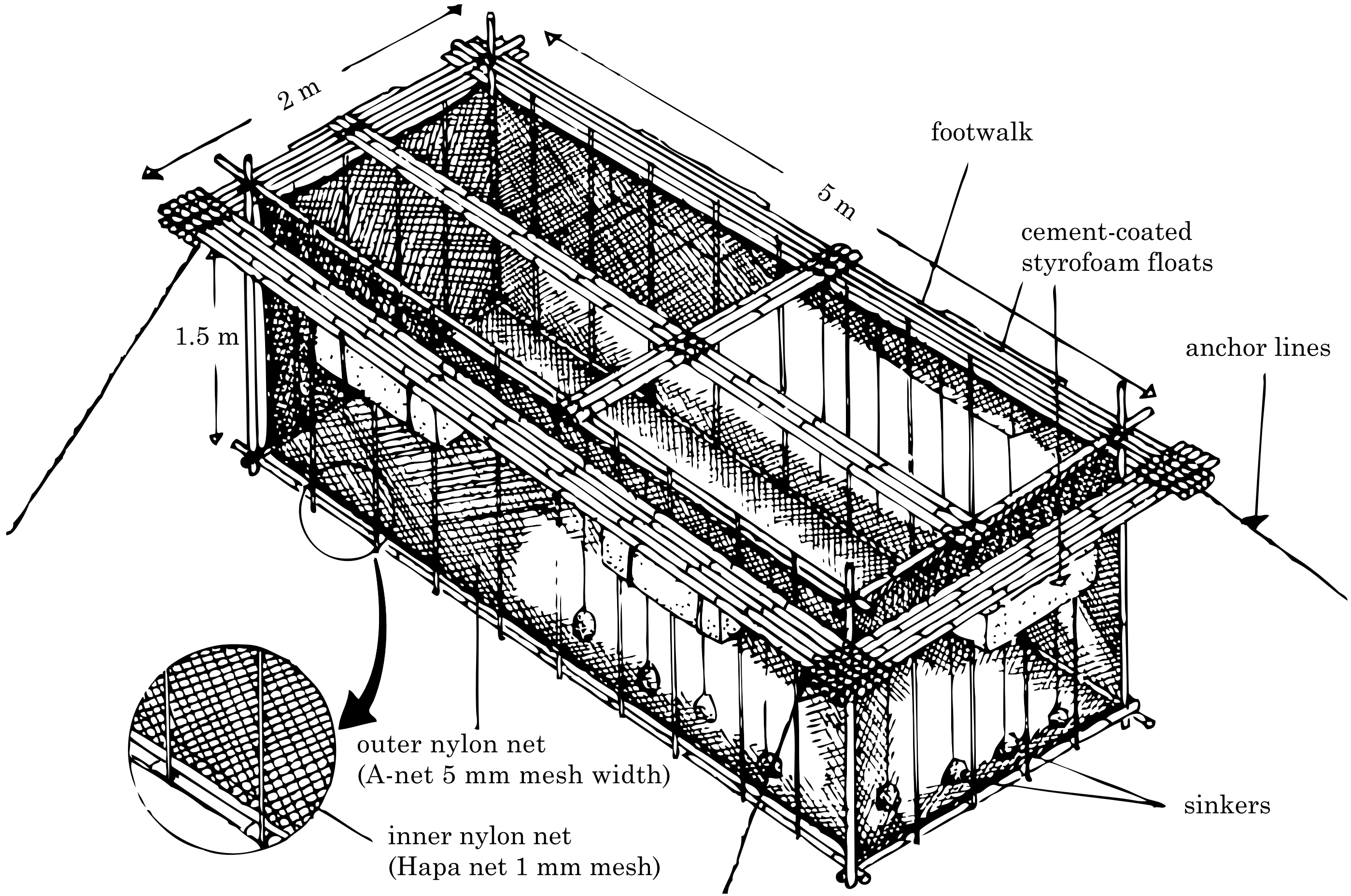

Fig. 3. Full view of a floating nursery cage with bamboo cage frame, floats, netting materials (de la Pena et al 1985)

fry they bought from hatchery operators which they later sold at juvenile stage to grow-out pond operators. Some hatcheries provide their own nursery system.

To reduce costs, some grow-out operators develop their own nursery or provide a net enclosure right in the grow-out pond where the fry are intended to be stocked.

Juveniles reared in a nursery pond or in a net enclosure adjacent to or within the grow-out pond area are merely transferred or released without acclimation. Tank-reared juveniles or fry from the wild may require acclimation to pond conditions. Failure to gradually adjust salinity and temperature of transport water to that of the pond water during stocking can result in high mortality. Some traditional farmers do not even care to know the salinity and temperature of transport and pond water. At present, prawn farmers are very particular with the salinity level of the fry source. If it differs from their pond salinity, they request the hatchery or nursery source to adjust the salinity of the transport water to that of their pond.

Stocking density. Stocking density is dependent on the culture system including food availability, water depth, and efficiency in water management. Fish farmers engaged in extensive operations stock 2 000-10 000 *P. monodon* per ha. When natural food is abundant, about 500-2 000 milkfish fingerlings per ha are added. Combining prawn with milkfish is favorable to both species. Results obtained from various studies on the polyculture of milkfish and prawn (Pudadera 1980, Eldani and Primavera 1981, Apud et al 1983) confirmed some beneficial effects. Eldani and Primavera (1981) specifically pointed out that one of the important benefits of prawn in polyculture with milkfish is the control of the population of chironomid larvae. These can occur at very high density (40 000-50 000 per sq m) during certain periods and compete with favored stock for food, oxygen and space. Gundermann and Popper (1977) reported the disappearance of *Chironomous* larvae in Fiji ponds several weeks after stocking with *P. merguiensis* and *P. indicus.*

Stocking densities in semi-intensive operations vary from 20 000 to 80 000 per ha. These density levels are based on industry experience and the results of various studies on prawn grow-out conducted at SEAFDEC AQD Leganes Research Station (Mochizuki 1979, Apud et al 1981, Norfolk et al 1981, Pascual, pers. comm., Corre, pers. comm.). At these density levels and industry experience, a survival rate of 60-80% and average body weight of 33-43 g are normally achieved in 120-135 days. Growth is highly dependent on water management and depth as well as on quality of supplementary feed or formulated diet. Stocking densities for intensive systems range from 100 000 to 400 000 per ha with the optimum of 150 000-250 000 per ha as practiced by most intensive growers. Survivals vary from 60 to 80% and average size from 28 to 38 g at a culture period of 120-135 days. Table 1 shows the different density levels and expected ranges in yield per ha per crop.

Table 1. Different density levels for *P. monodon* and expected yield per hectare per crop

Density levels (pcs/ha)	Yield/ha/crop (kg)
2 000 - 7 500	50 - 200
10 000 - 15 000	250 - 350
20 000 - 30 000	400 - 700
40 000 - 50 000	750 - 1 200
60 000 - 80 000	1 300 - 2 500
100 000 - 120 000	2 500 - 3 500
150 000 - 250 000	4 000 - 7 000
300 000 - 400 000	7 500 - 12 000

Fry transport and stocking. The proper time for transport and stocking is also keenly observed by grow-out pond operators. To ensure best results, harvest and transport of fry are done at the earliest possible time so that these should reach the pond before sunrise. Stocking including acclimation should be finished not later than 0900 h. Transport of fry is conveniently done with the use of oxygenated plastic bags. The bags are placed inside styrofoam boxes or "pandan" bags. Older or bigger fry are transported in aerated tanks. In both cases ice is used to reduce and maintain temperature at water at 20-22°C during transport period.

In order not to delay stocking, counting of fry is done at the source. This will also eliminate stress at the pond site where facilities are not as good as in hatcheries. Acclimation can be done by first allowing the oxygenated bags to float in the pond. When temperature of transport and pond water equilibrates, the bags are opened one by one and pond water is added gradually to adjust salinity. When fry are observed to start moving, the mouth of the bag is dipped and the fry are allowed to swim against the water. The adjustment of salinity by about 2 ppt per hour is advisable. For best results, fry are distributed throughout the area when released into the pond.

Feed and Feeding

Extensive farming of prawn relies heavily on natural food grown in the pond. Supplementary feeds are provided only occasionally when natural food production is low and stocking density is higher than 7 500 *P. monodon* per ha. In contrast, densities ranging from 20 000-80 000 per ha in semi-intensive culture require regular supplementary feeding in addition to natural food, while formulated diet is regularly provided 3-6 times per day in intensive farming.

Natural food and supplementary feed. The natural food growing in the pond varies according to pond condition and location. Extensive culture as practiced in Northern Panay, parts of Bataan, Bulacan, Pangasinan, Samar, Leyte, and some areas in Mindanao depends to a great extent on aquatic plants. The two most important species are *Najas graminea* and *Ruppia maritima.* Both plants normally occur in lower-salinity (10-20 ppt) areas. *R. maritima* has a crude protein content of 15% (Apud et al 1983). Both grow well in water 50-100 cm deep. Prawns graze on the soft parts of the plants associated with small animals and particularly on the decaying remains of the plants in the pond bottom (Primavera and Gacutan 1985). The plants likewise provide shelter or substrate and improve water quality as silt and other particles are deposited on their leaves and stems.

Filamentous green algae such as *Chaetomorpha* constitute another food item grown by some farmers in low-salinity areas. They also provide a refuge for small animals eaten by prawns, however, excessive growth can be harmful by entangling the fry.

Some farmers remedy the situation by stocking milkfish or applying inorganic fertilizers on the algal mats to soften the plants through plasmolysis.

Plankton, the microscopic plants and animals suspended in water, form the base of the food chain. Deep ponds of low to medium salinity (10-25 ppt) are conducive to plankton growth. Plankton bloom is detrimental as it can deplete oxygen early in the morning through respiration. On the other hand, moderate growth, particularly of zooplankton, can be beneficial as these are grazers of phytoplankton.

A microbenthic complex consisting of blue-green algae, diatoms, and other microscopic plants and animals known as *lablab* is a nutritious food for milkfish and young prawns. The environmental conditions under which it grows best (shallow water, 20-25 cm depth, and higher salinity of 28 ppt and above) are not suitable for prawn. Its excessive growth also depletes oxygen and deteriorates the pond bottom by producing ammonia and hydrogen sulfides during the decomposition process.

Although the "stock" in extensive culture depend heavily on natural food, some farmers provide various kinds of supplementary feed, such as trash fish, mussel meat, toads, chicken entrails, cattle hide, snails, etc. In semi-intensive culture, processed feeds (formulated diet) and/or trash fish are stored to provide adequate and ready supply of feeds.

Formulated diet. Formulated diets in pelleted form are mainly utilized in intensive and semi-intensive culture systems. The daily recommended rates which decrease with time are 12-13% of estimated total biomass of prawns. The daily ration is initially given twice a day, 40% in the morning and 60% in the afternoon during the first month. In the second month, feed is given three to four times a day; third and fourth months, five times a day. The earliest time the technicians start feeding is 0600 h and the latest is 0100 h. The percentage or amount given per feeding time depends upon the physico-chemical condition of the water and the response of the prawn to the feed at certain periods. Close monitoring of feed consumption, prawn population, molting, health condition, and average body weight including the physico-chemical parameters is beneficial for good feeding management. A typical example of determining the daily feed ration (DFR), total feed requirement (TFR), and projected feed conversion (PFC) is shown in Table 2.

A standard feeding time, feeding frequency, feed distribution and recommended feeding rates (FR) are shown in Table 3.

Table 2. A typical example of determining daily feed ration (DFR), total feed requirement (TFR), and projected feed conversion ratio (FCR)

Elapsed time (days)	Ave. body wt (g)	Estimated survival (%)	Feeding rates (% biomass)	Daily feed ration, (kg/day)	Feed required every 15 days (kg)
0	0.006	100	10.0	0.036	0.54
15	0.210	95	8.0	0.960	14.40
30	1.700	90	6.0	5.510	82.65
45	5.350	85	4.0	10.910	163.71
60	11.100	80	4.0	21.310	319.68
75	16.900	75	4.0	30.420	456.30
90	23.650	70	4.0	39.730	595.98
106	31.400	70	3.5	46.160	692.37
120	35.000	70			
		Total feed requirement			2,325.63

A. Given values and assumptions:

1. Initial Stock (IS) = 60,000 pcs/ha
2. Total Feed Requirement (TFR) = 2,325.63 kg
3. Final Survival Rate (SRf) = 70%
4. Final Average Body Weight (ABWf) = 35 g
5. Initial Biomass (BMi) = 0.006 g x 60,000 pcs = 0.36 kg

B. Calculation:

1. Projected Yield (PY) IS x SRf x ABWf
   = 60,000 pcs x 0.70 x 0.035 kg/pc
   1,470 kg

2. Projected FCR $= \frac{TFR}{\text{Weight Gained}} = \frac{TFR}{PY\text{-}BMi}$

   $\frac{2{,}325.63 \text{ kg}}{1{,}470 \text{ kg} - 0.36 \text{ kg}} = 1.58$

3. Daily Feed Ration (DFR) = IS x SR X ABW x FR

Where:
- IS — Initial Stock
- SR — Survival Rate, beginning of the period
- ABW — Average Body Weight, beginning of the period
- FR — Feeding Rates (% BM), recommended for a particular feed.

Table 3. A standard feeding time, feeding frequency, feed distribution, and recommended feeding rates

A. FEED TIME, FREQUENCY, AND FEED DISTRIBUTION

Time of feeding (hr)	PL20 - 1 g (1-30 days) Starter	1 - 3 g (3145 days) Grower	3 - 8 g 46-60 days Grower	8 g - Harvest 61 days-harvest Finisher
0600	40%	30%	25%	20%
1000			20%	15%
1400				10%
1800	60%	40%	35%	35%
2200		30%	20%	20%

Increase feed by 5% the next day if feed is consumed in one hour.

Decrease feed by 10% if feed is not consumed until next feeding.

B. FEEDING RATES

Weight of prawns in grams	Feeding rate (F.R.) (%)
PL - 1.0	8.0 - 12,0
1.0 - 5.0	5.5 - 6.5
5.0 - 10.0	5.0 - 5.5
10.0 - 15.0	4.5 - 5.0
15.0 - 20.0	4.0 - 4.5
20.0 - 25.0	3.5 - 4.0
25.0 - 30.0	3.0 - 3.5
30.0 - 35.0	2.7 - 3.0

Water Management

The periodic change of water is an important management practice which should be observed properly by prawn farmers. In extensive farms water change is made by draining water during low tide then allowing new water to come in during high tide. For the whole period of 5-6 days, total water change can reach as much as 50 to 100%.

In semi-intensive and intensive farms, water change is done in two ways. First, by pumping in new water at the same time draining an equal volume (flow-through system). Second, by draining first a given volume then introducing new water. The latter method provides an effective replacement and dilution due to mixing. Paddlewheel operation is also necessary not only to provide adequate levels of oxygen but also to mix water and prevent stratification. A standard schedule for paddlewheel operation in a one-hectare pond is shown in Table 4.

The total water replacement during the entire culture period varies according to stocking density, water quality, and feeding scheme. Normally, the amount of water replaced for every water change is 20 to 50%. The frequency of change is minimal during the initial period--once or twice a month for the first month, three or four times in the second month. In the third month, water is changed twice a week and in the fourth, every four to five days. The frequency and amount of water change are based on pH levels, salinity, and turbidity.

Control of Pests and Predators

The appearance of pest and predators during the culture period can not be totally avoided. Most common are tilapia, gobies, small crabs (*Varuna litterata*), tarpon (*Megalops cyprinoides*), ten pounder (*Elops hawaiiensis*), sea bass (*Lates calcalifer*), etc. The presence of these unwanted species may create a big problem during the culture period. Tilapia and gobies may occur in large quantity and compete with prawns for feed, space, and dissolved oxygen. Presence of predatory species such as tarpon, ten pounder, and sea bass in large quantities can drastically reduce the population in a short period of time.

Table 4. Standard schedule for paddlewheel operation at stocking density of 20-25/sq m

Days of culture	Operating schedule		Number of hours/ day	Number of paddle-wheels/ha
1 - 15	12 NN	3 PM	11	6
	11 PM	7 AM		
16 - 30	12 NN	3 PM	13	6
	9 PM	7 AM		
31 - 45	12 NN	3 PM	15	6
	7 PM	7 AM		
46 - 60	12 NN	3 PM	16	8
	6 PM	7 AM		
61 - 75	12 NN	3 PM	17	8
	5 PM	7 AM		
76 — Harvest	12 NN	10 AM	22	8

During heavy rains, cloudy, days and water exchange, paddlewheels should be turned on.
During feeding time, aerators may be turned off.

Some growers engaged in extensive culture system try to control the population of tilapia by throwing cast net or allowing some people to fish by hook and line. Gill nets are also utilized to catch bigger tilapia. In the case of gobies, collection by feeding trays or traps is resorted to. The above measures may help but do not completely solve the problem.

Growers engaged in intensive and semi-intensive culture suffer some initial difficulties due to the unavoidable occurrence of gobies and tilapia no matter how they try to filter water. However, a selective pesticide, teaseed powder, has solved the problem. Teaseed powder is an imported by-product of tea (*Camellia* sp) which contains saponin poisonous to finfishes. Another organic pesticide effective in eliminating ten pounder, tarpon, and other finfishes at levels tolerable to prawns is rotenone. Rotenone is a white odorless crystalline substance which acts as an inhibitor of cellular respiration in fishes (Apud et al 1983). It is extracted from derris root and comes out in powder preparation or in liquid form at a level of 5-8% rotenone.

The possibility of developing techniques for selective elimination using locally available derris root is very promising. A bioassay of powdered derris root (Tumanda 1980) indicated its selective effect. At 5-10 ppm, the powdered material kills tilapia, tarpon, ten pounder, milkfish, and other finfishes but does not affect *P. monodon.*

Harvesting and Post-harvest Handling

Prawn growers engaged in extensive system usually synchronize harvest with the spring tide during new moon and full moon. It has been observed that prawns are active and hard-shelled two or three days after the peak of spring tide. If timing is off, a greater percentage of harvest may be soft-shelled. To avoid this condition, prawns are induced to molt five days before the expected harvest by abruptly changing the pond water from 50-70% to expose them to stressful condition. This is normally practiced in intensive or semi-intensive farms to ensure better quality of prawn product.

Methods of harvesting. There are two ways of harvesting prawns in ponds: partial and total or complete harvesting. Partial harvest is done when there is a wide range of stock sizes in ponds. Harvest gears usually utilized for this purpose are bamboo traps, cast nets, and pond nets. The latter is effective in selecting marketable sizes as smaller prawns easily pass through the net mesh used in the trap (Figure 4).

Total harvest is done using a bag net installed at the drain gate. During draining, prawns tend to go with the water; hence, they are collected inside the bag net. The bag net has an opening at the end portion where the collected prawns are released and transferred to a basket or a net bag. There is some difficulty in getting all the prawns from the pond when pond bottom elevation and slope towards the drain gate are

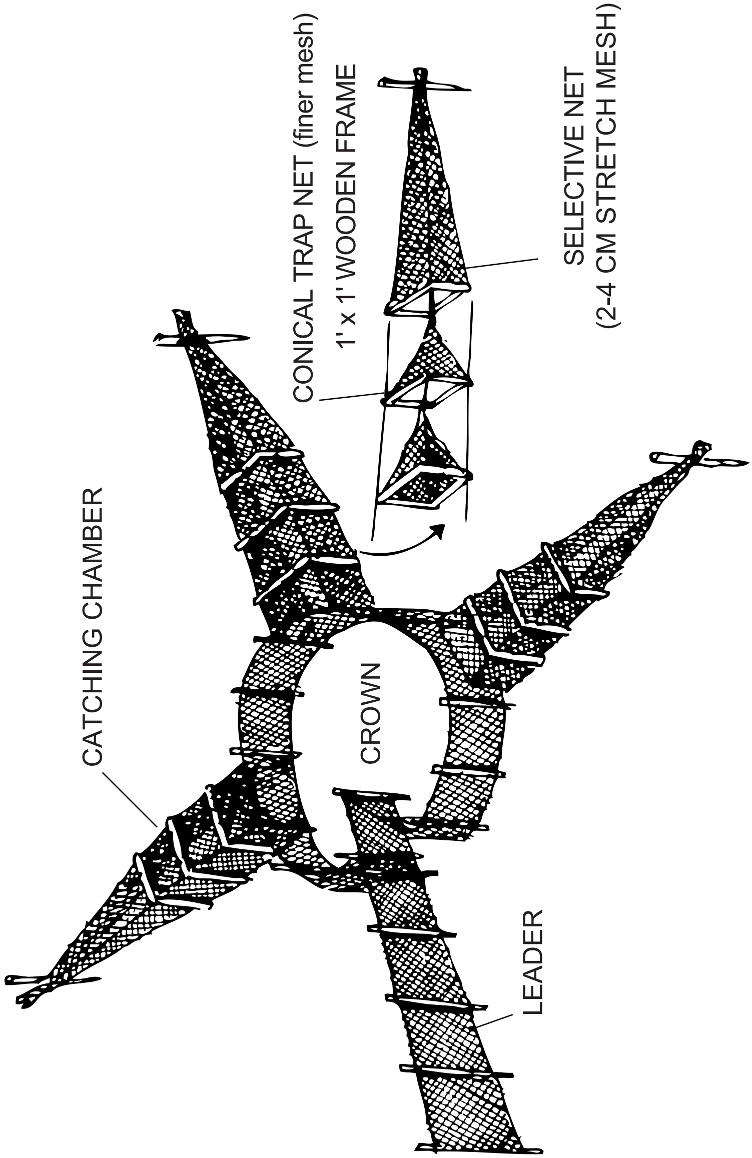

Fig. 4. Selective harvesting net collects only large prawns; undersized stock pass through the net (Suemitsu 1983 in Apud et al 1983)

inadequate. Also, if prawns are not so active or if they are molting, they tend to burrow themselves in the mud. In some cases, farmers resort to handpicking. While it takes much effort and time, prawns harvested this way easily deteriorate and, therefore do not command a good price.

Another method of harvesting prawns is with the use of a large suspension net installed at the discharge portion of the drain gate. Prawns can be accumulated in the net either by allowing them to swim against the water when flooding with tidal water or allowing them to go with the current when draining the pond. This is best suited for a limited volume where prawns can be kept alive for better negotiation in price.

Post-harvest handling. The best care for newly harvested prawns is to wash them thoroughly and immerse them immediately in chilled water (10°C) preferably while still alive. Those that are picked from the mud should be immediately released in clean water to give them the chance of releasing mud and other impurities in the gills prior to chilling. While some farmers are aware of this, many still fail to handle their product properly; hence, they usually do not get a better price.

Depending on the preference of the buyer, prawns particularly *P. monodon*, are classified into different size groups; e.g., 6-18, 19-25, 26-40, and 41 pc per kg and above. All prawns falling under the last category together with the soft-shelled are bought at a much lower price or rejected. Another classification practiced by most buyers in the Visayas is 20 and below, 21-30, 31-40, and 41 pc, and above. The last group and the soft-shelled are also either bought at a much lower price or rejected. Prices fluctuate every now and then reaching its peak in the month of November and part of December. Production results achieved from various farms are shown in Table 5. Average growth rate of prawn at 15-day intervals is shown in Table 6.

PROBLEMS AND PROSPECTS

Problems

While the movement of the industry is shifting into high gear, some problems have developed along the way. Most common among these are the marketing aspect, feed and

Table 5. Production results achieved in various farms at different stocking densities

Location	Stocking density (pcs/m²)	Survival rate (%)	Ave. body wt. (g)	Yield (kg/ha)	Feed consumed (kg)	Feed conversion ratio
Visayas	4.60	78.00	33.36	1 091.50	1 656.90	1.51
Visayas	5.30	70.00	26.08	1 005.50	1 479.86	1.47
Visayas	10.00	70.00	35.70	2 500.00	4 000.00	1.60
Mindanao	8.00	86.60	30.67	2 255.76	3 492.41	1.55
Mindanao	12.31	84.50	32.27	3 490.11	5 178.81	1.60
Elsewhere	25.97	70.11	34.55	6 292.16	11 955.10	1.90

Table 6. Growth rates of prawns, *P. monodon* at 15-day intervals for both intensive and semi-intensive culture systems

Elapsed time (days)	Farm 1 (g)	Farm 2 (g)	Farm 3 (g)	Average weight (g)
0	0.006 (PL_{20})	0.006 (PL_{20})	0.006 (PL_{20})	
15	0.240	0.210	0.236	0.23
30	1.360	1.700	1.470	1.51
45	3.390	5.350	5.350	4.70
60	10.370	11.100	10.350	10.60
75	15.610	16.900	14.990	15.80
90	21.960	23.650	21.390	22.33
106	27.520	31.400	29.640	29.52
120-130	33.700	37.600	35.800	35.70

feeding, soil and water quality, design and construction, diseases, pest and predator control, seasonal variation, sourcing of inputs, and manpower.

Classification and pricing. Many prawn farmers complain about the wide disparity in the classification and pricing pattern adopted by buyers. Better classification and pricing terms can be offered by buyers depending on the guts and wisdom of the producer during negotiation.

Nutritional requirement. The nutritional requirement of prawns has not yet been fully understood. Many food sources and feeding practices have been tried for semi-intensive culture, but the results are as varied as the kinds of feed and feeding scheme used. Some farmers are also tempted to buy cheaper prawn pellets just to find that these turn out to be more expensive because of the poor conversion ratio and lower quality of prawn product. Soft-shelling and bluish prawns have been attributed to nutritional deficiency.

Maintenance of water and soil quality. The high stocking density used in intensive culture system requires high protein feed inputs which result in high metabolic wastes. This condition easily deteriorates the water and soil quality and becomes unhealthful to prawns. The presence of mineral pyrites and organic acids in large amounts in some areas can worsen pond conditions which may result in loss of appetite, disease, and eventually death of prawns.

Design and construction of pond facilities. Some farmers have not followed the design and construction of pond facilities according to the standard requirement and function related to prawn production operations. This aspect has not been seriously studied and fully understood by many prawn farmers such that a number of production failures are still associated with design and construction defects.

Pests, predators, and disease control. Pests and predators still bother many prawn farms. Proper screening can at least minimize but not totally eliminate their presence, especially tilapia and gobies. The application of selective pesticide like teaseed powder and derris root has at least improved the situation; however, this practice may not be economical for the extensive system. Diseases also become a big problem as intensification increases. Disease can be an offshoot of poor pond preparation, poor seed supply, nutritional deficiency, stress due to poor environmental condition, handling, ineffective water management, poor water and soil quality, heavy loading of ponds, and industrial or agricultural pollution or contamination from other farms.

Others. The seasonal variations and other realities in aquaculture are not yet understood by some investors. They tend to program production throughout the year without considering that at certain periods production can be largely influenced by water conditions; supply and quality of fry and other inputs; outbreak of disease; pest and predators; soil and water quality; domestic, agricultural, and industrial runoffs; and deficient manpower know-how and responsibility.

Finally, the excessive use of deepwells for intensive culture makes aquifers vulnerable to sea-water contamination. In some areas artesian wells have started to dry up while adjacent agricultural lands are contaminated by sea-water.

Prospects

The import demand for frozen prawns in Japan and the United States for the last five years has been increasing steadily (Figure 5). In 1983, the importation of each country reached an average of about 150 000 metric tons. In 1987, such importation attained between 220 000 and 250 000 metric tons (van Eys 1987). In effect, the total market potential for frozen prawns in Japan and United States alone reaches about 470 000 metric tons, not including demand from the European market.

The Philippines evidently possesses the right resources in its waters. Prawns have been a common by-product of many milkfish farms. The warm tropical condition and the quality of most of the country's soil and water are favorable for prawn production. Also, the established brackishwater fishpond industry in the country makes it easier to shift to the prawn industry resulting in the dramatic increase of frozen prawn exportation in recent years (Figure 6).

There is also rapid progress in the development of hatchery and broodstock and maturation techniques. Fry production has increased tremendously and once this can be stabilized and wild spawner supply can be adequately backed up by broodstock and maturation techniques, pond production can be a year-round activity.

CONCLUSION AND RECOMMENDATIONS

Despite the massive progress in the development of prawn culture in the Philippines in the last two years, production has yet to be stabilized. Yield per unit area in extensive, semi-intensive, and intensive culture systems vary, depending on numerous factors such as weather condition, fry quality, pond management practices, soil and water quality, technician/caretaker, pond and its support facilities, etc. Intensive farming requires closer and continuous monitoring of pond parameters, including the health condition of prawns and

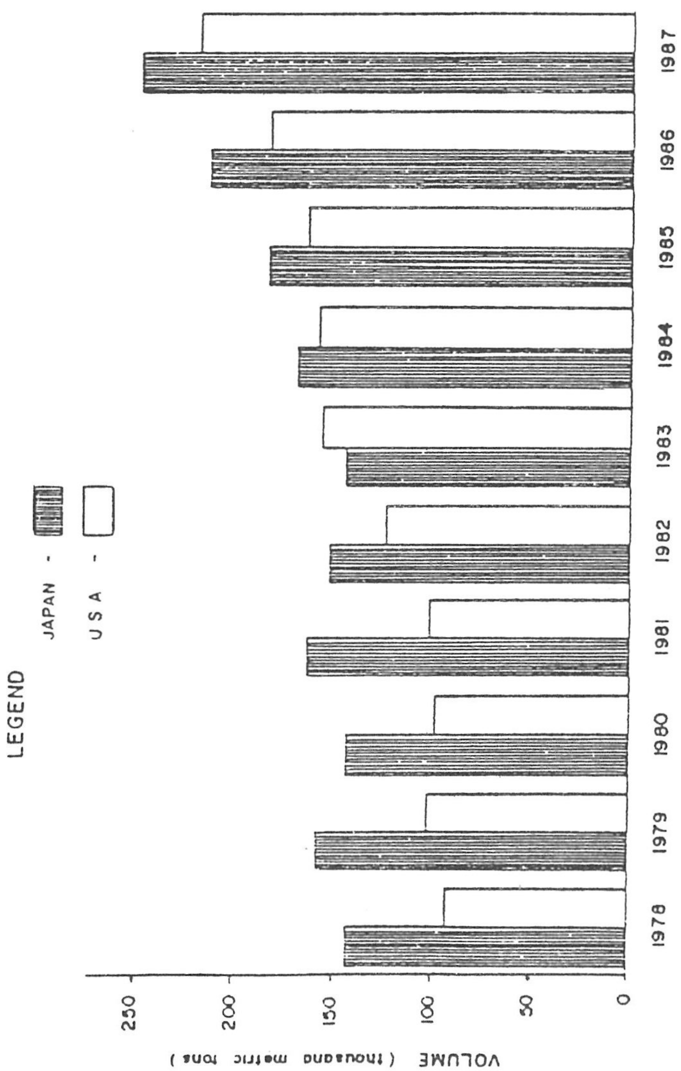

Fig. 5. Japan and U.S. imports of shrimps, 1978-1987 (FAO 1986, van Eys 1987)

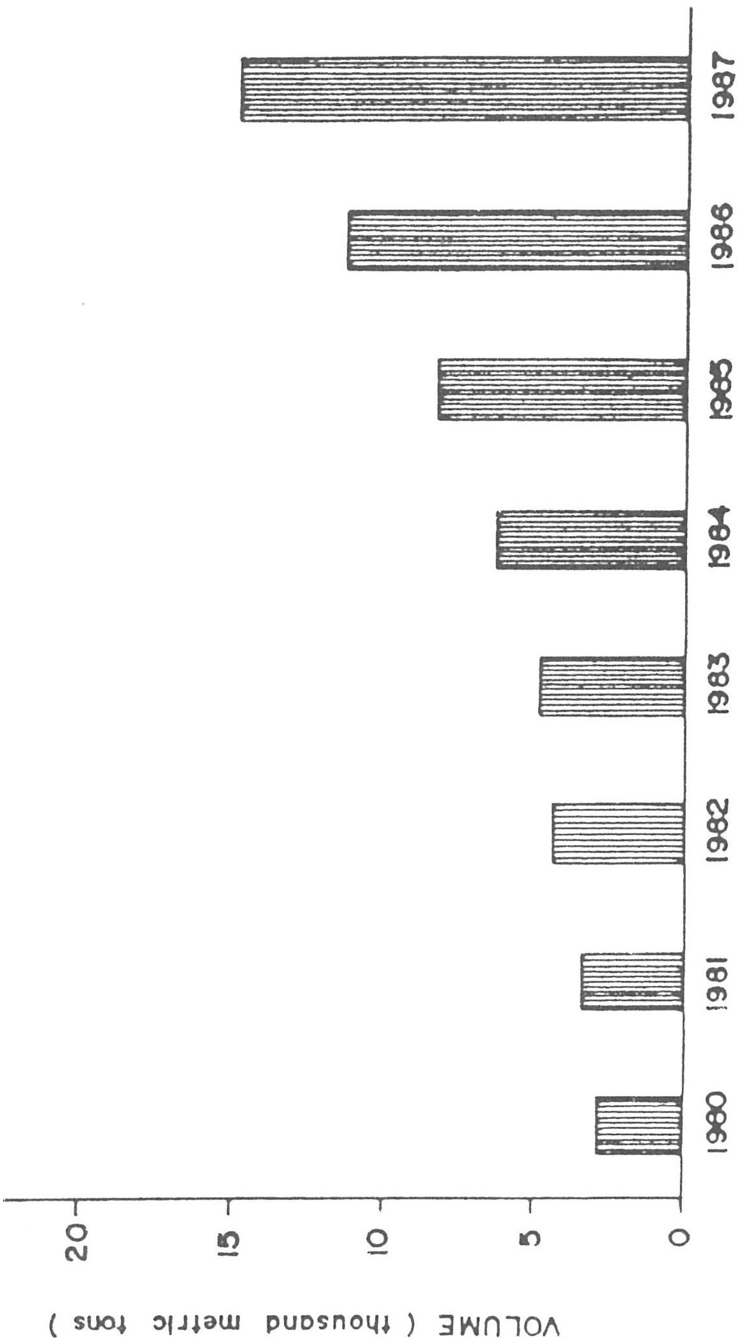

Fig. 6. Total Philippine shrimp exportation, 1980-1987 (BFAR 1980-87)

that of the pond bottom. Early deterioration of the pond bed and late discovery of disease may cause devastating effects on the operation.

Site suitability and pond engineering design are basic considerations that can spell success or failure of the operation. These factors are sometimes taken for granted by some investors who appreciate their importance only after a series of failures because of problems associated with site and pond engineering design and construction.

Pond management practices such as pond preparation, handling, transport and stocking of fry, water management, and feed and feeding management are other key factors in the success of the operation. These are more of an art rather than an exact science; hence, the degree of success can be influenced by the ability of the caretakers and technicians in dealing with these factors.

The market demand for prawns has not been saturated; however, there is a need to develop marketing strategies and postharvest/handling and transport methods to ensure high quality and better price.

There is a great need to improve and standardize the quality of hatchery-bred fry to protect farmers from getting fry in poor condition. Hatcheries should not be too dependent on spawners coming from the wild. Broodstock and maturation techniques should be perfected in order to meet spawner requirements.

The industry generally feels the staggering increase in construction and some operating costs. The capital investment and working capital, particularly for intensive culture, require a sizeable amount so that some investors tend to think twice before investing.

There is a need to further develop support industries such as feed milling and storage; propagation and preparation of organic pesticides; fabrication of blowers, water pumps, paddlewheels, harvesting gears, and maintenance and transport equipment; and processing and storage plants.

The technical, training, and extension services of various consulting firms are prime movers in the development of the prawn culture industry in the Philippines. The government should therefore continue to provide support to these activities as well as provide credit facilities at low interest rates with minimum and simple loan processing requirements. It should also provide some marketing incentives or protection to prawn farmers.

Prawn growers should form themselves into cooperatives to have better collective bargaining power with the government, suppliers, and exporters. As a group, they can also establish an operational pathology laboratory whose staff can undertake monitoring of prawn health, identify disease if any, and make necessary recommendations. They can also invest in research and development work in order to continuously improve the system and facilities that will ensure stable production.

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