

The Operation And Production In Penaeid Farm

Ludi Parwadani Aji*

Technical Implementation Unit For Marine Biology Conservation, Research Centre For Oceanography, Indonesian Institute of Science (LIPI), Biak - Papua Barat.

Abstract

Penaeid prawn demand in the world market has brought about a dramatic raise in the price of prawns, so, the aquaculture prawn industry also increase. Prawn farming can be divided by intensive, semi intensive or extensive culture system. Extensive culture system has low stocking densities, whereas, intensive culture (very high stocking densities) has highest level of environmental control such as recirculation system and stable ecological system. Predation and disease is the major obstacles in culture system. To deal with predation, farmers use net for covering the ponds and fencing the ponds. Disease organism such as parasites, bacteria, fungal and viruses may be eliminated through sterilization of the water. The commercial diets made from squid and white fish meal may replace fresh diet in semi-intensive culture as fish diet has a problem with preservation. Moreover, maintaining water quality such as dissolve oxygen, pH, nitrogen (ammonia and ammonium) and temperature is very important to support productivity and profitability in prawn farming. The most prominent aims at harvest are to pack the prawn in a way that avoids physical damage, minimize the quantity of prawn left on the bottom of pond, and directly chill prawn. Therefore, good management of water quality, feeding, disease, predation, and harvesting is important in prawn culture.

Keywords : penaeid, prawn, culture, production, water quality

Introduction

Penaeid prawns live in the continental shelf or deep water and as part of their life cycles; generally they migrate to coastal lagoons. They do not occur in areas where mean surface water temperature is below 20°C in summer, so, temperature is one of the limiting factors for them [22]. Penaeid prawn demand in the world market has brought about a dramatic raise in the price of prawns and the expansion of the fisheries around the world [2]. They have been cultured in Asia for many years which modern culture that was began in 1933 through the work of Fujinaga (Japanese zoologist) [7]. Technique in prawn culture has been developed to increase production mainly in the countries where ecological and geographical conditions are suitable for prawns. Since 1974, semi-intensive and extensive aquaculture has been considered in mainland France and more intensive prawn culture in the French overseas territories [8].

An aquaculture facility requires an adequate quantity of good sites and water quality to produce a high quality yield. Requirement for water treatment may exceed the profit potential [4]. For instance, marine shrimp farm in Chicago has established indoor facilities around hundred kilometers from the nearest ocean [7]. Thus, it easy to mix freshwater in the pond with seawater and it will give sufficient water quality requirement to shrimp culture. Soil selection is also eminent to establish pond culture [3]. Low standard soil characteristics may bring about seepage from pond [6]. As a result, having a poor site selection may lead to low profitability or financial disaster. On the other hand, to increase profitability and production, pond management such as control water quality, predation, disease, and feeding are important. Therefore, this paper aims are to examine the pond management in aquaculture farm in general.

Grow out system

Prawn farming can be divided by intensive, semi intensive or extensive culture system. The semi intensive (medium-high stocking densities) have higher production and operating cost than extensive but lower than intensive culture

*Corresponding address:

Ludi Parwadani Aji
Technical Implementation Unit For Marine Biology
Conservation, Research Centre For Oceanography,
Indonesian Institute of Science (LIPI),
Biak - Papua Barat
Email : ludi_bio@yahoo.co.id

system. The semi intensive culture system have water distribution canals, reservoirs, pumping station, use formulated feeds and farm layout is symmetrical. Moreover, the preparation of the pond may be dry-out once or twice a year. In that time, tilling and liming pond with various materials and manure (fertilization) with Phosphorus (P), Nitrogen (N) is necessary to promote natural production in the pond [12]. Natural productivity is eminent for juvenile growth during the early days at all intensities of prawn culture. Pelleted or formulated feeds contain around 30% protein are mostly applied 3 times a day by spreading over the pond surfaces. Feed quantity applied is adjusted based on estimates of prawn biomass [17].

On the other hand, extensive culture system with low stocking densities usually located in estuaries, coastal lagoons and bays. Ponds are stocked with wild prawn postlarvae and farmers usually not give food to prawn. Prawn take food source from natural resource (plankton, animal living in the ponds, small plant, organic matter suspended) and farmer do not control water quality [17]. While, in intensive or super-intensive (very high stocking densities) has highest level of environmental control. They have recirculation system; zero or low rates water exchange, heavy aeration and stable ecological system. [12].

Disease and predation

Disease reflects inferior standard rearing conditions and poor hygiene [19]. For instance, fungal disease caused by *fusarium* has affected prawn production around the world. It occurs because the density of prawns during the on-growing stage is too high and water circulation is poor [17]. The prawn antennae might be damaged if the density is high and it may be the site for fungus to enter. Disease organism such as parasites, bacteria, fungal and viruses may be eliminated through sterilization of the water [19]. The sterilization using ozone and UV light are suitable methods for application in aquaculture to avoid disease. In addition, maintaining a good or un-stressful environment for the culture organisms is the best option to prevent parasite and disease problem [9].

Predation is also one of the problems in culture system. Unwanted animals (crustaceans, mollusk and fish) enter pond with incoming water may has a negative effect on production. They can be competitors for food, predator of cultured animals and influence water quality [21].

To avoid that, filtering the water input to culture system may be achieved by passing water through netting or fine meshed screen. Netting and screens must be cleaned periodically as they tend to become blocked. For other predator such as turtles, water rat, snake, and bird can be prevented to enter pond by placing large mesh nets over and side the ponds [18]. The other method to avoid predation can be achieved effectively by drying out the ponds and using chemical treatments of water remaining. All benthic species and algae must be removed and cement structure should be cleaned in dry out period [9]. Moreover, applying calcium hydroxide also necessary to increase alkalinity and destroy pathogens.

Feeding and nutrition

Feeding is the important issue for semi intensive and intensive prawn's culture. The yield of intensive and semi-intensive culture is much higher than extensive culture. For example, semi-intensive rearing operations produce approximately 2 tonnes/ha [17]. Thus, unlike in extensive prawn culture, the artificially formulated diets is applied as they are produce a small amount of waste and are adapted to the needs of the prawns [14]. The commercial diets made from squid and white fish meal may replace fresh diet in semi-intensive culture. Fresh diet (mussels, small clams, etc) for prawns have problems of quality, preservation, and various price throughout the year. For larval *Penaeids*, live organisms such as *Isochrysis*, *Chaetoceros* and *Artemia* are provided as a food [18].

All of prawn food will pollute the pond bottom if not be eaten. It leads to toxicity and mortality in the cultured prawns [15]. Therefore, feeding time for prawn is important to be known. Prawn like *Penaeus japonicus* is nocturnal species that burrow during the day. Therefore, feeding activities may be given at nightfall when the prawn leaves their burrows. Food shall be distributed in the deepest part of pond, so any uneaten food can be removed in the following day.

The protein diet between *Penaeus* species is different. For instance, *P. merguensis* require 20% and *P. japonicas* needs higher protein at around 55% [17]. For minerals, prawn needs a level of 1.7% in the diet and they can extract calcium from seawater. Prawn also have requirement of vitamin and cholesterol, but high level of

cholesterol and vitamin C can inhibit prawn growth [20].

Water quality

Maintaining water quality is very important to support productivity and profitability in prawn farming. The pond water quality in Penaeid prawn is always controlling and monitored to prevent ponds crash that can lead to mass mortality in growout prawn. The workers measure water quality in the field with meters and probes or by collecting water sample to be analyzed in laboratory. Thus, managing the quality of intake water, soil condition and pond water are important for good penaeid prawn husbandry.

1. Dissolve oxygen

Dissolve oxygen (DO) are extremely essential parameter in penaeid pond culture. Poor growth and mortality in penaeid ponds is mostly caused by low dissolve oxygen. The level of DO can be unstable owing to fluctuation in oxygen production by phytoplankton photosynthesis [1]. During the day, sunlight is available for plankton and algae to do photosynthesis process. From photosynthesis, carbon dioxide will be absorbed and oxygen will be released. However, during the night, all aerobic organisms will absorb O_2 and release CO_2 because of respiration process. Therefore, DO level will be increase during the day and decrease during the night. It may need to sample dissolve oxygen at mid-afternoon and dawn. When a problem is discovered, several actions to add O_2 may be taken such as pumping water from the pond into the air, adding new well oxygenated water and allowing water to splash back [18].

To maintain DO level in the pond, Penaeid farm do water exchange and use paddlewheel aerator. According to Chen and Malone [10], water exchange is an effective equipment to increase dissolve oxygen level and flush out wastes. The water exchange should be done periodically by fixed schedule rather than flexible schedule. Paddlewheel will create continuously current and splashing water that lead to increase the diffusion process of O_2 from the atmosphere to the water. The splash created

by paddlewheel aerator also allowing ammonia and CO_2 to be released into the atmosphere [10].

2. pH

The pH in Penaeid farm are maintained around 7.4 - 8.3 with pH less than 6.5 have higher risk than pH more than 8.5. Low pH can influence the mineral accumulation in the prawn exoskeleton after moulting which lead to soft prawn [17]. When the dissolved carbon dioxide is higher, the pH is lower (at dawn) and when the dissolved CO_2 is lower, the pH will be higher (in mid afternoon). Therefore, maintain algae and phytoplankton community in the ponds is necessary because they can take CO_2 for photosynthesis. By photosynthesis, CO_2 will decrease and pH will increase [1]. When the pH start to drop below 7, the buffering compound should be added to the pond. It may be done by liming the ponds to increase alkalinity [7]. Higher alkalinity will make phosphorous available in water because if the alkalinity is low, soil will bind phosphorous and phosphorous will not available in water. The available of phosphorous in water will give nutrition for phytoplankton and lead to phytoplankton bloom.

3. Nitrogen

Nitrogen exist in pond in many forms such as nitrite (NO_2^-), nitrate (NO_3^-), ammonium (NH_4^+), un-ionized ammonia (NH_3), dissolved gaseous N_2 and organic molecules (urea, amino acid) [3]. Ionized ammonia in the form of ammonium and nitrates can be assimilated by phytoplankton. Ammonium is transformed into nitrites then nitrates by oxidation which called nitrification process (figure 1). However, if ammonium is transformed to NH_3 , even in low level it will be toxic and lead to poor growth. The amount of NH_3 will increase with declining of salinity, CO_2 , hardness or increasing of pH and temperature [4]. Uneaten food, die offs of organism (algae, plankton, cultured species, etc) and waste from prawn (protein digestion) can be accumulated as nitrogenous wastes which can have toxicity for cultured prawn. Hence, do not overfeed, water exchange and liming the pond can be applied to minimize ammonia concentration in the ponds [5].

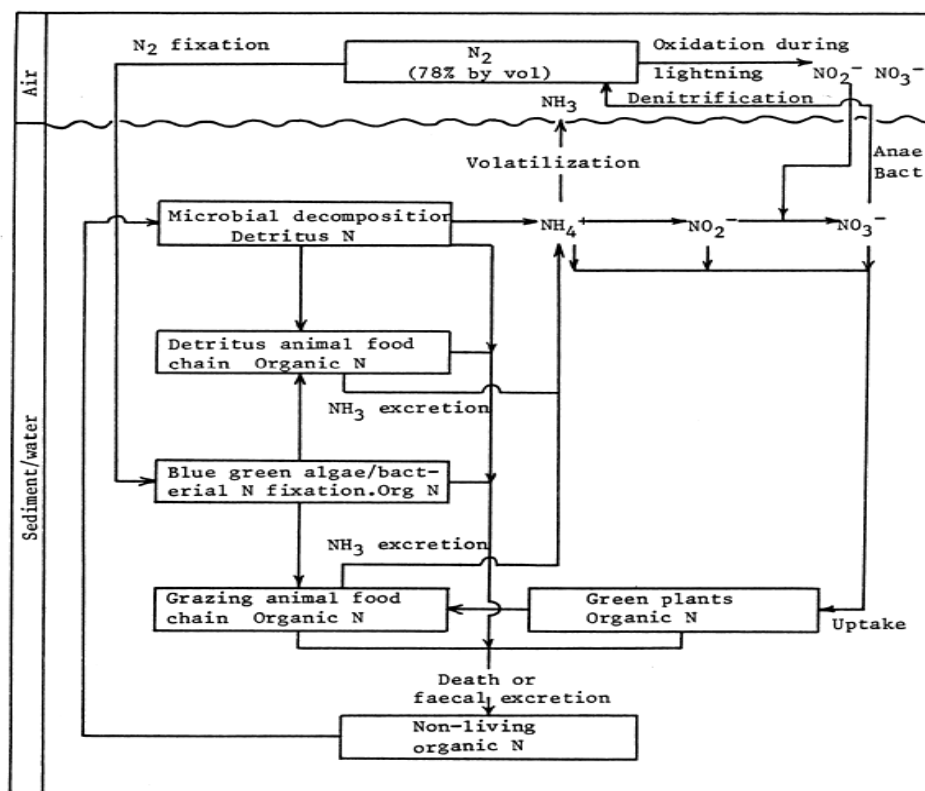


Figure 1. Nitrogen cycle in ponds (Source: FAO).

4. Temperature

The metabolic rate of penaeid prawn is influenced by temperature. Prawn can live in range temperature between 24 – 30°C and if the temperature below or above ambient, their growth rates will not maximal [17]. Temperature outside the optimum range can act as stressors that lead prawn not feed as usual. Waste feed from uneaten food will be decayed by bacteria that lead to higher biological oxygen demand (DO level decrease). In addition, uneaten food will increase ammonia accumulation in ponds [4]. Therefore, regularly checked temperature is important.

Harvesting

Harvesting is one of critical issues in prawn culture. Prawn is highly perishable, easily damaged or fragile, require careful handling, and no amount of manipulation can reinstate product quality once it is lost [22]. The most prominent aims at harvest are to pack the prawn in a way that avoids physical damage, minimize the quantity of prawn left on the bottom of pond, and directly chill prawn. Farmers have to know exactly when the time to harvest prawn that some consideration must be taken such as

prawn size, price and maximizing the economic return of the production cycle. Before harvesting time, prawn texture must be monitored by collecting sample to be determined the proportion of them which are molting [17]. Market have great expectation to receive prawn that have hard shell rather than soft prawn (molting) or semi-hard (post molting).

Prawn farm are harvesting the production by draining through a net or by using a harvest pump. Around 1-2 days before harvesting, water level in the pond is lowered to around 50% of their operational levels. This practice is commonly used to reduce prawn stress that will influence the quality [18]. In addition, prawn is handled carefully during packaging to minimize damaging the product. Harvested prawn is separated into different size and layered with ice to reduce metabolic activity.

Conclusion

Good management of water quality, feeding, disease, predation, and harvesting is important in prawn culture. However, to increase profitability and productivity in prawn culture, genetic improvement may also a good way as prawn have high fecundity and short generation

interval [17]. By genetic approach such as selective breeding, prawn which has tolerance of disease and higher growth rates may be achieved. Moreover, good management is not only to increase productivity and profitability but also should not have negative impact for surrounding environmental.

References

- [1] Ackefors, H., Huner, J.V., Konikoff, M. (Eds.), 1994, Introduction to the general principles of aquaculture. Food Products Press, New York.
- [2] Anderson, R.K., P.L. Parker and A. Lawrence, 1987 A $^{13}\text{C}/^{12}\text{C}$ tracer study of the utilization of presented feed by commercially important *Penaeus vannamei* in a pond grow-out system. J. World Aqua. Soc., 18(3): 148–155
- [3] Anon. 1981 Compost Technology. FAO/UNDP Regional Project RAS/75/004 (Improving soil fertility through organic recycling), Project Field Document No. 13 214 p.
- [4] Arce, R.G. and C.E. Boyd, 1975 Effects of agricultural limestone on water chemistry, phytoplankton productivity, and fish production in softwater ponds. Trans. Am. Fish. Soc., 104:308–312
- [5] Arce, R.G., Boyd, C.E., 1975. Effect of agricultural limestone on water chemistry, phytoplankton productivity, and fish production in soft water ponds. Trans. Amer. Fish. Soc 2, 308-312.
- [6] Ballesteros, O.Q. and S.P. Mendoza, 1976 Brackish-water fishpond management, pp. 19–27. In Pond Construction and Management. Western Visayas Federation of Fish Producers, Inc., Philippines
- [7] Barnabe, G. (Ed.), 1990, Aquaculture. Ellis Horwood, London.
- [8] Barnabe, G., 1994, Aquaculture biology and ecology of cultured species. Ellis Horwood, London.
- [9] Brock, J.A., 1986. Pond production systems: Diseases, competitors, pests, predators, and public health considerations. In: Lannan, J.E., Smitherman, R.O. and Tchobanoglous, G., 1986(Eds). Principles and practices of pond aquaculture, Oregon state university press, USA, pp. 169-191
- [10] Chen, S. and Malone, R.F., 1991. Suspended solids control in recirculating aquacultural systems. In: Engineering Aspects of Intensive Aquaculture, Proceedings from the Aquaculture Symposium, Cornell University, Ithaca, NY. Northeast Regional Agricultural Engineering Service, NRAES, 49: 170-186
- [11] Cho, C.Y., C.B. Cowey and T. Watanabe, 1985 Finfish nutrition in Asia: methodo-logical approaches to research and development. Ottawa, Ont., IDRC - 233e, IDRC, 1985. 154 p.
- [12] Colvin, L.B., 1985. Intensive grow-out systems for shrimp 1V-1. In Texas Shrimp Farming Manual (G.W. Chamberlain, M.G. Haby and R.J. Miget, Editors). Texas Agricultural Extension Service publication of invited papers presented at the Texas Shrimp Farming Work-shop on 19–20 November, 1985 in Corpus Christi, Texas, USA
- [13] FAO, 2006. State of world aquaculture 2006, Food and agriculture organisation of the United Nations, FAO Fisheries Technical Paper No. 500, Rome, 2006
- [14] Fernandez, R. and F. Puchal, 1979. Studies on compounded diets for *Penaeus kerathurus* shrimp. Proc. World Maricul. Soc. 10:781–787
- [15] Garson, G.I., R.M. Pretto and D.B. Rouse, 1986 Effects of manures and pelleted feeds on survival, growth and yield of *Penaeus stylirostris* and *Penaeus vannamei* in Panama. Aquaculture, 59:45–52
- [16] Ionno, P.N.D, Wines, G.L., Jones. P.L. and Collins, R.O., 2006. A bioeconomic evaluation of a commercial scale recirculating finfish growout system — An Australian perspective, Aquaculture, 259: 315–327
- [17] Lucas, J.S., Southgate, P.C. (Eds.), 2003, Aquaculture farming aquatic animals and plants. Blackwell Publishing, Oxford.
- [18] Stickney, R.R. (Ed.), 2005, Aquaculture an introductory text. CABI Publishing, Cambridge.
- [19] Thoesen, J.C., 1994. Suggested procedures for the detection and identification of certain finfish and shellfish pathogens. Version I. fish health section, American fisheries society, Bethesda, MD.
- [20] Thomson, K.R., Metts, L.S., Muzinic, L.A., Dasgupta, S., Webster, C.D., 2006. Effects of feeding practical diets containing different protein levels, with or without fish meal, on growth, survival, body composition and processing traits of male and female Australian red claw crayfish (*Cherax quadricarinatus*) grown in ponds. Aquaculture Nutrition 12, 227-238.
- [21] Timmons, M.B., Ebeling, J.M., Wheaton, F.W., Summerfelt, S.T. and Vinci, B.J., 2001. Recirculation aquaculture systems, Northeastern Regional aquaculture centre, New York, USA, 650pp
- [22] Yamaguchi, M. (Ed.), 1991, Aquaculture in tropical species. Midori Shobo Co., Ltd, Tokyo.