

NURSERY AND GROW-OUT OPERATION AND MANAGEMENT OF *PENAEUS MONODON* (FABRICIUS)

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ABSTRACT

The results of research on nursery and grow-out rearing of prawn conducted by the SEAFDEC Aquaculture Department for over a decade are reviewed. Different rearing facilities designed to accommodate hatchery-produced prawn fry are presented with corresponding data on growth, survival and production. Studies on stocking density, fertilization/natural food production, water management, feeds and feeding schemes and harvest/post-harvest handling are evaluated and viable technology identified. Diseases, pests and predators and other factors considered as production constraints are also mentioned.

The success in hatchery operation for prawn coupled by the gradual emergence of nursery and grow-out rearing technology have triggered off a technology-dependent prawn industry. When SEAFDEC AQD was established in 1973, there were very few commercial prawn monoculture ventures in the country. Prawn pond production was mostly an incidental crop in milkfish culture. At present, various prawn grow-out techniques ranging from extensive, semi-intensive and intensive culture systems are in practice. SEAFDEC AQD focused its research on the extensive and semi-intensive culture systems which are within the reach of most farmers in contrast to the intensive system that is highly capital-intensive.

There have been much work done in nursery and grow-out operations, but much remains to be done in research, among which are the development of nutritionally-efficient and low-cost feed, control of diseases, etc.

INTRODUCTION

According to the Food and Agriculture Organization, total world shrimp production increased by no less than 32% in 1974-1984. The Philippines ranked 12th among the 14 major shrimp-producing countries of the world. Its production rose from 5.4 mt in 1974 to 52.2 mt in 1984. The Asian region produced 49-61% of the world total (Sjeb von Eys 1986).

More than 75 000 mt of cultured shrimp was produced in 1983 and it is estimated that by the end of this decade, shrimp production will be about 200 000 mt (Feller 1986). Although India, Indonesia, Thailand, and Taiwan are considered the most important countries that culture shrimp, other Asian countries are increasing their production significantly, one of them being the Philippines. Cultured shrimp production in the Philippines was 2700) mt in 1977 and increased to 4250 mt in 1983 (Feller 1986) and is projected to produce about 20 000 mt by 1990. Likewise, Thailand produced 10 091 mt in 1983 and is projected to produce 35 000 mt by 1990.

The demand for shrimps in the world market, particularly in Japan, United States, and Europe, brought about the upsurge in the production of shrimps. Around 90% of the cultured shrimps in the Philippines is exported to Japan while about 5% are exported to the United States and 5% to Hongkong and Europe (Fernandez 1985). Shrimp consumption in the U.S. reported to be 1 000 mt in 1973 and increased to 11 100 mt in 1982. Likewise, Japan consumed around 109 200 mt in 1973 and 162 700 mt in 1982.

This paper reviews results of studies on the nursery and grow-out phases of prawn at the Leganes Brackishwater Station of the SEAFDEC Aquaculture Department (AQD) since its establishment in 1973. Research results and recommendation on the nursery and grow-out phases of *P. monodon* have been disseminated through training, extension, and consultative meetings.

NURSERY OPERATION

Rearing Facilities

About a decade ago, milkfish ponds were utilized for nursing hatchery-produced prawn fry using a similar management method for

milkfish fry culture. However, the system could hardly obtain profitable rates of survival. To improve prawn post-larval production, various nursery systems were studied by the Leganes Brackishwater Station, namely, suspended hapa net, earthen pond, concrete tank, and floating cage nursery systems.

In a study by Primavera (1976) using suspended hapa nets as nursery facility, survival of prawn fry at different stages were consistently within the range of 50-70%. The suspension nets measured $3 \times 2 \times 2$ m with a stocking density of 200 fry/m². Comparable results were obtained by Apud (1979) when the earthen nursery system consisting of 200 m² and 500 m² compartments (Fig. 2) were utilized. However, the former was found to be best suited for postlarvae, PL₁₅ and older, while younger postlarvae, PL₄ to PL₅, could be reared in the latter system. With the use of concrete tanks for nursery operation, Mochizuki (1979) obtained survival of 70-80%. Likewise, using the tank nursery system with tank sizes of 3-40 t integrated in hatchery system, Gabasa (1982) achieved comparable results. In a preliminary run using marine plywood tanks a much higher survival (96-98%) was obtained by Soeprayitno (1976).

The use of floating cages made of bamboo measuring $2 \times 5 \times 1.5$ m with cement-coated styrofoam sheets as floats was tried by de la Pena et al (1985). These cages were installed offshore where water depth was at least 2 meters during the lowest tide. Based on 25 production runs, an average survival of 41.0% was obtained in a 2-3 week culture period.

Among the nursery systems studied, the tank nursery system has been found to be superior in production output, but it requires relatively higher initial capital investment compared with the other systems. Unlike the earthen or tank nursery, the floating cage nursery system is more economical to operate as it requires no aeration and pumping. It can be installed inside the fishpond just like hapa nets, but is more appropriate in coves with slow currents and other protected areas with suitable conditions.

Rearing Methods

Nursery rearing facilities are necessary and technical knowledge of the rearing method is a prerequisite for higher post-larval production. The unavailability of a good culture method for nursery system some-

time in 1974 resulted in very low survival rates of from 0-10% when prawn fry from the hatchery were stocked directly in ponds by fish farmer cooperators of SEAFDEC AQD. Since then, different culture techniques have been tried by the Leganes Brackishwater Station research staff on optimum stocking density, feeding rates, fertilization rates, and proper water management.

Stocking Density

Various stocking densities from as low as 15 fry/m² to as high as 150 fry/m² have been tried in earthen nursery ponds by (Apud et al 1979). Generally, stocking densities lower than 50 fry/m² gave higher survival rates. Higher survival rate at 100 fry/m² which tended to decrease as stocking density increased to 150 fry/m² were obtained by Tabbu (1984). Both studies showed that prawn fry can be reared at higher than 50 fry/m² in earthen nursery ponds with survival rates of 40-80% provided feeding is supplemented with mussel meat at 100-20% body weight or artificial diet at 50-30% body weight and water is frequently renewed.

In 1978, Platon obtained an average survival of 50% at stocking density of 5 000 fry/t of sea water using the tank nursery system. On the other hand, fry survival was very much improved (70-90%) when stocking rates from 2 500 to 3 000 fry/t was used (Gabasa 1982).

In the floating cage nursery system, the highest stocking density tried was 50 000 fry in 10 t of water but the optimum density recommended is 30 000 fry (De la Pena et al 1984).

Feeding versus Fertilization

Prawn fry have been found to prefer natural food or *lablab* which consists of microbenthic organisms such as algae and diatoms. The growth of natural food in pond is influenced by the amount of nutrients in the water and soil; hence, natural food varies from one pond to another. Problems related to propagation and maintenance of *lablab* have led to the search for alternative feed.

Experiments with prawns fed with mussel meat at various feeding rates showed that fry stocked at 150 fry/m², fed 100% of body weight daily for the first 16 days and subsequently reduced to 20% for the rest of the rearing period, attained an average survival of 57.4% (Apud et al 1979). When feeding was abruptly stopped after 16 days, survival dropped to 25.5%. Very low survival (15.5%) resulted when mussel

meat was given at 20% body weight daily throughout the rearing period. The storage and erratic supply of mussel meat led Mochizuki (1979) to compare mussel meat with artificial feeds as supplementary feed. He suggested that prawn fry should be fed with artificial feeds twice daily at an adjusted feeding rate of 100%, 50%, and 25% body weight. Results from a study by Tiro et al 1984 showed that there was no significant difference in growth and survival between those fed with fresh mussel meat and those fed with artificial feed containing 40% protein.

With the use of a SEAFDEC AQD formulated-feed given at adjusted feeding rates of 50%, and 30% body weight, better growth and survival of fry compared with those completely dependent on natural food was obtained by Tabbu (1984). The artificial feed contained approximately 35% crude protein and 3 400 kcal of M.E./kg of diet. Natural food was propagated by using chicken manure and inorganic fertilizer/ammonium phosphate (16-20-0) at the rates of 3 t and 50 kg/ha, respectively, with subsequent application of 16-20-0 at 25 kg/ha every 2 weeks to maintain good growth of natural food organisms.

Water Management

Water quality is another critical factor in fry rearing. The common practice of changing pond water by tidal fluctuation is possible only during spring tides which occur at a 2-week interval. This method can not maintain the desired water quality with high stocking densities and artificial feeds, hence, the use of water-moving devices were studied.

Apud (1979) found out that aeration has a significant effect on fry survival. Higher survival was obtained in earthen ponds with aeration compared with those without aeration. Frequent water flow prevented increase in salinity and at the same time replenished water lost through evaporation and seepages. Water flow-through was effected through an adjacent reservoir pond where water was pumped in and flowed out at periods of low oxygen at 0500r800 hr and at 1300-1600 hr when temperature was usually high.

Harvest and Post-harvest Handling

Prawn fry are normally harvested after reaching the PL₃₅ - PL₄₀ stage or one month after stocking from the hatchery. At this time, the prawn size may vary from 0.5 - 1.5 g depending on the age at stocking,

stocking density, and management techniques. The method of harvesting is similar for tank and earthen pond nurseries except that harvesting from the earthen pond is more laborious and tedious. When *lablab* is abundant, fry is entangled in it, making sorting and counting difficult.

The bagnet and the harvesting box are useful but their effectiveness have to be assessed. The 2-3 days it takes to completely harvest the juveniles in earthen ponds causes some mortality.

The problem of transporting prawn juveniles for stocking in grow-out ponds was solved by Yap et al (1979). Their study on optimum packing density and ice quantity showed that prawns of 40 mg size can be packed to as much as 3 000 per plastic bag containing 8 l sea water and 16 l oxygen for a maximum transport period of 15 hours. Packing densities above 3 000 per bag with 8 l sea water and 16 l oxygen can be used only for short transport periods. They also found out that about 50 g ice/hr is needed to maintain the packing temperature of 20°C. Packing density depends largely on distance or travel time, fry size, and storage facility.

GROW-OUT REARING OPERATION

Rearing Facilities

Prawn grow-out rearing ponds were mostly developed out of fishponds originally designed for milkfish production; hence, rearing of prawns to marketable size in such ponds was not very efficient. These ponds could hold only 30 cm of water, had only one gate, and were irregular in size resulting in abrupt fluctuations of water temperature and salinity and difficulty in water exchange.

Apud and Sheik (1979) found that milkfish ponds characterized by big and irregular compartments with a single gate could not facilitate total movement of water in the pond because water at the farthest side of the gate remained practically unchanged. Santiago et al (1975) indicated that higher survival rates of *P. monodon* are obtained in compartments with deeper water, close to the gate, and with proximity to fresh tidal water for replenishment. Likewise, Primavera et al (1976) observed that the compartments near the gate had the advantage of being in the direct line of water flow; hence, growth rates of prawn were consistently higher in these compartments than in those with the same stocking densities opposite the gate. The shallow depth affected

the growth of prawn because less water volume means less living space for feeding. Mochizuki (1978) observed that milkfish pond which is usually 30 cm deep causes abrupt fluctuations of water temperature and salinity during intense sunlight or heavy rain and is, therefore, too shallow for prawn culture.

Apud et al (1984) studied the effect of water depth on the growth and survival of *P. indicus* stocked at 50 000/ha with supplementary feeding and cultured within a period of 90 days. Favorable results were obtained in ponds with water depth of 70-100 cm compared to those with 40-70 cm depth. Mean survival of 70.4% and production of 343 kg/ha/crop were significantly higher in deeper ponds compared with those in shallow ponds, 37.5% and 180 kg/ha/crop, respectively. This confirmed the need to use ponds of about one meter deep for prawn culture.

Another important factor for the successful production of prawns is pond size. In determining pond size, the ease in water change or movement and the convenience in harvesting are of primary consideration (Apud and Sheik 1978). In addition, the pond bottom should decline toward the outlet gate for convenience in water management, stock manipulation, and harvesting (Esguerra 1979). Mochizuki (1978) found out that the pond size suitable for extensive culture without feeding is 1-3 ha while 3 000 m² - 5 000 m² was appropriate for intensive culture.

SEAFDEC AQD has recommended an appropriate pond design and layout for prawn culture. Salient features of the design include provisions for a canal and a two-gate systems as supply and drainage facilities. For a 1-ha pond, construction of a diagonal canal of 5-10 meters wide and 0.3-0.5 meters deep extending from inlet to outlet gates was recommended for convenient draining of water and harvesting and as hiding place for shrimps during daytime (Kungvankij et al 1986). In the development of these prawn ponds with earthen dikes, problems related to reconstruction of leaking dikes and erosion were solved by the use of plastic sheets along the dike or by digging a trench along the leaky area and using the excavated materials as reinforcement for the dike (Apud 1984). The pond gate systems introduced by SEAFDEC AQD were the monk type culvert (Fig. 1) and the open sluice gates (Fig. 2) made of ferrocement. These gates are cheaper, more convenient to construct and install, and effective as tertiary and secondary gates.

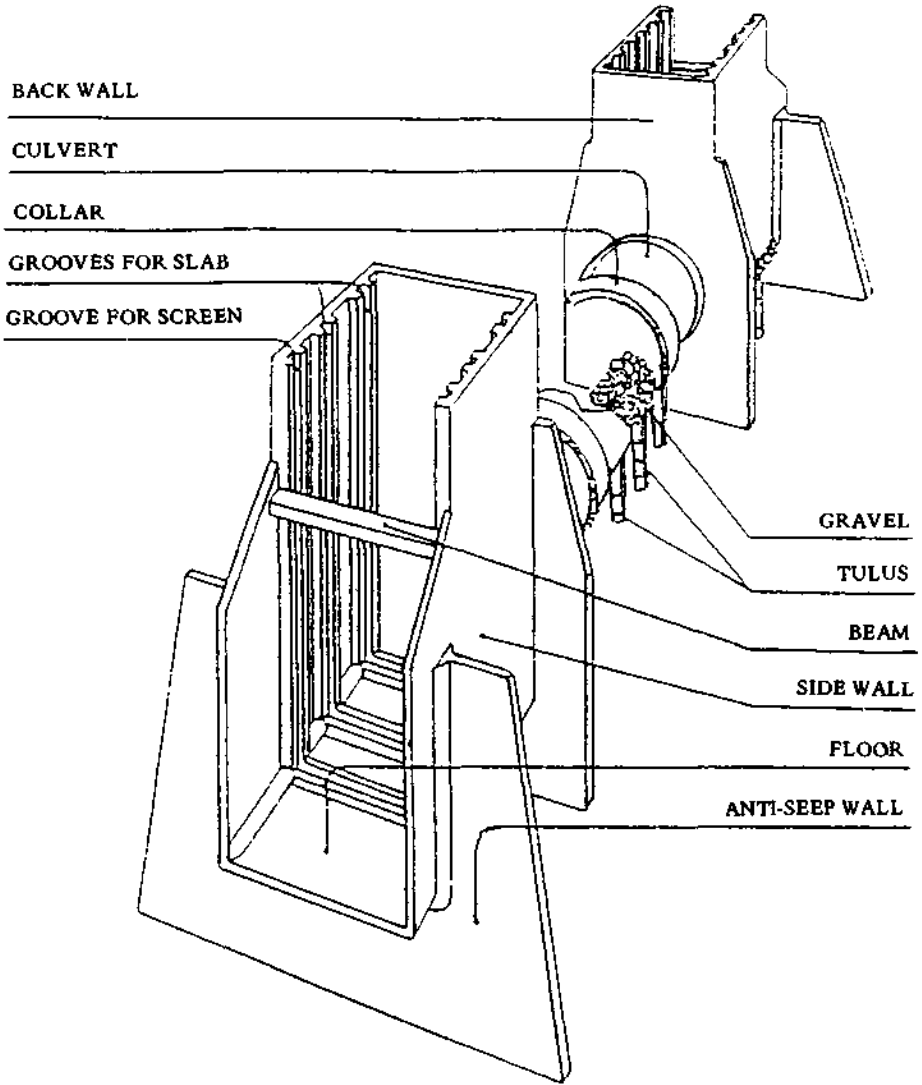


Fig. 1. Ferrocement culvert gate, LRS SEAFDEC AQD (Torres 1983)

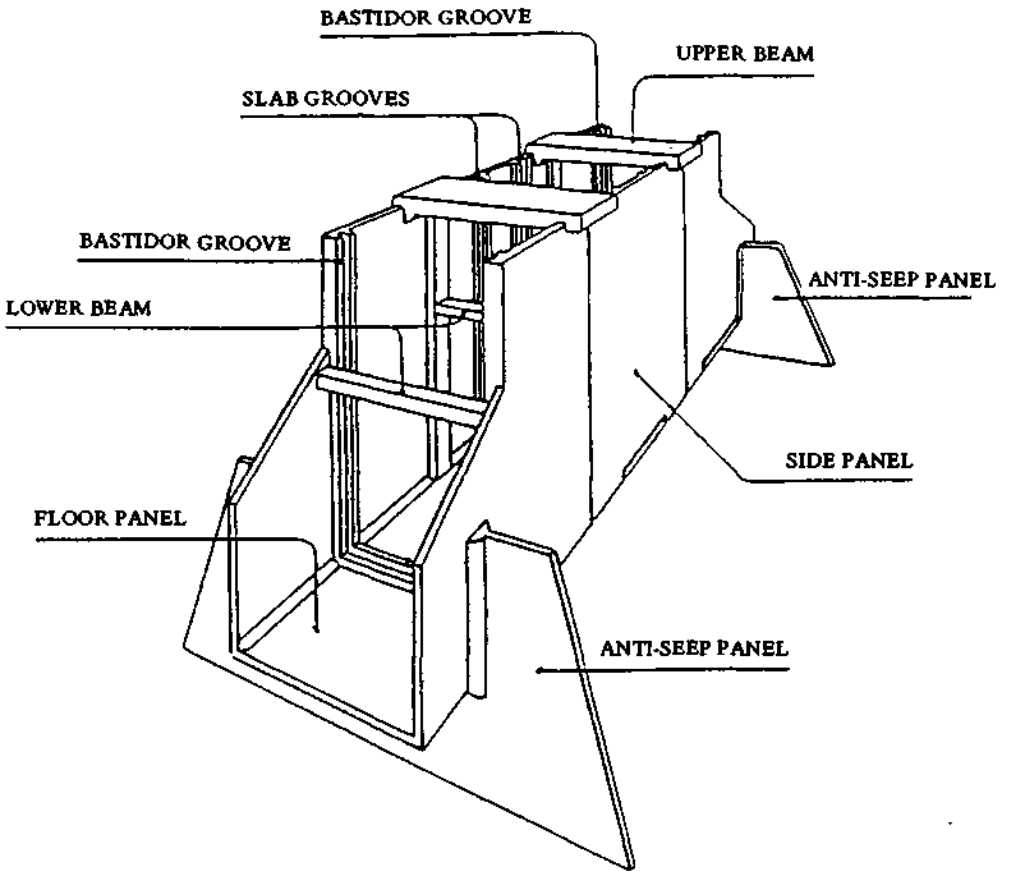


Fig. 2. Ferrocement sluice gate at LRS SEAFDEC AQD (Torres 1983)

Rearing Methods

The lack of an effective rearing method for prawns was earlier considered one of the main constraints to prawn culture. Fish farmers were hesitant to raise prawns in monoculture, thus, for many years prawns remained a secondary crop to milkfish in brackishwater ponds. Studies have been conducted at the Leganes Brackishwater Station to develop pond culture technology of prawns that can be adopted by the private sector. Studies have been focused on the monoculture of prawn, polyculture with milkfish, stocking density, water management, feed and feeding schemes, fertilization, and other pond management techniques.

Fertilization

The effect of fertilization on the growth of *P. monodon* has been tested through the years. Santiago et al (1975) showed that by fertilizing the pond with an inorganic fertilizer (mono-ammonium phosphate 16-20-0) at 200 kg/ha at a stocking density of 10 000/ha an average survival rate of 72.7%, mean body weight of 16.4g, and a production of 160 kg/ha was obtained in 5 months of culture. However, a comparable production of 150 kg/ha was also obtained in unfertilized ponds. In a related experiment, where chicken manure was applied at approximately 1 200 kg/ha during pond preparation, prawn production reached only 66 kg/ha in 4 months. In contrast, Apud et al (1984) obtained a yield of 105 kg/ha when chicken manure at the rate of 2 000 kg/ha was used. The effect of organic fertilizer in the form of mudpress at 5 t/ha and a combination of 0.5 t/ha chicken manure plus 4.5 t/ha of mudpress was evaluated. Both treatments gave relatively low production (40 and 60 kg/ha, respectively), attributed to inadequate growth of natural food and the presence of competitor and predators. A combination of chicken manure at 1 t/ha and inorganic fertilizer consisting of 15 kg nitrogen and 30 kg phosphorus/ha yielded 180 kg/ha in 86 days of culture; the prawns were stocked at 7 000/ha (Subosa unpublished). The source of nitrogen and phosphorus were taken from chemical fertilizers, di-ammonium phosphate (18-46-0), and urea (46-0-0), applied during pond preparation and subsequently at 15-day intervals following every water exchange by tidal movement.

At present, SEAFDEC AQD recommends that soil analysis should be conducted prior to application of fertilizer to determine the organic

matter content of the soil and subsequently the amount of fertilizer to be used. It was reported that when organic matter is higher than 16%, fertilization is not required (Kungvankij et al 1986). Generally, chicken manure is applied at 1-2 t/ha followed by inorganic fertilization at 75-150 kg/ha of mono-ammonium phosphate (16-20-0) and 25-50 kg/ha of urea (46-0-0).

Stocking Density

Results of fertilization studies indicate that the optimum stocking density of prawn is below 10 000/ha for stock completely dependent on natural pond productivity. As pond yield is relatively low, higher density levels from 10 000/ha and above have been tried with supplemental feed and frequent water exchange by tidal movement and by pumps.

Apud et al (1981) obtained good growth and survival at a stocking rate of 25 000-50 000/ha with artificial diet as supplemental feed. Increasing the density from 100 000-200 000/ha did not affect the survival rate but the growth rate significantly decreased. Furthermore, the pelleted feed given twice daily at feeding rates of 10%-5% of biomass resulted in feed conversion ratios (FCR) of 1.5-2.6.

Results from a study by Kungvankij et al (1984) showed best growth performance at 40 000/ha stocking rate of prawn fed with artificial diet at 10% to 3% of biomass per day. Overall yield was high at higher stocking rates, but body weight at 80 000/ha and 120 000/ha was low (mean weight of 11 g) compared to a mean weight of 25 g when stocking density was at 40 000/ha. Higher yield of 284 kg/ha was also obtained by Tiro et al (1986) at stocking rates of 40 000/ha compared with 171 kg/ha at 10 000/ha and 317 kg/ha at 20 000/ha. However, pond yield in 40 000/ha was lower compared with those obtained by other workers probably because supplemental feed was given only after the second month of culture, whereas others started feeding a few days after stocking (Apud et al 1981, Tabbu 1984, Kungvankij et al 1984, Corre unpublished). In general, results indicate that the optimum stocking rate of prawn in monoculture with supplemental feed and improved water management is 40 000/ha with corresponding pond yield of 300 kg/ha-850 kg/ha in 3-4 months culture.

The polyculture of prawn and milkfish at varying stocking combinations has been studied to maximize pond production through efficient utilization of available space and food. A study by Pudadera and

Lim (1980) showed that a stocking combination of 2000 milkfish/ha plus 6000 prawn/ha was economically feasible with combined net production of 463.6 kg/ha in 100 days. Moreover, the polyculture treatments had higher total production than monoculture although prawn production in monoculture (144.3 kg/ha) was significantly higher than in polyculture with 2000 (75.6 kg/ha) and 4000 (49.8 kg/ha) milkfish/ha. Comparable results were obtained by Eldani and Primavera (1981) except that combined net production (492.1 kg/ha) slightly increased at stocking combination of 8000/ha prawn and 2000/ha milk fish.

The possibility of raising prawn with Nile tilapia (*T. nilotica*) has also been tried and results showed that the polyculture of 6 000/ha prawn and 4000/ha tilapia proved profitable (Corre 1983). In this combination, the presence of tilapia is favorable, evidenced by higher production of prawn in polyculture (137.69 kg/ha) compared to monoculture (123.21 kg/ha). Competitive relationship did not exist in the above combination but was evident at a stocking combination of 6 000 prawn/ha plus 6 000 tilapia/ha.

The efficiency of integrating polyculture of shrimp and milkfish with poultry has been evaluated (Apud et al 1983). Results of two successive experimental runs consistently achieved higher net production (80-129 kg/ha) and mean body weight (10-14.6 g) of *P. indicus* culture in ponds with poultry than in those without poultry. The net production did not vary for milkfish which is 401-549 kg/ha.

The problem related to overgrowth of plankton due to continuous manuring of ponds with poultry led to the search for additional species which efficiently feeds on plankton. In a study by Pudadera et al (1986) tilapia (*T. nilotica*) at varying densities were tested with *P. indicus* and milkfish stocked at 50 000/ha and 2 000/ha, respectively, integrated with poultry (chicken broiler). A total production of 680.2-936.3 kg/ha can be attained with best net production of tilapia at 15 000 ha. The poultry operation with chicken broiler production of 1809-2174 kg/ha gave major contributions to the total net earnings and a free source of fertilizer from the droppings.

Baliao (1985) tried the modular method of prawn culture at 5 000/ha and 10 000/ha. Similar growth (39.8 g and 38.4 g, respectively) and survival (96.5% and 90.5%, respectively) were obtained in both stocking densities. However, production at high density (348 kg/ha/crop) was more than double than at low density. At 20 000/ha.,

Tiro et al (1986) obtained higher yield of 525 kg/ha/crop in 120 days culture when the prawns were transferred 60 days after stocking. A slightly lower yield (422 kg/ha/crop) was obtained when transfer was done every 45 days.

Water Management

Basically, water management in prawn ponds is patterned after that used in milkfish culture. Water change at 20-30% of water volume is done once a week or every two weeks by tidal fluctuation. This method is normally practised in ponds where stocking density is low (10 000/ha) and the stock completely dependent on natural productivity.

The need to increase production by increasing stocking density and supplementing natural food in pond has led to studies to determine effective water management. Yokokawa (1978) earlier suggested that water supply must be checked frequently. Water must be changed frequently with tide and water pump, and whenever there is sudden change in the color of the water and unhealthy prawns are observed, water renewal must be more frequent.

The need for water renewal by tidal movement and pumping and the effect of feeding/artificial pellets at varying rates in prawn culture were studied by Norfolk et al (1982). Increasing water renewal daily at 5-20% of water volume did not influence the growth and survival of prawn but affected the low early morning dissolved oxygen particularly at higher feeding rates. On the other hand, Suemitsu (1983) obtained better growth of prawn in ponds provided with aquamill as a water-moving device in addition to tidal movement in contrast to prawns grown in ponds completely dependent on tidal fluctuation.

Feeds and Feeding

The amount of natural food in pond declines at a certain period depending on stocking density and pond fertility and thus becomes insufficient to meet the growing demand of prawns. Supplementary feeding is needed when stocking density is more than 10 000/ha (Apud 1981). Supplemental feed such as rice bran with trash fish, chopped frogs, snakes, chicken entrails, mussel, and clam meat are commonly used but problems related to their availability and storage have led to the search for alternative feed.

The Feed Development Section of SEAFDEC AQD has been undertaking studies related to the nutritional requirements of *P. monodon*. Results of these studies are used in the formulation of diets screened under laboratory conditions and then tested under pond conditions. SEAFDEC-formulated diets and commercial pellets were tested by Mochizuki (1978). Growth of prawn fed with SEAFDEC diet at 10%-5% of biomass was similar to that obtained with a commercial pellet. Both feeds resulted in high survival 74.7-82.8% and production of 645.6-695.9 kg/ha in 3 months. A comparable yield (518-581 kg/ha) was obtained when SEAFDEC-formulated practical diet containing 40% crude protein was pilot-tested in ponds stocked at 25 000/ha. The artificial diet was given daily one month after stocking at a decreasing feeding rate of 10, 8, 6, and 4% of the biomass; feeding rate was adjusted every 2 weeks. High yield and low feed conversion ratios (1.6-2.1) achieved in this study demonstrated the efficiency of SEAFDEC-formulated prawn grow-out diet in semi-intensive culture (Pascual unpublished). Results from a study by Tabbu (1985) showed that the pelletized feed containing 45% crude protein resulted in better growth than the formulated diet with 35% crude protein, both with high survival of 82.6-91.8%. Better growth (23.96 g mean weight) and yield (839.7 kg/ha) were obtained when pelleted feed (75%) containing 35% crude protein was fed in combination with trash fish (25%) in ponds stocked at 40 000/ha (Corre unpublished).

Supplemental feeds are given either by the broadcast method or by the use of feeding trays or both. In the broadcast method, the feeds are spread over the pond surface. For bigger ponds, a flat-bottom boat is used so that the mid-portion of the pond can be reached. Kungvankij et al (1984) pointed out that the use of feeding tray is very advantageous because it prevents feed wastage, at the same time provides information on prawn condition and feed consumption. A combination of the broadcast and feeding tray methods is being employed to ensure efficient feed utilization.

In computing feed requirement, a decreasing feeding rate is generally used with 10, 8, 4% of the biomass given daily and adjusted every 15 days after the stock are sampled by cast net or prawn trap. The feeds are given 2-3 times a day and daily feed ration is apportioned accordingly.

Harvest and Post-harvest Handling

Prawns are normally harvested upon reaching marketable size (25 g or more or after 3-4 months). Traditionally, harvest is done during full moon or right after the water is changed, thus fish farmers oftentimes harvest molting or soft-shelled prawns. To minimize this problem, a good time to harvest is 2-3 days after the peak of spring tide or 5 days after an abrupt change of water. The stock must be checked or sampled to determine prawn condition before harvesting.

Harvesting may be complete or partial depending on demand. Complete harvest is commonly done with a bagnet attached to the sluice gate while partial harvest is accomplished with bamboo traps, pound nets, or cast nets. The new harvesting technique documented by SEAFDEC is staggered harvesting using an eight-knot pound net (stretched mesh =2-4 cm). Results from a study by Suemitsu et al (1985) showed better growth, survival, and feed conversion rates in staggered-harvest treatment than in a single-harvest treatment. In the staggered harvest, bigger prawns are caught earlier thus reducing competition and giving the smaller ones a better chance to grow.

Upon harvesting, Kungvankij et al (1986) suggest that prawns be washed in clean water and soaked immediately in chilled water (10-15°C) for about 15 minutes prior to packing. The prawns should be packed in styrofoam boxes with alternate layers of crushed ice at a ratio of 1:1. Moreover, if bigger styrofoam boxes are used, the box should be filled up with chilled water, prawns, and ice to avoid physical damage to prawns.

Diseases and Parasites

Very few cases of disease-related problems have been reported in ponds with extensive and semi-intensive methods of culture. There has been a report of "red disease" in prawn. Gram-positive cocci were consistently isolated; however, experiments with the disease have to be replicated to determine other possible factors that influence its incidence (Lio-Po pers. comm.). The incidence rate of black shell syndrome among prawn juveniles in ponds is being checked. The preliminary data are currently being analyzed (Lio-Po and Pitogo pers. comm.).

A field survey of prawn ponds in the island of Panay conducted by the SEAFDEC AQD Fish Health Section staff showed that occurrence of soft-shelled prawns could be predicted with 98% accuracy with poor pond soil and water conditions. In soft-shelled prawns, calcium

and phosphorus levels were significantly higher in the hepatopancreas, and phosphorus was significantly lower in the exoskeleton compared to hard-shelled prawns. Chitinoclastic bacteria, *Vibrio* and *Aeromonas*, were isolated from soft-shelled prawns but experimental infection with these species to induce soft-shelling gave largely negative results. Laboratory experiments with an organostannous pesticide revealed that a 96-hr exposure to at least 0.0154 ppm of the pesticide could result in soft-shelling of 47-60% of the prawns and that soft-shelling could be reversed by dietary manipulation (Baticados et al 1986). Successful re-growth and survival were observed in prawns fed with 14% mussel meat.

ECONOMICS

A comparative economic analysis of different culture systems in 1985 showed that all production systems are profitable with integrated production systems generally more profitable than individual production systems (Israel unpublished). The profitability indicators (Table 1) show that the integrated hatchery-nursery system is the most profitable and that the extensive polyculture of prawn and milkfish is the most profitable grow-out culture method. A similar result was obtained in 1986 in a polyculture study by Kuntiyo and Baliao (unpublished). Economic analysis showed a higher annual profitability of US\$135.3 net income after tax, 45.2% return on investment (ROI) and payback period of 2.21 years for polyculture of 20 000/ha prawn plus 2 000/ha milkfish as against the monoculture of prawn (20 000/ha) having annual profitability of US\$2 660.7, 38.69% ROI and 2.49 years payback period. The most recent culture system introduced which is highly viable is the monoculture of prawn in a modular pond system. Cost and return analysis showed ROI of 69.5 and 72% and payback period of 1.4 and 1.3 years for prawns stocked at 15 000/ha and 20 000/ha, respectively (Pudjatno and Baliao unpublished).

PRODUCTION CONSTRAINTS

In spite of the headway that AQD made in the culture of *P. monodon* through research, problems continue to beset both the nursery and grow-out phases of the industry. Some of these are:

1. Erratic and insufficient supply of seeds for intensive culture.
2. Lack of knowledge of nutrient requirements.

Table 1. Profitability indicators of individual and integrated prawn production systems

	Payback period (yr)	B/C ratio	IRR
Backyard hatchery	1.1	1.47	123
Pond nursery	2.2	1.08	54
Extensive monoculture	4.5	1.14	29
Semi-intensive monoculture	4.5	1.11	28
Extensive polyculture of prawn and milkfish	3	1.27	45
Extensive polyculture of prawn and shrimp	5.5	1.08	23
Integrated hatchery-nursery system	0.5	1.58	225
Integrated hatchery nursery-grow-out system	1.2	1.38	86

Israel unpublished.

3. Insufficient supply of locally produced good quality feed ingredients.
4. High cost of formulated diets. About 60% of the operational cost of the culture of prawn is due to feed.
5. Financial constraints. Although the intensive method of culture has been found profitable, the development and operational cost is staggering.
6. Shortage of trained and qualified technicians.
7. Absence of effective harvesting devices for *P. monodon*.
8. Unacceptability of shrimps in the world market due to sub-standard quality resulting from inefficient post-harvest handling of product. Lack of ice plants, lax quality control measures, lack of marketing infrastructure, transport and handling facilities.
9. Lack of systematic technology verification and transfer of prawn culture under different environmental conditions.

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