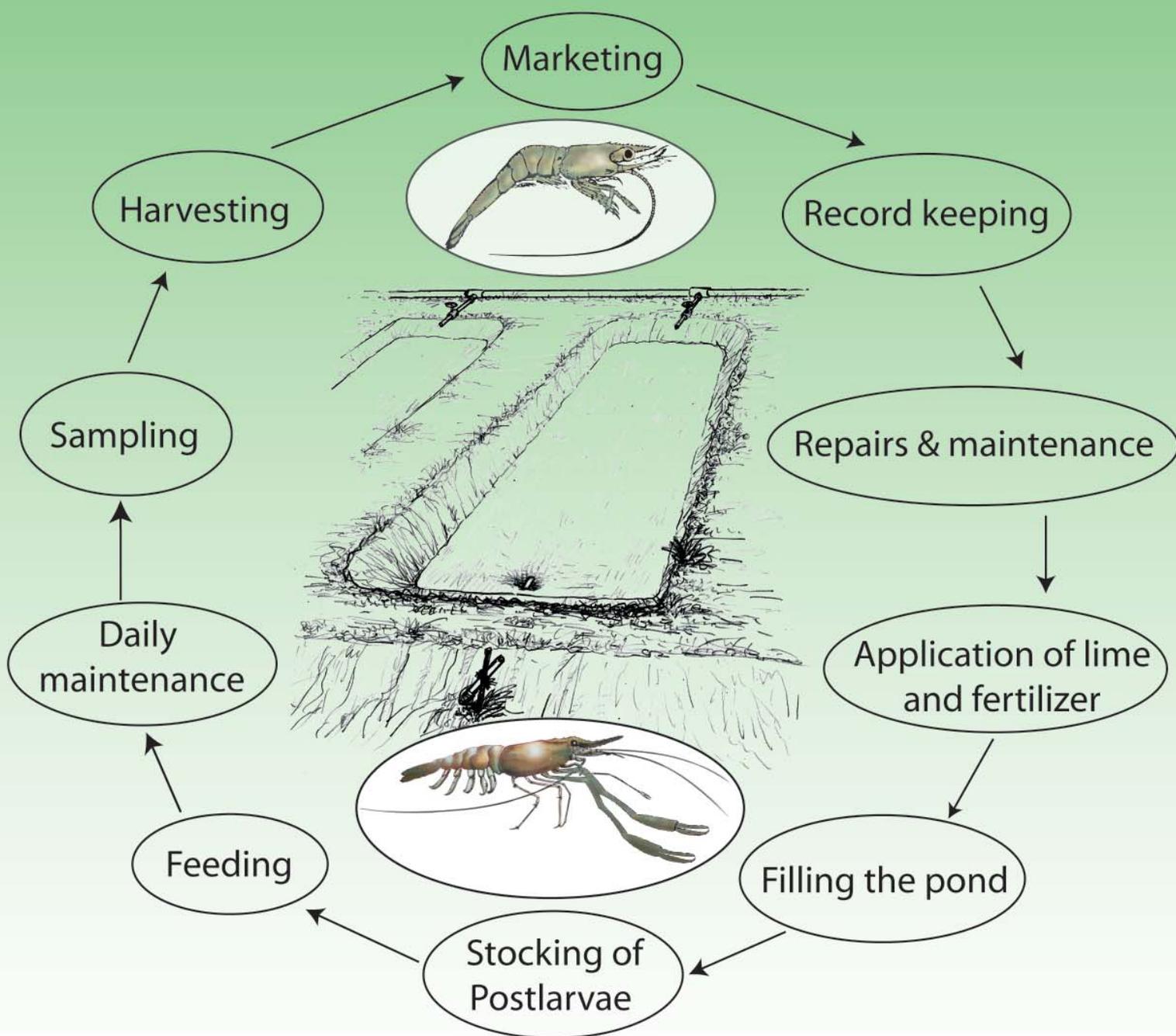


Freshwater prawn *Macrobrachium rosenbergii* farming in Pacific Island countries

Grow-out in ponds

Volume 2

Satya Nandlal
and
Timothy Pickering



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Grow-out in ponds

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SPC
Secretariat
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Preface

Since the 1980s, freshwater prawn (*Macrobrachium rosenbergii*) farming has been tried in several Pacific Island countries. *Macrobrachium rosenbergii* is the main freshwater prawn species used for commercial aquaculture because of its fast growth, attractive size, meat quality and omnivorous (eating both plants and animals) feeding habits. There is also good demand for it in domestic and export markets. This species is presently farmed and sold in Fiji Islands under the name “river prawn”.

In Fiji Islands, production grew from less than 500 kg in 1986 to about 5 metric tonnes (t) in 2003 and continues to expand. Total annual production in Fiji Islands is forecast to reach 50 t by 2010. This growth in interest in freshwater prawn farming provided the stimulus for the preparation of this manual.

The manual is intended for freshwater prawn farmers operating on a small-scale commercial level. It can also be used as a textbook by Fisheries Department officers, staff of rural community development projects, school teachers, or others responsible for providing training to people engaged in freshwater prawn farming in Pacific Island countries.

There are many other booklets and training materials available for freshwater prawn farming. However, these are written mainly for Asian readers and contain detailed technical information aimed at large-scale commercial growers (see Further reading). This manual is aimed specifically at small-scale growers in Pacific Island countries. It presents the essential information that farmers need to get started and is based on practical experience of what works in the environmental and cultural circumstances of the Pacific Islands.

In preparing this manual the authors have drawn heavily on information gathered during training workshops run in Fiji Islands from 2002 to 2004 by the Institute of Marine Resources of the University of the South Pacific (USP), the Fiji Fisheries Department, and the Aquaculture Programme of the Secretariat of the Pacific Community (SPC). The costs of producing the manual were met by AusAID through funding granted to SPC’s Aquaculture Programme

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1.0 Introduction

Pacific Island countries and territories have a suitable climate for culture of the giant river prawn, *Macrobrachium rosenbergii*. Despite this, there is currently only limited production of prawns within the region. Now, increasing demand and record prices for seafood are raising the profile of freshwater prawns as an important aquaculture commodity.

Although earlier attempts to farm *M. rosenbergii* in Hawaii, French Polynesia and New Caledonia failed, some farms are now operating successfully in Fiji Islands. Other countries such as Vanuatu and Papua New Guinea are moving in the same direction.

Freshwater prawn farming is not nearly as technically demanding or capital intensive as farming of sea prawns (penaeid shrimp) so it is a more accessible system for small-scale operators. In addition, freshwater prawn production tends to be more environmentally sustainable (compared with penaeid shrimp) because prawns are territorial in nature and are stocked at lower densities. They can be farmed in warm climates wherever there is a suitable site with a good supply of fresh water. Provided small-scale operators can obtain a supply of prawn postlarvae from a hatchery, they can raise freshwater prawns in earthen ponds using similar methods to those used for farming tilapia in ponds. Unlike tilapia farming, however, the farming of freshwater prawns in earthen ponds is still in its infancy in the Pacific, with the exception of Fiji Islands.

Macrobrachium rosenbergii has been introduced for aquaculture to many areas outside its natural range. It is farmed in China, India, Thailand, Vietnam, Bangladesh, Malaysia, Taiwan, and in Ecuador in South America. In the Pacific, it is farmed in Fiji Islands, Hawaii, and even New Zealand.

Another freshwater prawn, *Macrobrachium lar* (monkey river prawn), is native to many countries in the Pacific Island region and also grows to a large size. Techniques for rearing *M. lar* larvae in hatcheries have not yet been developed. However, in some countries (for example, Vanuatu and Futuna) wild juveniles are traditionally grown in taro swamps.

Freshwater prawn culture involves three phases: hatchery, nursery and pond grow-out. The technology to produce prawn postlarvae under artificial conditions in hatcheries has developed to the stage where it is now being extended to the private sector in Fiji Islands. A companion volume to this one (Freshwater prawn *Macrobrachium rosenbergii* farming in Pacific Island countries. Volume one: Hatchery operation) describes techniques that have proved to be suitable for a small-scale freshwater prawn hatchery under Pacific Island conditions. There are two suppliers of postlarvae and juveniles in Fiji Islands and increased demand will lead to the establishment of more hatcheries.

While there is a great deal of interest in prawn farming, intending producers must carefully investigate the requirements for achieving success. Freshwater prawn farming is not for everyone and is certainly not for the “weekend farmer”. Like other live animals, prawns require daily attention and a patient approach. Because they are farmed at relatively low densities (i.e. fewer per cubic metre of water) compared to penaeid shrimp, for example, yields are much lower. In addition, at harvest, freshwater prawns tend to vary more in size than penaeid shrimps, which affects production and marketing.

To increase the commercial viability of prawn production, it is important that production rates are maximised by following the methods described in this manual. Advice is available from fisheries extension or fish project officers, and other educational materials are available from SPC (see Further reading). This information can help people decide if they should become involved in prawn farming.



Whether the intending grower plans to use personal resources or a bank loan to finance the development of the project, a feasibility study is needed. The feasibility study will guide the planning and development of the project. Construction costs, operating costs, and a financial analysis to calculate returns on investment should be included in the feasibility study.

This manual assumes that the decision to become a freshwater prawn farmer has already been made and provides practical information on site selection, pond construction and preparation, prawn stock management, prawn harvesting, and other information needed for semi-intensive grow-out of freshwater prawns in ponds in Pacific Island countries. Although some farmers grow postlarvae for a few weeks in nursery ponds or tanks before transferring them to grow-out ponds, the method described in this volume is for pond grow-out without a nursery phase.



2.0 Biology of *Macrobrachium rosenbergii*

To operate successfully a prawn farm, the grower must reproduce the conditions experienced by the prawn in its natural environment. This requires an understanding of the biology of *Macrobrachium rosenbergii*, which is briefly described in the following sections.

2.1 Distribution

Freshwater prawns belong to the genus *Macrobrachium*. Species of the *Macrobrachium* genus are distributed throughout the tropical and subtropical zones of the world. About 200 species of the genus are described in various books and journals. These prawns are usually found in inland freshwater areas including rivers, streams, creeks, irrigation canals and ditches, lakes, ponds and estuarine areas. Most of the species require brackish (slightly salty) water or seawater in their larval stages of development and at this stage are usually found in water that is directly or indirectly connected to the sea.

2.2 Morphology

The adult *M. rosenbergii* (Fig. 1) is easily distinguished from other *Macrobrachium* prawns by the following characteristics:

- The adult male has a pair of very long legs (chelipeds).
- The rostrum is long and bent in the middle with 11–13 dorsal teeth and 8–10 ventral teeth.
- The movable finger of the leg of the adult male is covered by a dense mat of spongy fur.
- There are distinct black bands on the dorsal side at the junctions of the abdominal segments.

Males are larger than females of the same age. The male has a head (cephalothorax) proportionally larger than the abdomen, which is narrow, and very large chelipeds. There are three types of adult males:

- The blue claw (BC) has large, blue, spiny, hairy claws and is the most sexually active.
- The orange claw (OC) has large, spineless, light-orange claws; within this type, the small individuals (SOC) are more sexually active than the larger ones.
- The small male (SM).

The female has a smaller head and slender claws compared to the male. The first three abdominal pleura are elongated and broad and form a brood chamber for incubating eggs. There are three types of females:

- Virgin females (V or VF).
- Berried females (BF), which are egg-carrying females.
- Open brood chamber (spent) females.

When the female is in a “ripe” condition, the deep-orange ovaries are visible through the carapace, extending from just behind the eyes to the first abdominal segment.

The first and second pairs of legs end in claws and are used for capturing and holding food. The third, fourth and fifth pairs are used for walking. The pleopods are used for swimming. The prawn moves or jerks backwards using the telson and the uropods.



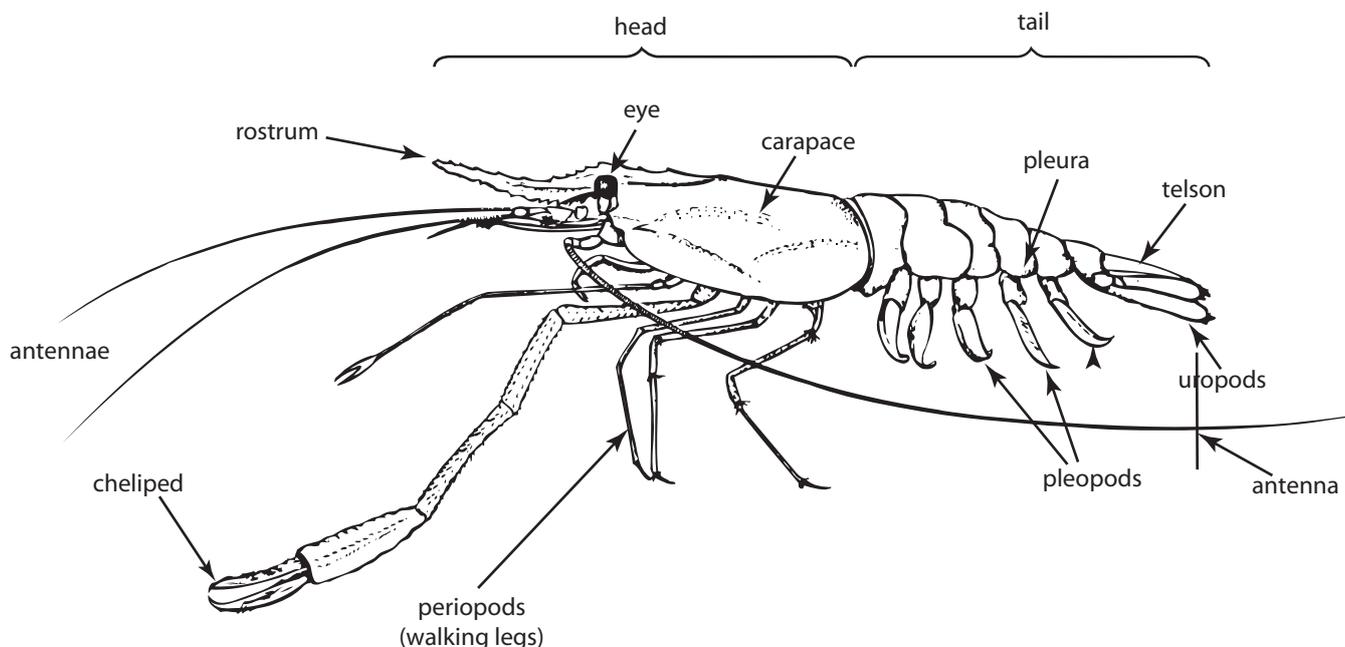


Fig. 1. External anatomy of freshwater prawn *Macrobrachium rosenbergii* (male)

2.3 Life history

The larvae hatch from eggs carried on the underside of the female and reach brackish waters or coastal zones with salinities of 8–14 parts per thousand (ppt) within 1 to 2 days. At this stage, larvae swim upside down and tail first. They feed on plankton and the larvae of other aquatic organisms. The larvae change their body form (metamorphosis) into that of miniature adults called postlarvae (PL). These PL settle to the bottom and migrate from the coast upstream to inland areas. PL are whitish, grey and brownish in colour, gradually changing to light-brown and bluish as they grow into juveniles and adults.

Juveniles and adults are slow moving and hide in shade and under shelter in the shallow areas of rivers, canals and ponds during the day to avoid sunlight but are very active at night. They normally swim slowly and constantly but if disturbed in any way, they jerk backwards and retreat.

As in almost all crustaceans, the prawn has to cast off its hard shell (exoskeleton) in order to grow. The soft weak prawn that emerges pumps water into its body to expand its size before the new shell hardens. The process of regularly casting off the hard shell to allow further growth is known as moulting. After the animal has grown, the soft membrane-like new shell gradually hardens. Shell hardening may be delayed by acidic water or a lack of calcium in the diet. While the shell is still soft, the prawn is at its most vulnerable stage, helpless against predatory fish such as eels or cannibalism by other prawns.

Prawns grow faster when they have plenty of high-quality food and the right environmental conditions, especially in terms of dissolved oxygen and water temperature.

Both males and females grow at a similar rate for the first 2–3 months. They both reach first maturity at about 15–35 g, within 4 to 6 months after the postlarvae stage. After the prawns reach maturity (about 20–35 g in size), the females begin to divert more energy into egg production and less into growth, so males end up much larger than females.

Some males become socially dominant and can reduce the growth of other males, leading to significant variations in size. This is one of the drawbacks of farming this species of prawn.



Adult males show strong territorial behaviour and individuals maintain a clear area around themselves, within the radius of the sweep of their antennae, into which no other members are allowed.

Juvenile and adult prawns are omnivorous and feed on a wide variety of food items such as aquatic worms, insects and their larvae, small molluscs and crustaceans, flesh and offal of fish and other animals, grains, nuts, seeds, fruits, algae, and tender leaves and stems of aquatic plants. They prefer animal sources of food and sometimes may even be cannibalistic. They also consume their moulted shells.

Prawns locate their food mostly by touch with their antennae. When prawns are farmed, food is often not completely eaten immediately because of their territorial nature, so feeds that last well in the water and maintain an attractive odour are needed.

3.0 Comparison of prawn and tilapia farming

In Pacific Island countries where tilapia farming is already established, freshwater prawn farming can be carried out in tilapia ponds, as a continuation of tilapia farming. Farmers who have no experience in any aquaculture are strongly advised to read Volumes 1 and 2 of *Tilapia fish farming in Pacific Island countries*. They are also urged to consider starting with tilapia farming to learn some basic aspects of fish farming before trying prawn farming.

Freshwater prawns can be raised successfully from the PL stage to market size in the same types of ponds as used for tilapia. Prawns can also be fed the same types of formulated diets as used for tilapia. The main attraction of prawn farming is that it is more profitable than tilapia. However, prawns are not as hardy as tilapia. Raising prawns in ponds requires more daily attention and technical skill in pond management than tilapia farming (Table 1).

Table 1. Advantages and disadvantages of farming freshwater prawns in comparison to tilapia

Advantages	Disadvantages
Much higher price per kg than tilapia	Not as hardy as tilapia
More profitable use of pond area	Require higher quality water
Can use same type of pond as for tilapia	Farmers need more knowledge and skills
Can use same pelleted feed as for tilapia	Higher risk - poor water quality can kill prawns
No loss of value when sold dead or frozen	PL must be obtained from a hatchery
Easy to harvest and handle because of shells	More valuable, so more risk of theft

In summary, anyone new to freshwater aquaculture would be well advised to start with tilapia farming. Once they have developed the ability to farm tilapia successfully, they can then consider moving on to the more profitable and demanding activity of prawn farming.



4.0 Establishing a prawn farm

A suitable site is essential for prawn farming and is one of the critical factors for a successful farm. This is because, compared with tilapia, prawns are less tolerant of poor pond conditions. Starting a farm on the wrong site is likely to result in failure and losses to growers and investors. It is therefore essential that intending growers consult a qualified adviser from the government or an appropriate agency for advice and guidance on any proposal to develop a prawn farm.

4.1 Selecting a farm site

Below is a list of the ideal requirements for a farm site:

- Flat or gently sloping land that does not get flooded.
- Reliable supply of good quality, pollution-free fresh water available at low cost.
- Water source preferably on land owned by the grower.
- Water source preferably at a higher level than the ponds, so that the ponds can be filled by gravity rather than by pumping.
- Place for water to drain away that is lower than the ponds so that the ponds can be emptied by gravity rather than by pumping.
- Water discharged from the pond will not mix with water used for domestic purposes.
- Soil has enough clay to hold water.
- Site is located near grower's residence.

If there is a limited choice of site, then ensure that as many of the above requirements are met as possible. For example, a prawn farm may still be profitable if water has to be pumped into or out of the ponds when filling and emptying them. However, it may not be as profitable, especially if water has to be pumped both in and out.

4.2 Initial considerations

Once a site has been selected, the following questions must be answered before any further work is done:

- Is there proof of ownership (that is, documentation) of the site area?
- If the land is traditional land or is owned by a clan, are there documents showing approval for leasing or using the site area?

The grower should then check with local authorities for any planned developments or operations upstream that could affect the water source for the ponds (for example, pig or chicken farms, factories, pesticide spraying). There may also be competition for use of land and water sources. For example, fishing, manufacturing industries, public utilities, recreation and other related activities nearby could affect the project and may compete for resources.

In addition, it is important to ensure that the project will not block or interfere with traditional rights of way, underground water pipes and power lines, or work planned by the government.

4.2 Surveying and planning

Once the above factors have been checked, a survey should be carried out to decide the layout of ponds, water intake and discharge, access roads, reservoir, power poles, farm buildings and so on.

The worst error a prawn farmer can make is to construct ponds quickly without first planning and consulting with the right people. Once constructed, the physical structure of the ponds becomes permanent and it is expensive and difficult to correct mistakes later. Money will be wasted and the project will be difficult to operate if not carefully planned. Poor planning has been a major cause of project failure in several Pacific Island countries.



4.3 Topography of the site

One of the most important aspects of site selection is suitable topography or “lie-of-the-land”. The configuration of the land in terms of water resources and slope greatly affects the efficiency of pond construction and farm operation. Pond construction involves excavating soil or bringing it in from another area. Because moving large quantities of soil is very expensive, moderately sloping or low and flat areas (with slopes between 1–2% or 1–2 m in 100 m) close to a water source are preferable.

Low and flat areas usually require high dykes to protect the ponds from floods. In some instances, soil will have to be carted to the site to make the dykes. If the area is very low, drainage will be a problem.

Very hilly or mountainous areas should be ruled out as it is likely to be too expensive to move large quantities of soil during pond excavation. There may also be a problem in finding somewhere to put the excess soil. While this could be solved by constructing high, wide dykes, large dykes result in a smaller pond water area.

4.4 Climate

Consider the climate of the area to help decide whether prawns can be cultured year-round or only during certain times of the year. The interaction between climate and farm site determines the suitability of the site for pond production of *M. rosenbergii*. Important climatic factors include:

- rainfall
- temperature
- sunlight
- wind exposure

The temperature of the pond water is the most important factor in deciding the best time to stock the ponds and the number of yearly harvests. For example, prawns will only grow well when the water temperature can be maintained at 22–32°C for 4 to 6 months, which is the period needed to grow-out prawn PL to a marketable size.

The temperature of the water in the pond is controlled by the combined effects of the temperature of the incoming water, air temperature, solar warming, wind and evaporation. Pond-water depth also affects the water temperature. For example, ponds with a surface area of 500–1000 m² and water depth of 80–100 cm are preferred. To ensure that a good water balance is maintained, the evaporation loss should be equal to or slightly lower than the amount of rainfall and incoming water combined. However, in some islands and locations, this balance will change seasonally with periods of high rainfall (when deeper ponds are preferred) and high evaporation (which reduces the amount of water in the pond).

Wave action resulting from wind helps to oxygenate the water. However, strong winds can increase water loss by evaporation and generate excessive wave action, which erodes the dykes.

4.5 Water supply

Macrobrachium rosenbergii is normally farmed in fresh water and in some places in slightly saline water (<7 ppt is acceptable). Water can be obtained from surface water sources, which include rivers, streams, creeks, reservoirs and irrigation canals, or from sub-surface sources such as springs, wells and boreholes. The farm should have its own independent water source or supply that is delivered to the farm through a suitable system or, where possible, by gravity flow. The water source must not be shared with a school or village water supply and must be free from pollution, particularly agricultural chemicals and pesticides, and any predators and competitors.



Regardless of water quality, prawns cannot be raised successfully unless there is enough water available. A bulk supply of water (from a river, lake, canal, or purpose-built reservoir) is ideal. It is also important that the water source does not dry up in the dry season or during droughts. When water levels in creeks, streams and rivers fall too low, the water quality can change and become unusable. Water is needed to:

- fill the ponds initially
- top up the ponds to replace water lost through seepage or evaporation
- partially flush the ponds with clean water regularly
- in emergencies, flush out ponds if prawns are dying as a result of poor water quality.

As a general rule, it is necessary to have enough water to be able to flush through approximately 10% of the volume of water in each pond each day or at least every two days. A water pump will be required if the pond cannot be either filled or drained using gravity flow. The costs of fuel or electricity for the pump, and maintenance of pumps and hoses should be taken into account in the feasibility study as these are all expensive.

Water from fast-flowing rivers or streams with rocky or stony beds is usually rich in oxygen, has a moderate amount of nutrients, and may contain no pollutants. This is the preferred source. Well water or borehole water can also be used, but these sources are poor in oxygen and nutrients. Water from marshes or peat swamps should be avoided as it is acidic.

The quality of the water should be tested to see whether values for temperature, pH (acidity), DO (dissolved oxygen), hardness, salinity and other factors are in the ranges known to be good for prawn growth and survival (Table 2). In most cases, farmers do not have access to the equipment needed to make these checks. However, these services can be requested from the Fisheries Department or provided by a professional water analytical laboratory. If investing in a large farm, the grower should buy and learn to use hand-held meters for measuring pH and DO to make daily water quality checks.

Below is a summary of the ideal range of values for various water quality factors (experience has shown that these values are good for prawn survival and growth):

- Water temperature: 26–31°C (at least 120 days of water temperature >22°C).
- Dissolved oxygen: 3–7 ppm (minimum 3 ppm at dawn).
- Acidity: ideally pH 7.0–8.5.
- Hardness as calcium carbonate (CaCO₃): range 30–150 ppm.
- Salinity (saltiness): ideally fresh water (0 ppt), preferably less than 7 ppt for good survival and growth.
- Water colour: light-green or light-brown.
- Water transparency: 25–40 cm.

Table 2 gives a comprehensive list of the water quality parameters recommended for prawn farming.

Table 2. Water quality requirements for freshwater prawn farming

Parameter	Recommended range	Lethal or stressful to juvenile prawns	Levels observed in successful farms
Temperature (°C)	26–31	<18 and > 35	22–28
pH (units)	7.0–8.5	>9.5	5.5–8.3
Dissolved oxygen (ppm)	3–7	>2	
Salinity (ppt)	<7		
Transparency (Secchi reading in cm)	25–40		
Alkalinity (ppm CaCO ₃)	30–60		7–102
Total hardness (ppm CaCO ₃)	30–150		10–75
Non-ionized ammonia (ppm NH ₃)	< 0.3	>0.5 at pH 9.5	
Nitrite nitrogen (ppm NO ₂)	< 2.0		0.1–1.7
Nitrate nitrogen (ppm NO ₃)	< 10		

Source: New and Valenti (2000).



4.6 Soil

Soils for pond construction should be composed of clay, silt and some fine sand. The physical strength, permeability, plasticity and physico-chemical interactions of the soil need to be considered in making decisions on overall site suitability and the most appropriate method of pond construction. It is recommended that soils contain at least 20–50% clay to prevent excessive seepage of water from the pond. If the soil is too sandy, the pond banks will erode easily and water will seep through the pond sides and bottom. If there is porous soil under the pond site, such as sand or gravel, and there is no suitable alternative site, then a layer of clay soil should be compacted over these areas to prevent excessive seepage.

Three simple tests can be used to check whether the soil has enough clay content: the water retention test (Fig. 2), and the soil ball and soil ribbon tests (Fig. 3).

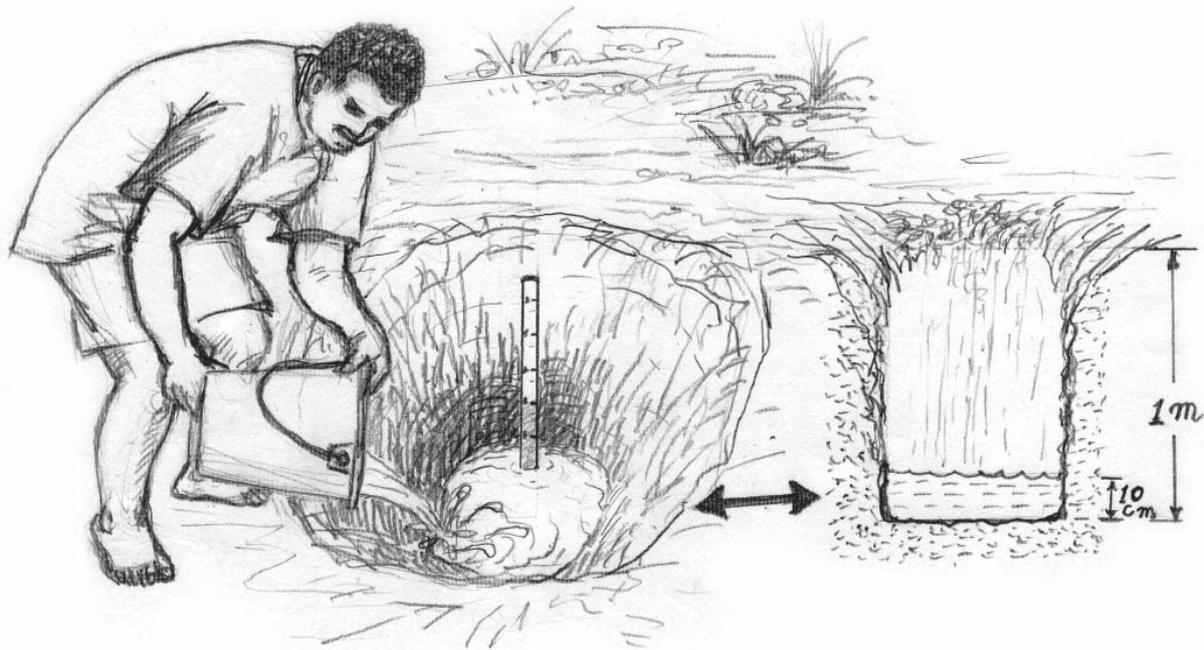


Figure 2. Water retention test

- With a spade, dig three or four pits (holes) of 30 cm diameter and 1 m depth in different parts of the proposed pond site.
- Fill the pits to about 10–20 cm deep with buckets of water.
- Wait about 15 minutes for the surrounding soil to get thoroughly wet, then make a mark on a stick, and drive the stick into the pit bottom so that the mark matches the water level.
- Check each pit again after an hour or so, take the new level mark, and measure how much the water level has dropped in millimetres. If the level has dropped by 3 mm/hour or less, the soil is suitable for pond construction. If the level drops by more than 5 mm/hour, the soil is unsuitable.

Worked example of water retention test

The hole is filled with water at 3.17 p.m. At 4.53 p.m. (96 minutes later) the level has dropped by 7 mm.

$$\begin{aligned}\text{Rate of seepage} &= 7 \text{ mm}/96 \text{ min} \\ &= 7/96 \text{ mm}/\text{min} \\ &= 0.0729 \text{ mm}/\text{min} \times 60 \text{ min} \\ &= 4.375 \text{ mm}/\text{hour}\end{aligned}$$

This is less than 5 mm/hour, indicating that the soil is satisfactory.



Soil ball test

1. Take some of the soil dug earlier from the pit.
2. Wet it slightly and form it into a round ball, slightly bigger than the size of a fist.
3. Drop the ball from head height onto flat ground. If the ball retains its shape, or goes only slightly out of shape, it contains enough clay for pond construction. A ball made from soil that is too sandy will flatten out, crack open, or even shatter on hitting the ground. Alternatively, if the ball remains intact and does not crumble after considerable handling, there is enough clay in the soil.

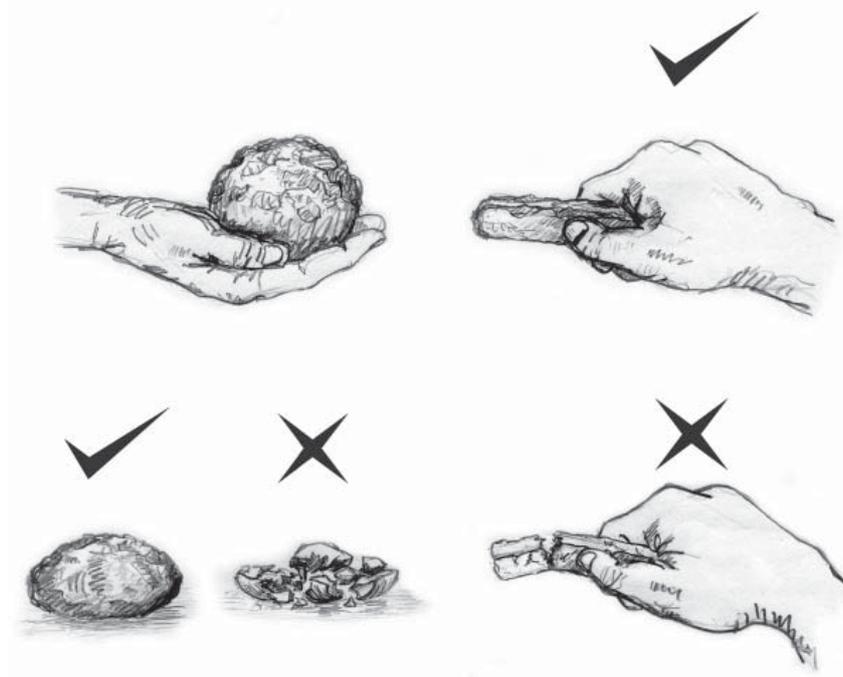


Figure 3. Soil ball test (left) and ribbon test (right)

Soil ribbon test

1. Take some of the soil dug earlier from the pit.
2. Wet it slightly, and try to mould it into a flat ribbon of earth about 3cm wide and 6mm thick. If the moist soil forms into a ribbon of this size, then the soil contains enough clay. If the ribbon cracks and falls apart, this indicates the soil is too sandy to hold water and is thus unsuitable for pond construction.

4.7 Other factors

4.7.1 Flood hazards

The risk of floods in the area needs to be considered. Since floods cannot be controlled, it is important to know whether the ponds will be safe during floods. If not, flood frequency and the extent of likely losses must be taken into account in financial forecasts.

Rainfall records for the past 10–15 years should be analysed. The size of creeks, rivers and drainage canals should also be checked to see whether they can take the run-off water from the pond site. The height of the biggest flood that has occurred in the area can be found by studying flood records from the government weather station and also by talking to people who have lived in the area for a long time.



4.7.2 Availability of technical assistance

Access to technical services and advice during the construction and management of the farm is very important for the successful operation of a prawn farm. These services are usually provided by government extension services, research institutions and NGOs or financing institutions. In the past, aquaculture projects have failed in Pacific Island countries because growers have not had sufficient technical back-up or follow-up services.

4.7.3 Sources of prawn postlarvae (PL)

The availability and cost of PL from local hatcheries or other sources, including the cost of transporting PL from the hatchery to the farm, should be worked out during the planning stages. There is also a need to consider the following:

- Will there be enough PL supplies to stock the ponds whenever required?
- Is the hatchery close enough to the farm to ensure that the PL will arrive in good condition?

4.7.4 Availability and cost of supplies and equipment

Ensure that supplies, such as feed and the equipment needed for the project, are available in the area or in the country. For example, fine-mesh net material for screens might be difficult to obtain or may be available only sometimes. If materials have to be imported, there may be restrictions or extra costs involved.

4.7.5 Availability of skilled labour

Locally available skilled labour is usually cheapest and should be used with due respect for customs, traditions and work ethics to ensure smooth operation of the farm.



5.0 Prawn farm facilities

Freshwater prawns are raised in earthen ponds, reservoirs, irrigation canals, ditches, pens, plastic-lined ponds or concrete ponds. The facilities used for prawn farming are similar to those used for farming fish such as tilapia and carp.

5.1 Pond structure

Before a pond is constructed, the site should be surveyed to determine the elevation and best layout for water intake, discharge of water, access roads, elevation of dykes, pond bottom and structures such as piping (Fig. 4). Ponds should be designed to completely drain within a day. This requires a slope of approximately 0.2–0.3%, or 20–30 cm per 100 m of pond length. Below are some of the features of a well-built pond.

5.1.1 Size and shape

The number of ponds and pond sizes depend on the availability of suitable land, financial resources, cost of construction and other factors. For example, ponds with a surface area in the range of 500–2000 m² are easy for a single household to manage. The amount of water available and the continuity of supply may also set an upper limit on the potential pond area of the farm. Although the number of ponds is a personal decision, several small ponds will cost more per surface area than a few large ponds.

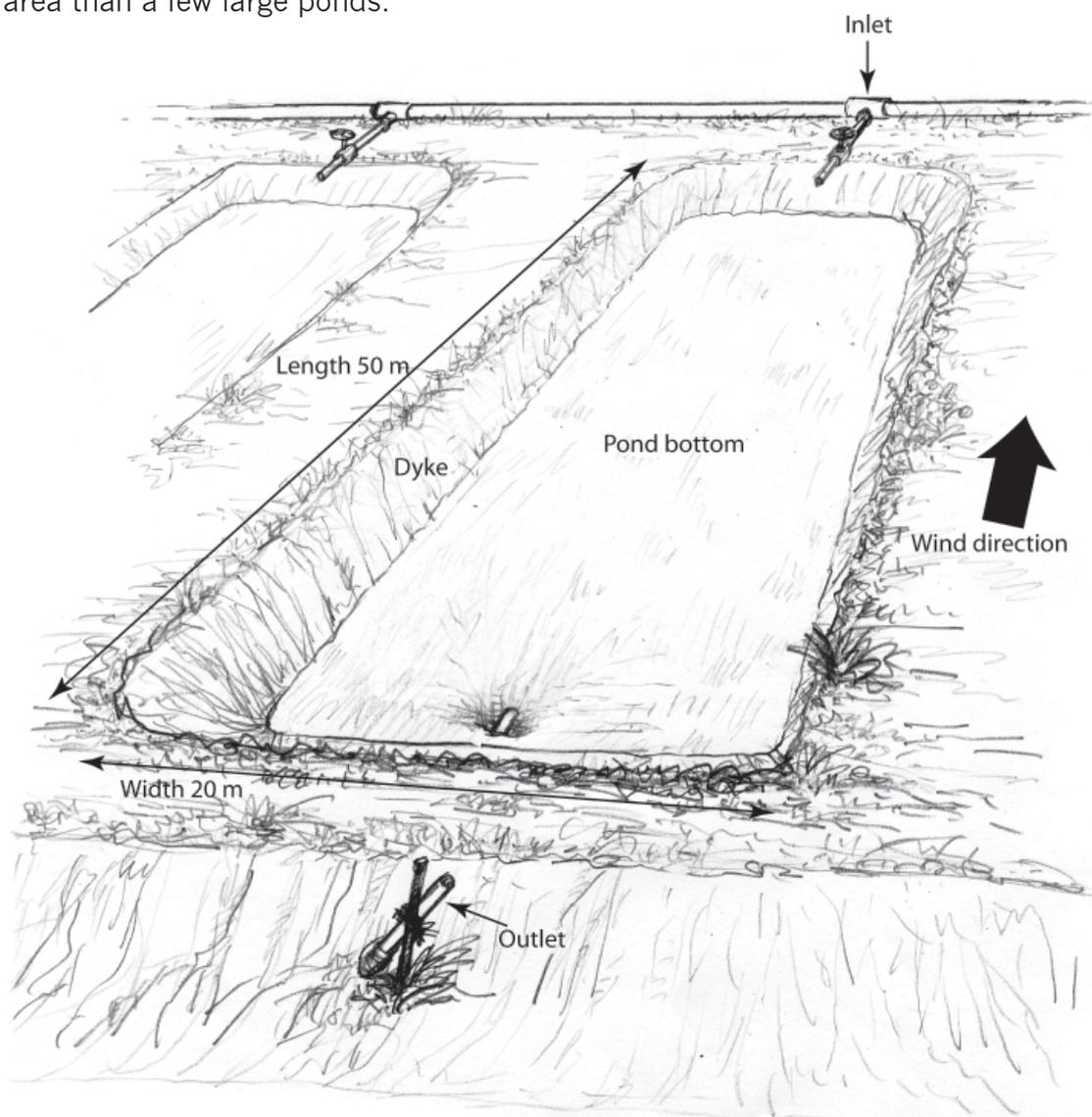


Figure 4. Overall view of ponds



Rectangular ponds are preferable as they are more suitable for harvesting using a seine net. The size of the pond will depend on the availability of land and the farmer's choice of length and width. A length of 20–100 m and width of 15–20 m are recommended. These dimensions will also match the size of the seine nets used for harvesting (the nets are usually provided by Fisheries Departments).

In places where dyke erosion from high winds will be a problem, the long side of the pond should be parallel to the prevailing wind direction (Fig. 4). If the area does not experience strong winds, the pond should be aligned to take best advantage of the wind blowing across the pond to facilitate mixing of the water in the pond.

The pond bottom should be smooth and free of any obstructions to make seining easier.

5.1.2 Pond depth

The depth of the pond plays an important role in the physical and chemical parameters of the water. For example, when the water is more than 3 m deep, there may not be enough photosynthetic activity at this depth to keep the deeper water oxygenated. There will also be difficulties in mixing the water through the action of wind and waves. The water temperature remains colder at this depth too, resulting in less plankton. The right water depth helps to regulate temperature and inhibit growth of underwater plants. At the same time, water needs to be shallow enough to maintain dissolved oxygen (DO) levels at the pond bottom. Ideally, the pond depth should be 80 cm at the inlet end and 120 cm at the outlet end, excluding the free board (see 5.1.3), for ponds of 200–2000 m² that have a good water supply. For rain-fed ponds, a water depth of 1.5 m is desirable at the outlet end.

5.1.3 Freeboard

The freeboard is the additional height of the pond dyke above the maximum water level. In other words, it is the vertical distance between the water surface in the pond at the designed depth, and the height of the dyke after dyke settlement. It prevents overflowing or overtopping of water due to heavy rainfall or wave action. A free board of 0.4–0.5 m is usually necessary to keep the prawns safe. An overflow or outlet pipe is also provided at the maximum water level (Fig. 5).

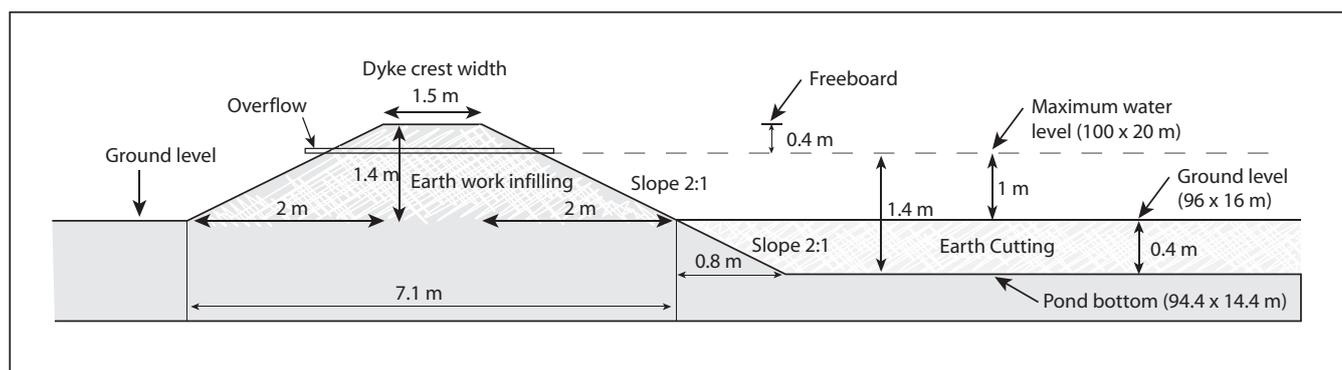


Figure 5. Cross-section of pond



5.1.4 Bunds (dykes, pond walls or bundh)

The top of the dyke (crest) is usually 1.5–3.0 m wide, or equal to the average height of the dyke (Figs 5 and 6). A much wider crest is required if vehicles are to drive along it. It should be noted that a wider crest requires a large area for the dyke and also a larger volume of soil, involving higher costs.

The design of the dyke should be strong enough to hold the maximum level of water and withstand the water pressure. It should also be stable and wide enough to prevent seepage. The inside slope should be no more than 2:1 for small ponds, increasing up to 4:1 for larger ponds. A gentle slope to the pond sides will help prevent erosion and make it easier to manage the pond.

The top 10–15 cm of soil on the dyke profile should be removed to get rid of vegetation and organic matter, thus ensuring a good bond with the excavated pond soil. If the soil for dyke construction is brought in from another area, then it should not contain large amounts of rocks, sand, wood, grass or plants as these will cause seepage.

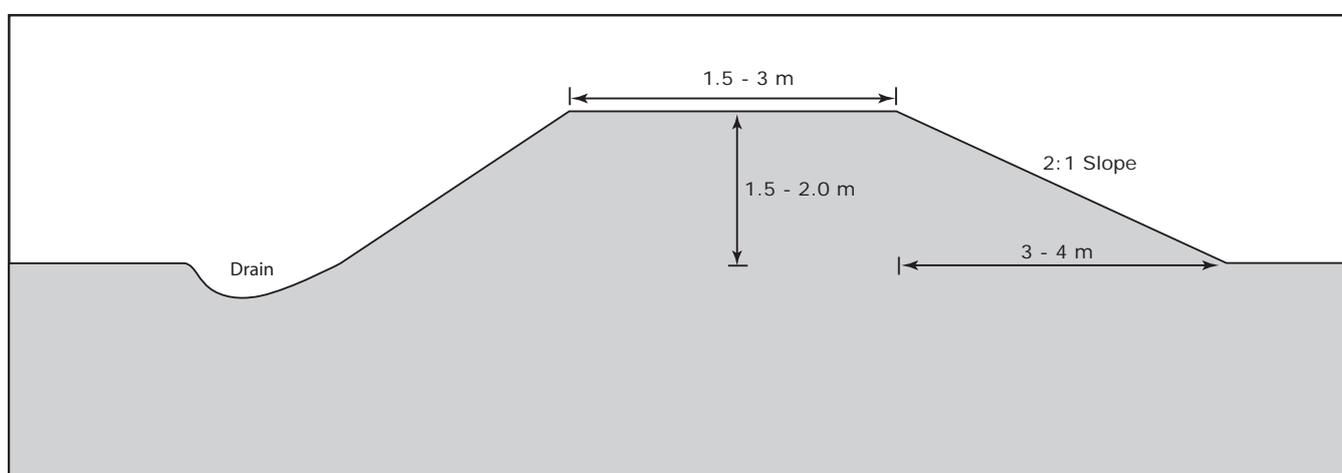


Figure 6. Dyke dimensions

5.2 Water supply and distribution

There must be plenty of water available throughout the culture period. As mentioned earlier, the water source is usually at a higher level than the pond water level so that it can be distributed by gravity flow through pipes or open channels. Water can also be pumped into ponds and culture facilities.

Each pond should have its own water supply from the central water distribution channel that brings water from the water source. In larger ponds, the flow of water into each pond must be controlled by valves (if piped) or shut-gates (if channelled).

There should not be any contact between incoming water and water drained or discharged from the ponds. Furthermore, ponds should not receive water discharged from any other pond. Transfer of water from one pond to another is not recommended since it means poorer water quality in the subsequent ponds and increases the risk of transferring disease.

5.2.1 Water inlet

The water inlet is a hollow pipe or open channel in the dyke that allows water to flow into the pond. It should have a screen to keep out wild fish, twigs, leaves and other trash. It should also have a gate valve or shut gates. Usually, 50–100 mm diameter PVC pipe is adequate to fill ponds of 500–2000 m².



5.2.2 Water outlet

The water outlet allows water to flow out of the pond (Fig. 7). The end of the outlet pipe inside the pond should be screened to prevent the prawns from escaping. The number of outlet pipes (drain pipes) and their diameter depend on the size of the pond. These pipes must be installed at the deepest part of the pond. Pipes with a diameter of approximately 150 mm are needed to drain 2000 t of water (that is, a 2000 m² pond will need at least two 100 mm diameter pipes). With this flow capacity, the pond will drain completely within a day. If more pipes or larger diameter pipes are used, then the pond will drain faster. For smaller ponds of 200–1000 m² in size, a 100 mm diameter pipe is usually adequate.

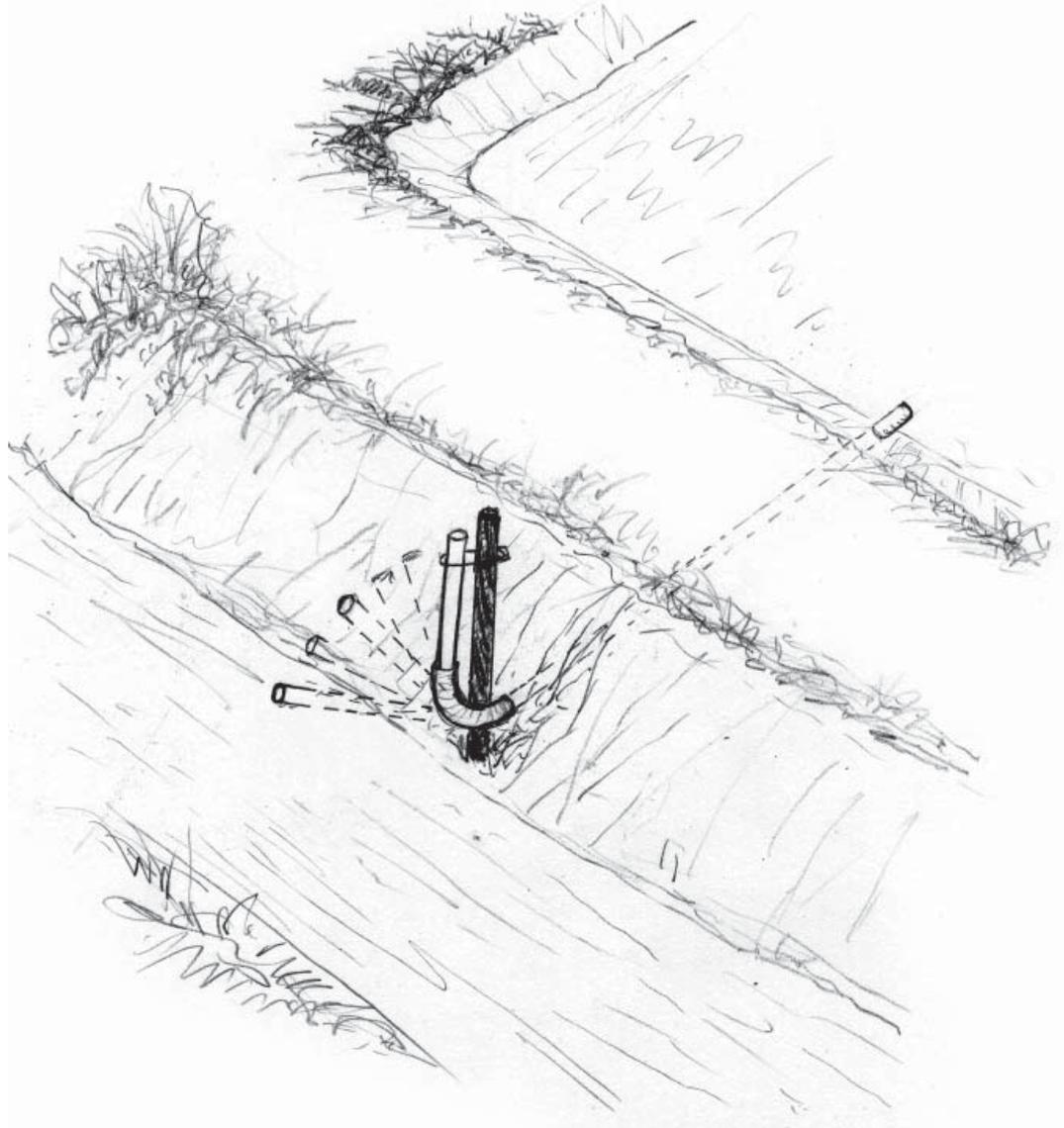


Figure 7. Position of water outlet pipe

5.2.3 Overflow pipe

An overflow pipe should be installed near the water outlet to allow excess water to flow out of the pond during heavy rainfall. It should also be screened to prevent the prawns from escaping.

5.2.4 Screening water inlets and outlets

Box screens are an effective way to prevent pest fish from entering the pond. Galvanized or plastic 1 mm mesh (similar to a mosquito screen) is used on both inlets and outlets. Cloth filters on the inlets may be necessary to remove fish eggs if the water comes from a river or canal.



5.3 Pond construction

Ponds are dug using either heavy mechanical equipment or manual labour. The choice of construction method depends on site characteristics, pond size and cost factors. Mechanical equipment is usually used to construct large ponds, whereas manual labour is used for small ponds. Construction costs vary considerably when using heavy mechanical equipment as there are various machines to choose from according to the specific site requirements.

The heavy equipment needed to excavate the pond area, such as excavators and bulldozers, is usually hired. The cost of construction is based on either the number of hours worked or on a contract based on the volume of soil to be excavated and made into a pond. The transport costs for the equipment are usually high and must be included in the cost of construction. In some countries, government agencies or the Fisheries Department may provide subsidies for pond construction. These types of subsidies are specific to each country.

The cost of constructing ponds by manual labour is usually based on the volume of soil to be removed and made into a pond. This price is normally agreed upon after negotiation. Farmers often choose to use manual labour because it is convenient and easy to organise. The money earned remains within the community and enhances goodwill among neighbours. In many communities, traditional relationships or kinship ties make it possible to mobilise sufficient labour for pond construction.

Manual pond construction takes longer of course, and in some cases the costs may actually work out to be about the same as mechanical construction. If no machines are available, however, then digging by hand is the only option.

5.3.1 Manual pond construction

Ponds dug by hand are generally small (100–300 m²). The tools required for digging include spade, hoe, mud-scoop, fork, wheelbarrow and wooden mullet (ram). The steps in construction are as follows.

Marking out the pond area

1. Prepare a sketch plan of the pond area (Fig. 8).
2. Clear the entire area of the pond of all grasses, trees and stumps. These should be either burnt or taken off the site.
3. Dig a channel or drain to allow water to drain away from the site at all times during construction of the ponds.
4. Outline the dimensions of the pond by first marking the outside edge of the dykes using wooden or bamboo stakes. For example, for a pond that will have a water surface area of 24 m x 14 m, first mark out a boundary measuring 30 m x 20 m. This will allow for a dyke around the pond of about 3 m wide at ground level. For bigger ponds, use these same dyke-width dimensions and just make the central area bigger on the plan. Mark out the corners of this rectangle with pegs and run a string between the pegs.
5. To get rid of roots, remove about 10–20 cm of topsoil from the 30 m x 20 m marked-out area. It is important that there are no roots or dead grass under the dyke because this will cause water leaks later. Note that this topsoil must be set aside. Later, it will be put back on the top and outer sides of the pond dykes.
6. Next, mark out a smaller rectangle of 24 m x 14 m inside the bigger (30 m x 20 m) rectangle. This will show where the inside of the dykes will be at ground level. This 24 m x 14 m rectangle is the area of ground that is going to be dug out. The soil that is dug out will be used to make the tops of the dykes. The bottom of the dyke at the shallow end of the pond and along the other two sides will begin from about another 1.5 m inside this smaller rectangle. The bottom of the bank in the deepest part of the pond will be about 2 m from the lower end of this smaller rectangle.
7. Then mark a third rectangle in the centre of the pond, measuring about 21 m x 11 m. This is called the central area and it forms the flat bottom of the pond.



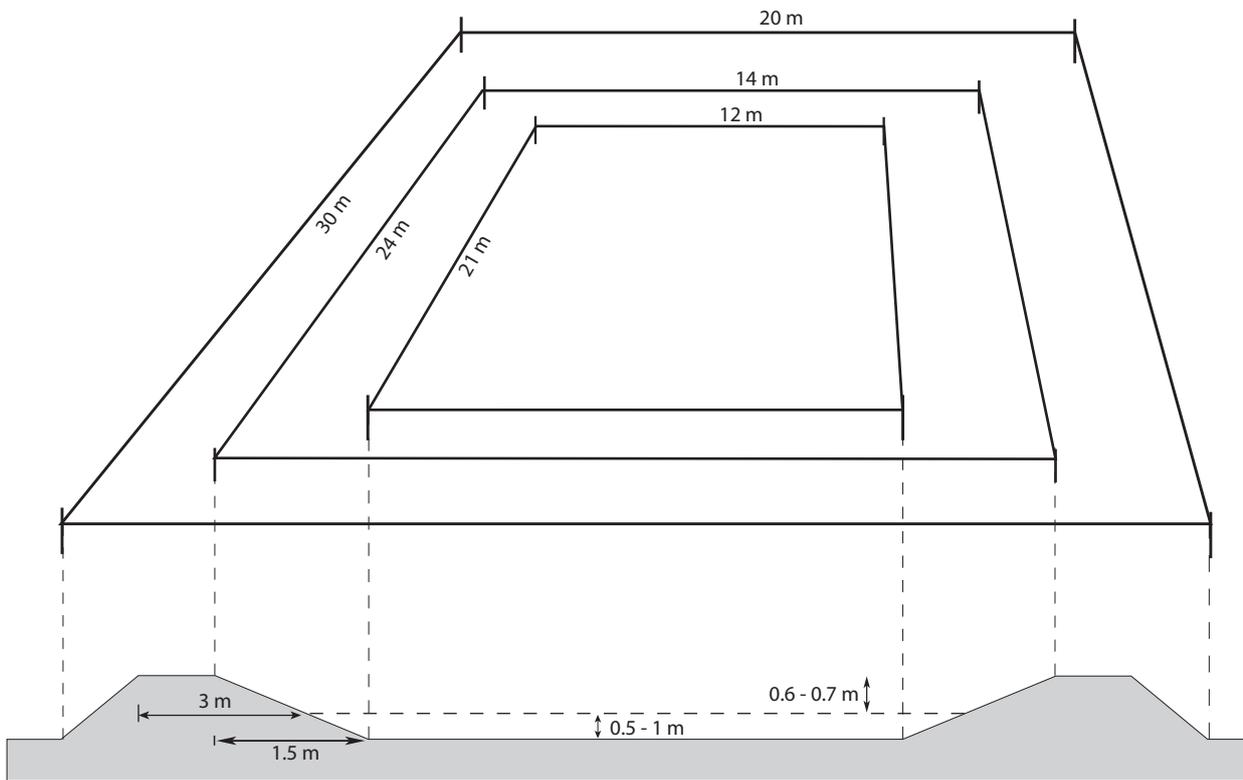
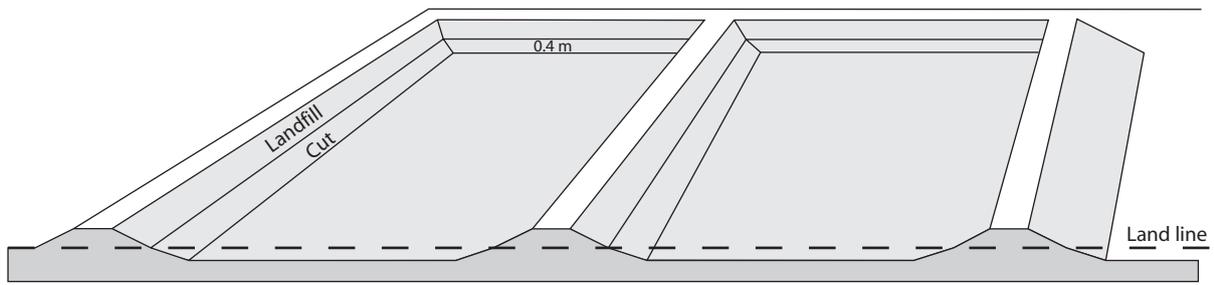


Figure 8. Plan of pond marked out on the ground before digging begins

Digging the pond

The central 21 m x 11 m area is dug out first and the soil is used to build the pond dyke. The workers should be organised in a row with shovels and digging forks. Digging begins at the shallow end of the pond, at the string marking the central area.

The pond is dug to about 20 cm deep at the shallow end, increasing gradually in depth towards the other end. At the deepest part, at the string marking the central area, the depth should be about 30 cm.

As the soil is dug out, it should be placed in the space marked out for the dyke, between the 24 m x 14 m rectangle and the 30 m x 20 m rectangle. It is recommended that the soil be placed nearest to the digging area so that the banks will become higher and wider towards the deeper end. Whenever the loose soil placed on the banks reaches about 30 cm (knee height), it should be packed down tightly. This can be done by compacting the soil with a heavy length of tree trunk. It is very important to ensure that the slope of the pond bottom is as regular as possible.

Once the first 20–30 cm layer of soil from the central part has been dug out, the whole process can be repeated to take out another layer. As before, begin the process by digging out 20 cm deep at the shallow end and 30 cm deep at the other end. As before, the soil that is removed is placed on the dyke area and packed down tightly.

Then, for a third and last time, another layer of soil is dug out of the central area and packed down tightly on the dyke.

Shaping the dyke

When the digging is finished in the central area, there will be a pit measuring 21 m x 11 m with straight sides. The dykes can then be shaped by digging the soil away from the edges of the central area to form a slope up to the 24 m x 14 m string with the slope continuing smoothly up to the top. This soil can be placed on top of the dyke and packed down tightly. The inside of the dykes should slope more gently than the outside. Figure 8 shows how the dyke should look when it is finished. The top of the dyke should be about 1.5 m wide, straight and flat all the way around the pond.

The topsoil removed at the beginning should now be placed on the top and outer sides of the dyke.

The bottom of the pond should be about 1.3 m below the top of the dyke at the shallow end, and about 1.7 m below the top of the dyke at the deep end. The bottom of the pond should be fairly smooth and regular. All loose soil and other rubbish on the bottom of the pond should be removed.

Side-by-side ponds

When marking out ponds to be built side by side, leave an extra 1.5–2.0 m between the two big rectangles (30 m x 20 m markers) to allow for the slopes of the dykes inside the adjoining ponds (Fig. 8).

Installing the water inlet

The water inlet should be placed at the point nearest to the water source. Usually, this will be at or near the shallow end of the pond. The inlet pipe should be 25–50 mm in diameter, and long enough to reach through the top of the dyke from one side to the other.

Once the position of the inlet has been decided, dig a ditch across the dyke. This should be dug to a level that will allow water to flow into the pond from the channel or pipe that brings the water from the water source, at a little above the water level on the inside of the dyke.

Place the inlet pipe in the ditch in the dyke, and rebuild the dyke over it. Alternatively, if an open channel is used to bring water into the pond, prevent erosion of the dyke soil by using roofing iron or hard plastic to line the bottom of the channel.

Installing the water outlet

The water outlet is made at the bottom of the dyke at the deepest end of the pond (Fig. 7). The outlet is usually made from PVC pipe and should be at least 100 mm in diameter. Since the dyke at the deep end will be wider than at the shallow end, and the outlet pipe is installed at the bottom of the dyke, several metres of outlet pipe will be needed. It may be possible to join pieces of pipe together to get the required length.

Dig a gap or ditch through the dyke where the outlet is to be located. It should reach from the deepest part on the inside of the pond through the dyke to a lower level outside of the pond to allow all the water to drain from the pond. If the outlet is below ground level on the outside of the pond, dig a drain to take the water away from the outlet. Place the outlet pipe in the gap in the dyke and rebuild the dyke over it.

Installing the water level regulator

The water level inside the pond can be regulated by an upstand pipe. This is mounted on the outlet pipe in an upright position, usually on the end outside the pond, using an elbow fitting. Alternatively, the upstand pipe can be installed inside the pond at the entrance to the outlet pipe to avoid accidental drainage of the pond. However, the outside position is preferable as it



allows the excess water to be drained from the bottom of the pond. The top of the upstand pipe should reach about 3–5 cm above the water level of the pond. If water rises above this level, it will overflow into the drain.

The upstand pipe should be tied securely to a pole driven into the ground so that it does not slip down accidentally and let the water out of the pond. When the pond needs to be emptied, the upstand pipe can be untied and gently pushed down, allowing water to flow out of the pond.

Using a siphon

During harvesting and other times, a siphon can also be used to increase the flow of water out of the pond. This can be a flexible hose (50–150 mm diameter) that is long enough to reach over the dyke from the pond to the drainage ditch. It must be long enough to extend from the deepest part of the pond, over the top of the dyke and down to the level of the drain on the other side of the bank (10–20 m long). To activate the flow of water, the hose must first be completely filled with water, with no air spaces inside it. One end must be tightly sealed with a plug or end-cap and the other end left open. This open end stays underwater while the sealed end is pulled over the dyke and down into the drainage ditch. When the end is unplugged, the water will flow rapidly out of the pond.

Installing screens on inlets and outlets

Care must be taken to place screens on the inlet, outlet and overflow pipes to prevent prawns from escaping as well as to stop wild fish entering the pond.

5.3.2 Mechanical pond construction

Heavy machinery used for pond construction includes excavators, bulldozers and backhoes. Bulldozers are best due to their rapid earthmoving capabilities and good compacting action. Excavators are a little slow but are very good for making pond dyke slopes and drains. In areas with a high water table, the soil may be too soft to support such heavy equipment. The local aquaculture officer or other appropriately qualified person should be present to supervise the digging operation to ensure the required procedures are followed.

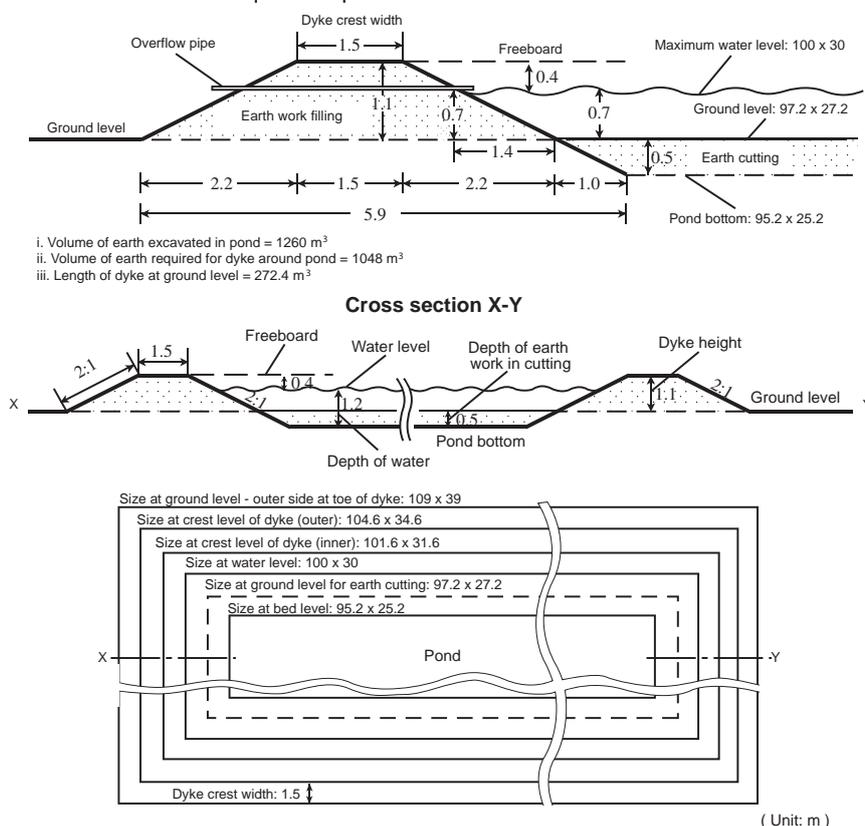


Figure 9. Plan and cross-section of grow-out pond showing earthwork requirements for dyke construction and pond excavation.



The usual method is to dig out the pond area and use the fill to construct the pond dykes. During excavation, the machine is run over the pond banks while they are being constructed to continually compact the soil.

The design and layout of the pond is the same as for a hand-dug pond with some modifications. The machine operator should be thoroughly briefed on pond shape, size, bottom slope and other features (see Fig. 5 and Fig. 9) and should follow similar procedures to those described for digging a pond manually. Construction should preferably be done during the dry season.

Example of calculation of costs for pond constructed by machine on level ground

The cost of constructing farm ponds and related structures must be budgeted for. As the pond is the most expensive structure, the estimated cost of constructing a typical pond of 0.3 ha in size is given below.

It is much cheaper to construct a pond on level ground, mainly due to the limited depth of cutting required. For example, a grow-out pond of 100 m x 30 m (size at water level) requires 1260 m³ of earth to construct a dyke of 1.1 m high above ground level (1.5 m including freeboard) with side slopes of 2:1 and crest width of 1.5 m (see Fig. 9):

Dyke slope.....	2:1
Dyke slope (outside)	2:1
Crest width of dyke.....	1.5
Depth of pond at maximum water level.....	1.2 m
Depth of pond at bed level (average depth of earth excavation).....	0.5 m
Freeboard.....	0.4 m
Considering the above, the pond size at different levels comes to:	
Size of pond at maximum water level.....	100 x 30 m
Size at ground level (where excavation will be started).....	97.2 m x 27.2 m
Size at mid-depth of excavation.....	96.2 m x 26.2 m
Size at pond bed level.....	95.2 m x 25.2 m
Size at crest level of dyke (inner).....	101.6 x 31.6 m
Size at crest level of dyke (outer).....	104.6 x 34.6 m
Size at outer toe of the dyke, that is, the total land area.....	109.0 x 39.0 m ²

The volume of earth excavation can be calculated by using the prismoidal formula:

$$V = \frac{A + 4B + C \times D}{6}$$

where

V = Volume of earth in excavation, in m³

A = Area at ground level from where the earth cut starts, in m²

B = Area at mid-depth of cutting, in m²

C = Area at pond bottom, in m²

D = Depth of excavation, in m

The amount of earth required to construct the dyke is calculated as follows:

Volume of dyke = central length of pond dyke x area of dyke

Area = (top and bottom) width of dyke section x height of dyke

This means that the amount of earth required to construct a 1.1 m high dyke around the pond is approximately 1108 m³. The quantity of earth produced by excavating a 0.5 m deep pond is 1260 m³. Using more earth than necessary to construct the dyke will reduce the pond area and thus the volume of water it can hold. It will also cost more. To avoid excess earth, the pond excavation depth can be reduced slightly. The estimated cost of excavating a pond is based on the quantity of earth to be moved and, of course, varies from country to country. Consult an appropriately qualified person for advice; for example, your local fisheries officer.



6.0 Grow-out in ponds — the pond cycle

The profit from prawn farming depends on two factors: (1) the yield and market price of the prawns, and (2) the cost of production. These two factors must always be kept in mind during grow-out.

The following features of the grow-out phase are critical for profit:

- size and quality of PL at stocking
- stocking density of PL in the pond
- time of stocking
- feed and feeding methods
- management of the ponds
- length of culture period
- size of prawns at harvest.

The activities involved in grow-out of prawns are like a circle with a series of steps that — when completed — take the operation back to the start. This is called the pond cycle (Fig. 10). To get good yields, the farmer must carry out each step in the pond cycle and be aware of the interactions between them. Each step is described in detail in the following sections.

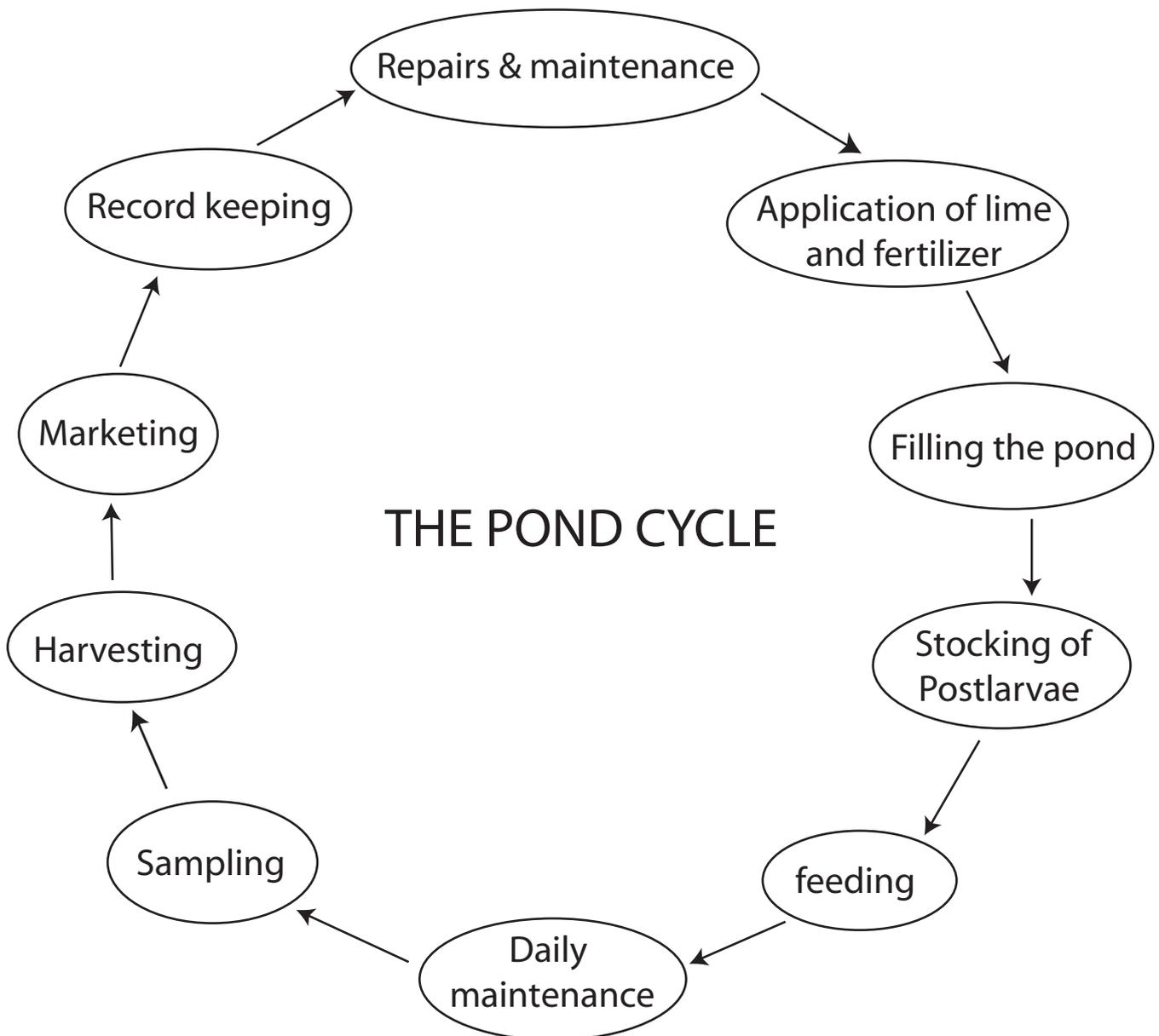


Figure 10. The pond cycle



6.1 Repairs and maintenance

After any defects in the pond have been repaired, the pond must be prepared to create a favourable environment for prawn growth. This includes completely draining the pond, eradicating pests, removing rubbish and excess silt, levelling the pond bottom, checking the dykes and water pipes, and cutting any overgrown grass on the bottom. It is also preferable to allow the pond to dry until the pond bottom cracks. Usually it is easier to carry out repairs and maintenance in a dry pond. The grass on the dyke crest and around the pond should also be trimmed to allow the breeze to blow over the pond water, enhancing oxygenation. However, do not remove all the grass on the dykes as it helps to hold the soil on the dykes and reduce erosion.

The screens on inlet and outlet pipes should be repaired or replaced. Drains should be cleared of plants, rubbish, or any other possible blockages.

6.2 Application of lime and fertiliser

Acidic water will not support the growth of phytoplankton, zooplankton and bacteria. All these organisms are important to provide the right environment for prawn growth. Acidic conditions also affect prawn shell development. Where the soil pH (measure of soil acidity) is less than pH 6.5, lime needs to be added to the ponds to correct the acidity of the pond soil to create a favourable environment for the prawns. The soil pH must therefore be measured. This is usually done at the start of the project. The pH can be measured using portable colour-test kits, or by a pH meter at a water quality laboratory. The Fisheries Department may assist with this testing, usually at the start of the project.

The pH of the water is a measure of acidity (the hydrogen ion content in the water). The water is “acidic” when the pH is 1–7 and “basic” or “alkaline” when the pH is 7–14. At pH 7 the water is “neutral”. The recommended pH for good growth of prawns is 7.0–8.5, though 6.5–9.0 is acceptable. If the pond is limed properly during its preparation, there is no need to add any more lime while prawns are in the pond.

The pH of the pond water will vary throughout the day. When the sun is shining, phytoplankton (microscopic plants) remove carbon dioxide (CO_2) from the water and use it for photosynthesis. This raises the pH of the pond (making it less acidic). A heavy plankton bloom during sunny weather can cause the pH during the day to rise as high as pH 9.0. At night, however, phytoplankton will release dissolved CO_2 , causing the water to become more acidic and the pH to drop again. These day–night fluctuations in pH are normal and there is no need to worry about them as long as the pH values are mostly in the acceptable range of 6.5–9.0.

6.2.1 Applying lime and pest control treatments

Liming is generally not necessary in areas with a lot of limestone (CaCO_3) because the soil in these areas is not usually acidic. Lime may be necessary near mangrove areas where acid-sulphate soils are found.

Before applying lime and any other treatments, ponds must be drained and prepared. If ponds cannot be dried out completely, they should be treated to eliminate any predatory fish or other pests, 7–10 days before stocking. Common pond treatments are teaseed cake, rotenone, quicklime (CaO), or hydrated lime ($\text{Ca}(\text{OH})_2$). When applying lime or other treatments, operators should wear protective clothing (Fig. 11).

There are several forms of lime. The most common type of lime available is agricultural lime or powdered limestone (the kind used by gardeners). Other types include quicklime and hydrated lime. They differ in strength so have different application rates. Quicklime and hydrated lime also kill unwanted pests so they can be used instead of teaseed cake or rotenone (see below).



Rates of application:

- limestone (powdered): 1000–2000 kg/ha
- quicklime: 400 kg/ha
- hydrated lime: 600 kg/ha.

Limestone. Agricultural lime (powdered limestone) can also be used to raise the pH of pond water. The rate of application for limestone is generally twice that of quicklime. It should be added to the pond before filling with water.

Quicklime. When quicklime absorbs water, it becomes calcium hydroxide ($\text{Ca}(\text{OH})_2$). This raises the pH and draws oxygen from the water. As well as reducing soil acidity (raising the pH), quicklime kills unwanted fish, pests and bacteria.

Application rates for lime range from 1 kg for every 10 m² for established ponds to 1 kg per 5 m² for new or very acidic ponds. This equates to a range of 100 g/m² to 200 g/m². If the pond is 1000 m², for example, then a 100 g application would require 1000 x 100 = 100,000 g or 100 kg of lime.

Agricultural lime is usually sold in 20 kg bags, and can be applied by hand after cutting the bags open. Wear gloves and a spray-painting mask or similar protective gear to avoid breathing in the lime dust.

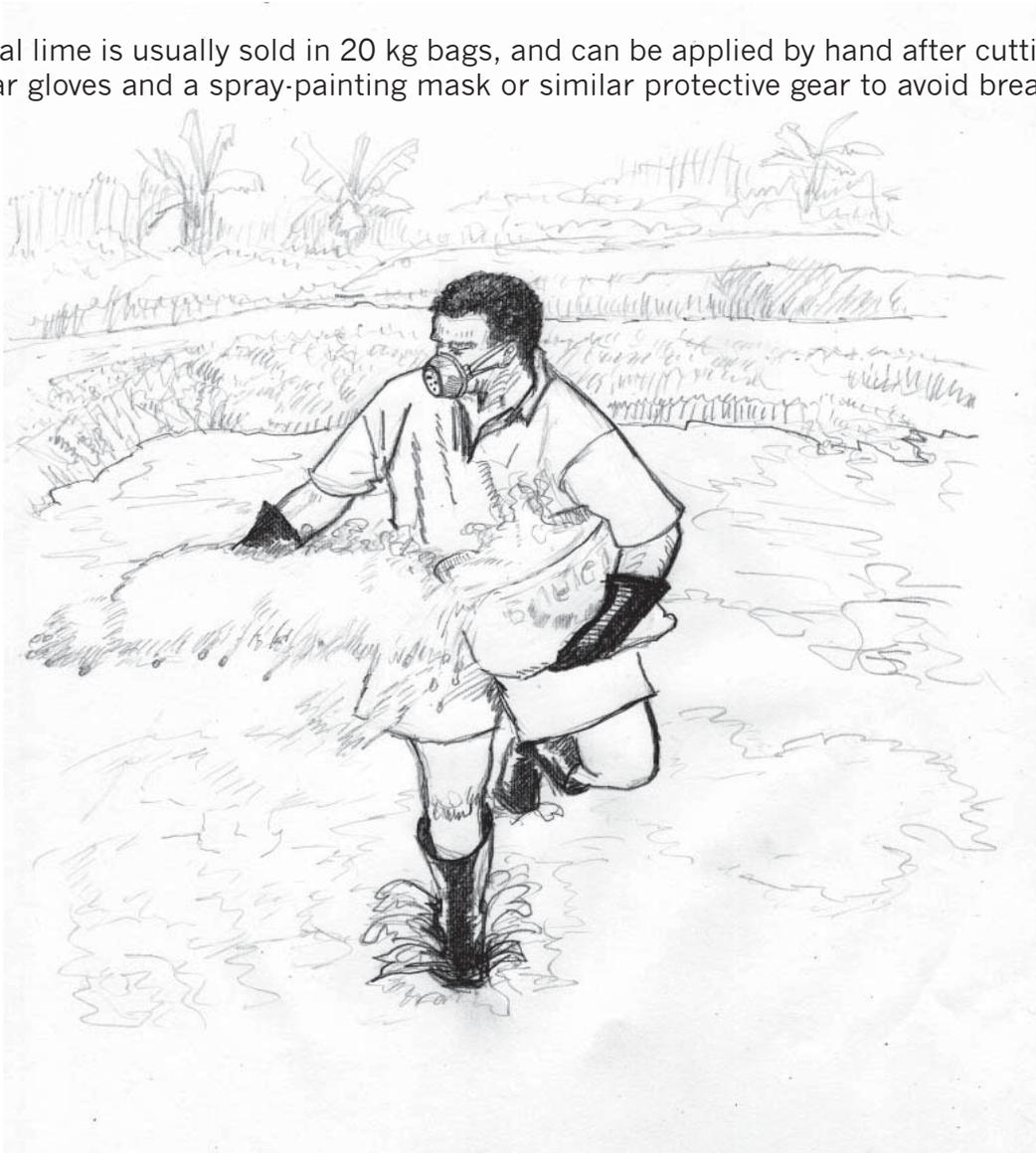


Figure 11. Application of lime

Spread the lime over the damp earth in a thin layer that covers the entire pond bottom. Close the pond water outlet so that rain or seeping water does not wash the lime out of the pond. Allow the lime to settle for 2–4 days before filling the pond with water. This will allow time for the lime to soak into the soil and condition it properly.



The following pest treatments may also be applied during this period:

Teaseed cake. This is a residue of the fruit of a plant (*Camellia sasanqua* or *C. semiserrata*) after the fruit oil has been extracted. The byproduct contains saponin, which is poisonous to fish. At a concentration of 10 ppm, saponin causes fish to die in a few hours. The general dosage is 1 kg of teaseed cake per 15 m² of pond area. Teaseed cake in powder form is first soaked in water until dissolved, then the solution is evenly spread over the pond bottom.

Rotenone. This is extracted from the roots of a plant (*Derris uliginosa* or *D. elliptica*) and may be available locally. The extracted solution contains about 25% rotenone, which is poisonous to fish. The recommended rotenone concentration for pond clearing is 2 ppm. The rotenone solution is first diluted 10–15 times with water and then evenly spread over the pond bottom.

When the pond is filled, if the pH of the water is too high it can be improved by “ageing”. This means filling the pond with water 2–4 weeks before stocking to allow natural biological processes to adjust the pH.

6.2.2 Applying fertiliser

Fertiliser supplies nutrients that encourage the growth of phytoplankton in the pond water. (Phytoplankton consists of microscopic plants, mainly algae, that float in water.)

Zooplankton and bottom-dwelling (benthic) animals such as tiny shrimps, worms and water insects feed on phytoplankton and decaying plant material so they also grow well if fertiliser is added. Ensuring a good density of plankton also provides cover for the prawns and prevents the growth of rooted aquatic plants. Prawns feed on this natural food as well as on the supplementary feed added to the pond.

When no pests remain in the pond, and lime has been applied to counteract any acidity in the pond soil, fertilisers can be broadcast over the pond bottom. Less phytoplankton is needed in a prawn pond than in a tilapia pond. Unlike tilapia, prawns do not eat phytoplankton directly, though they do benefit from eating the zooplankton and bottom-dwelling organisms that feed on phytoplankton. A more important reason for encouraging a moderate phytoplankton “bloom” is that prawns prefer water that is murky enough to screen out sunlight.

In prawn culture, the use of fertiliser requires a delicate balance (too much fertiliser will result in heavy plankton blooms that will reduce DO levels during the night and could kill the prawns).

Two main types of fertilisers are used:

- natural organic fertilisers such as manure from chickens, cows, goats, pigs or horses
- manufactured or inorganic fertilisers such as urea, TSP and superphosphate.

Organic fertiliser is cheap and should be readily available in rural areas. However, it takes time to collect, is smelly, and some people may not buy the prawns because they think they are being fed on manure.

Inorganic fertilisers may be either *single element fertilisers* that contain a single nutrient like ammonium sulphate, urea, or phosphorus; *incomplete fertilisers* that contain two nutrients such as nitrogen and phosphorus; or *complete fertilisers* that contain more than two nutrients, such as nitrogen (N), phosphorus (P) and potassium (K). Inorganic fertilisers are easy to use, do not smell and are always the same strength. However, they are more expensive. If there are several choices, the grower’s experience over time will indicate which fertiliser gives the best value for money. Chicken manure can be broadcast over the pond bottom at the rate of 1000kg/ha. Inorganic fertiliser, at the rate of 100–200 kg/ha (Table 3), can also be applied in combination with chicken manure.



Table 3. Fertiliser application rates

Type of fertiliser	Amount to use per m ²
Urea	6 g
TSP	3.5 g
Superphosphate	7 g
Chicken manure	15 g
Cow manure	70 g
Pig manure	50 g

Always measure the quantity of fertiliser required. If there are no weighing scales, use a canned-fish tin as a scoop to measure fertiliser, using the quantities shown in Table 4.

Table 4. Fertiliser quantities measured using a fish tin

Fertiliser	Small fish tin	Large fish tin
Urea	180 g	315 g
TSP	250 g	480 g
Superphosphate	250 g	480 g

There are two ways to apply organic fertilisers. For fast action to quickly stimulate plankton bloom (for example, when the pond is first filled with water), dissolve the manure in a drum of water, then pour it into the pond. Inorganic fertilisers can also be dissolved in a bucket of water for faster action. TSP needs warm or hot water to dissolve properly.

For slower action (to slowly release nutrients over time to maintain a steady plankton bloom), put manure or inorganic fertiliser granules into sacks, tie the top, and leave the sacks floating in the pond (Fig. 12). Take the sacks out again if a Secchi disc reading indicates that the bloom is getting too heavy. A Secchi disc is a simple way of measuring water transparency (see section 6.6.2).

If the pond water is not very green (Secchi value is greater than 35–40 cm) then add a little more fertiliser. If the pond water is too green (Secchi value is less than about 25 cm) then take the fertiliser sacks out of the pond, or open the water inlet for a short time to flush the pond. Fertiliser rates may be increased or reduced depending on how well the plankton grows.

Fertiliser should be stored in a dry, airy place that is well protected from rain. To keep inorganic fertiliser from getting damp, which will make it go hard, store the bags on wooden pallets, not directly on cement or dirt floors.



Figure 12. Sack of fertiliser floating in pond



6.2.3 Provision of shelters or substrate in ponds

Shelters consist of objects that are placed in the pond to provide additional habitat or surface area for the prawns (Fig. 13), which are bottom-dwelling organisms. This allows a higher stocking density and improves growth and survival. In addition, it helps to reduce competition for space and thus aggression. Shelter materials can consist of sawn-off PVC pipe (length 50 cm, diameter 10 cm, 2000–2500 pieces per hectare), coconut fronds (400/ha), lengths of bamboo with holes in them, or PVC barrier fencing. These materials should be placed horizontally on the pond bottom, except for the PVC fencing, which should be suspended vertically in the water. The surface area of the sides of the barrier fencing should be equivalent to at least 40–50% of the area of the pond bottom. Use bamboo or wooden stakes to support the PVC fencing in the water.

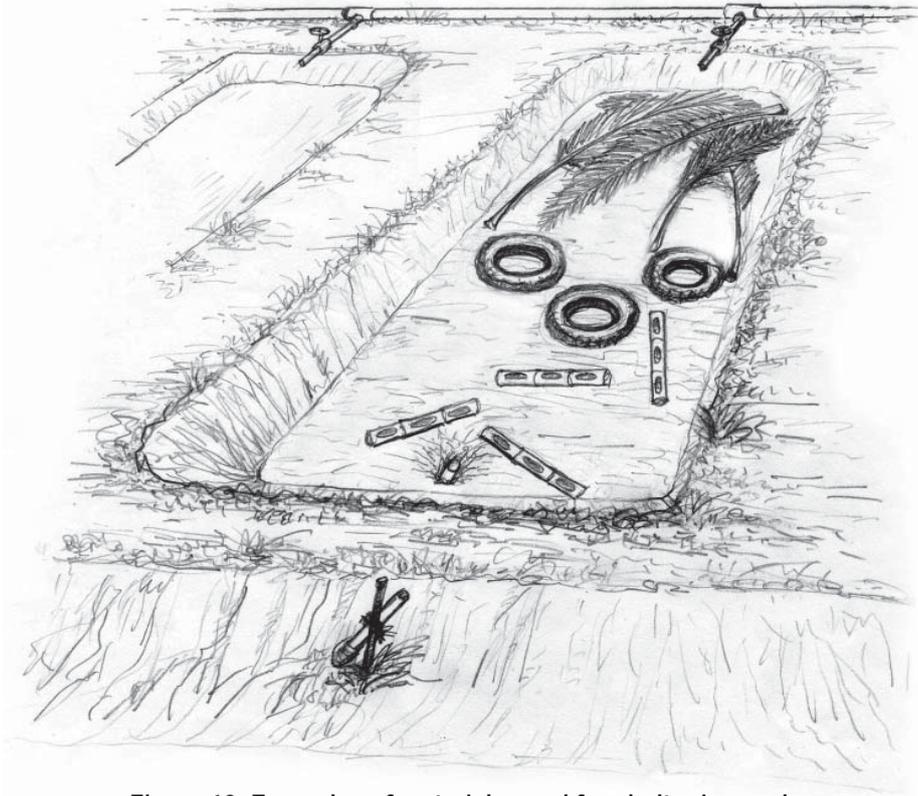


Figure 13. Examples of materials used for shelter in ponds

6.3 Filling the pond

After applying fertiliser and putting the shelters in place, the pond should be filled gradually. The volume of water required to fill the pond should be estimated before filling to ensure that there will be no effect on other farm operations. The incoming water should fall on a flat surface, such as a board, to avoid disturbing the soil at the bottom and sides of the pond. Ensure that screens are fixed on the inlet, outlet and overflow pipes to prevent predators entering and later escape of prawns. The water depth in the pond should range from 80 to 100 cm during the grow-out period.

Water quality influences the growth rate of the prawns and therefore water exchange is particularly important. A good water exchange programme is necessary. A continuous water flow-through system is recommended to:

- maintain good DO levels
- maintain pond water depth to compensate for seepage, evaporation, and other losses
- flush out wastes and toxic materials such as ammonia.

Enough water must be available to allow at least 10% of the pond water volume to be replaced at any time. The water flow-through system may be stopped during rainfall.



6.4 Stocking with postlarvae

After the pond has been prepared and filled, leave it for 5 to 10 days to allow enough time for plankton to bloom. It is then ready to be stocked with PL. The PL should be healthy and active. If juveniles are stocked, they should be of similar age and size.

In Fiji Islands, PL are put in ponds 2–10 days after metamorphosis (15–20 mm long, 0.015–0.02 g average body weight). Rearing PL in tanks or nursery ponds to a size of 3–5 g is recommended as it gives better growth and survival. However, this is not the usual practice due to unavailability of nursery facilities and difficulties in managing nursery ponds and tanks.

6.4.1 Transport of postlarvae

If the hatchery supplying the PL is a long distance away, or on another island, the supplier will need to prepare and pack the PL carefully for transportation. The methods used for packing and transportation are described in this book's companion volume — *Volume one: Freshwater prawn hatchery operation*.

When the PL arrive, the farmer should release them into the pond as soon as possible. However, they should not be released quickly into the pond because sudden changes in water temperature or water quality can harm them. Before they are released from the bags, let the temperature of the transport water adjust gradually to the temperature of the pond water by floating the bags in the pond for 15–20 minutes (Fig. 14, top).

Give the prawns time to adjust to their new water conditions. Once the bags are open, splash in some pond water by hand to mix around 50:50 with the water in the bag or container (Fig. 14, middle). After 3–5 minutes, tip the bag on its side and allow the prawns to swim out by themselves (Fig. 14, bottom).

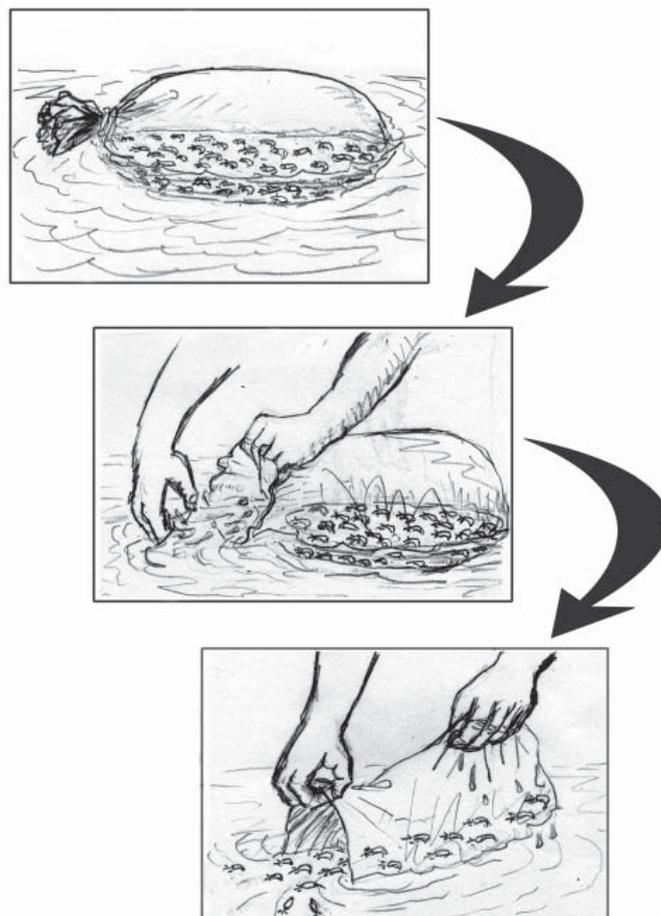


Figure 14. Gradually releasing prawn postlarvae into pond



6.4.2 Stocking rate

In choosing the stocking density (number of prawns per square metre), the grower should consider the market size desired at harvest. If the stocking density is high, the prawns will feel crowded and stressed and will grow much more slowly unless conditions are managed carefully to compensate for the higher density. For example, at high stocking densities, the supply of food and oxygen usually becomes limited and thus more care and attention is required in managing the ponds — more food must be given to the prawns, and to prevent oxygen shortages and reduce accumulation of prawn wastes (which also reduce the supply of oxygen), more water needs to be exchanged to flush out some of the pond water. Aerators can be used in the pond in addition to flushing.

In Fiji Islands, the preferred market size for prawns is about 30 g (head on) and this is usually achieved in 4–6 months of culture. The stocking rate ranges from 5–8 PL/m² and is reduced to 3–5/m² if juveniles are stocked. A few growers practise intensive culture with stocking densities of more than 12–20 prawns/m².

The following notes are a guide to choosing a suitable prawn stocking density for a farm:

- New prawn farmers should stock at a low density and develop technical expertise through several harvests before increasing the stocking density.
- Stock at a low density if large-size prawns are desired by the market.
- Lower stocking densities will yield larger prawns but will lower the total harvested weight and may also reduce profits.

6.5 Feeding

Prawns are bottom feeders and omnivores (eat both plants and animals). In the wild, they eat aquatic insects and larvae, worms, small snails and shellfish, other crustaceans, rotting flesh or offal from fish or other animals, grains, nuts, seeds, fruit, microalgae, tender leaves and stems of aquatic plants, and rotting plant material. They prefer animal sources of food to plant sources. Prawns are cannibalistic and also eat their own moulted shells. They locate their food mostly by smell or by touch with their antennae. Prawns benefit from natural food in the pond (plankton, insect larvae, and so on), which supplements the feed supplied by the farmer.

6.5.1 Supplementary feed for prawns

Prawns require a diet with a protein level of about 35–40% for the first month, reducing to 28–30% for grow-out from the second month to harvest time. Pellet feeds formulated for tilapia, which have a crude protein level of 25–30%, can also be used for prawns. For intensive prawn culture, feeds with higher protein levels and with added vitamins and minerals are used. Good prawn feeds contain 30–35% protein, 2–10% fat and 4–12% fibre.

Most formulated diets come in powder, meal, crumble or pellet form. During the early stages, the particle size of the feed should be small, increasing gradually as the animal grows. Powder or meal forms are normally used for PL and juveniles, and pellets are used for older juveniles and adult prawns.

Food added to the pond may not be eaten quickly. This means that supplementary feeds must last well in the water (at least 2–3 hours) and maintain an attractive odour.

6.5.2 Feeding rate

The amount of feed offered should be regulated according to the total weight of all the prawns in the pond (biomass), as well as observations on daily feed intake. The feeding rate will be higher at first, reducing as the prawns grow bigger.



Other factors that affect the feeding rate are the health of the prawns, water quality, oxygen level, temperature, ammonia content and feed particle size.

During the early stages of growth, prawns may be fed close to 30–50% of average body weight per day to promote fast growth. This is more than the PL can consume, but the uneaten food acts as a fertiliser to build up plankton density. When excess feed is added to the pond there may be no need for organic fertilisers. Overfeeding is continued until the phytoplankton density gives a Secchi disc reading of between 30 and 35 cm.

The feeding rate can be reduced gradually to 5% of total body weight by the end of the second month.

6.5.3 Feeding frequency

Generally, it is better to feed 2–6 times a day, with more feed given during evening hours. Observation and experience help the farmer to develop the best feeding schedule.

During their early stages of growth, the prawns are growing fast and have to be fed several times a day. It is advisable to start feeding six times a day and as the prawns grow, reduce the number of feeds per day. Adult prawns may only need to be fed twice a day with 70% of the feed ration given in the evening.

6.5.4 Method of feeding

Spread the feed all over the pond because the territorial behaviour of the prawns means that they do not venture very far in search of food.

Because prawns are most active at night, most of the daily feed ration (about 70%) should be given during the evening hours.

Use a feeding tray to check how much feed the prawns are taking (Fig. 15). Put a couple of handfuls of feed on the tray when broadcasting feed into the pond and lower it into the water. If most of the feed is still left on the tray at the next feeding time, reduce the amount of feed. If the prawns have eaten all the food on the tray, they are hungry and need more feed or more frequent feeding.

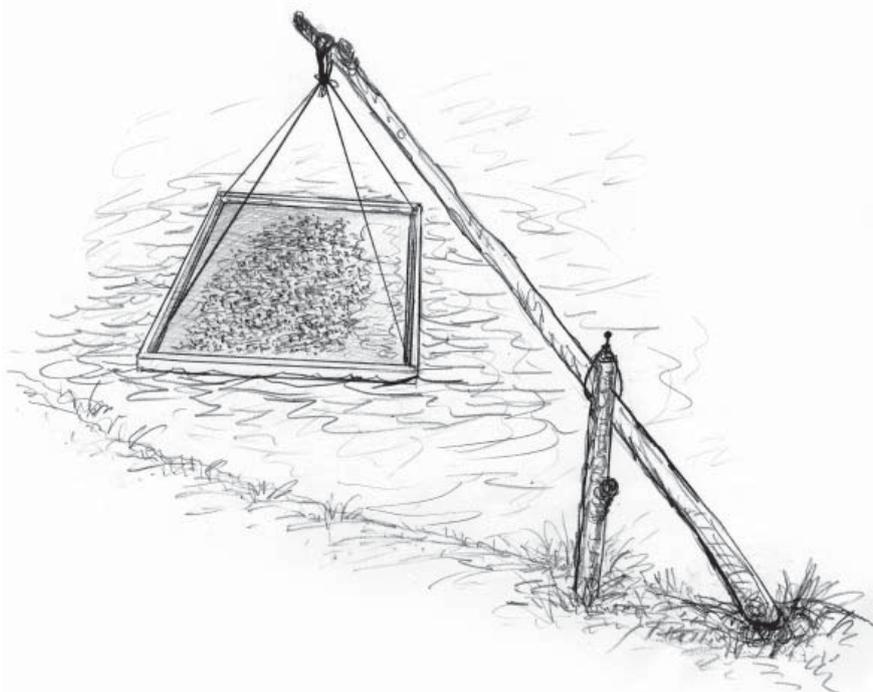


Figure 15. Feeding tray before it is lowered into the water



6.5.5 Summary of feeding guidelines

- Feed every day or at least six days per week, unless low DO arises. In this case, reduce the amount of feed given.
- Feed six times each day when the prawns are young.
- Feed according to the total weight of prawns in the pond. Increase the amount of feed as prawn weight increases. Sample the prawns every three weeks to calculate the weight increase and feed ration required.
- Prawns are active during the evening (they are nocturnal), so feed 70% of the ration in the evening.
- Weigh out the food to be given at each feeding time.
- Feed along the length of the pond dyke.
- Feed slowly; do not just “dump” the feed in at one place.
- Feed with the wind behind so that any dust from the feed blows into the pond and can also be eaten.
- Do not overfeed (see section 6.7.1). Ensure prawns are feeding properly. Check the pond bottom for any uneaten and rotting feed.

6.6 Daily maintenance

The condition of the ponds and the behaviour of the prawns must be checked daily. There are fewer margins for error with pond water quality for prawns compared with tilapia. Tilapia are much hardier and can tolerate poorer water conditions than prawns.

The daily tasks required in managing a pond include checks on:

- pond water level — should be at least 80 cm deep
- prawn behaviour — are they hiding or gathering at pond edges?
- condition of prawns — are there dead prawns floating in the water?
- water inlets and outlets — ensure mesh screens are in place and free of rubbish
- water colour and transparency
- growth of aquatic weeds, dyke erosion and damage to water lines
- temperature, DO, pH, and salinity if the pond has brackish water.

The daily observations should be written down in a notebook or pond logbook. These records will provide information on the performance of the ponds at different times of the year or under different management methods. A sample of a daily record is given below.

Sample “Pond Logbook” page

Date: 10 November 2005

Pond 1: Temperature 29 degrees. Water colour brownish-green (Secchi = 35 cm).

Pond 2: Temperature 30 degrees. Water very dark green, green scum floating on surface (Secchi = 15 cm). Prawns crawling to pond edges. Opened up water inlet to flow water and flush out plankton. Pond looks too shallow (50 cm). Tomorrow will raise upstand pipe on outlet to make water 30 cm deeper.

Water temperature, salinity (if the pond has brackish water), DO, pH and water colour and transparency must be checked every day to ensure that values remain in the range known to be good for prawns (Table 2). The smell of the water should also be noted. Look for any unusual prawn activity including crawling to the pond edges. If daily checks show that the water quality is getting worse, take action to improve it.

At times, at least 10% of the pond water needs to be replaced every two days by adding fresh water to the pond. In an emergency, where prawns are dying due to low DO, a lot of water (20–30% of the volume of water) must be flushed out of the pond.



6.6.1 Plankton

Plankton consists of microscopic organisms that live in the pond water. They include plants (phytoplankton), animals (zooplankton) and bacteria. When there is enough plankton, it makes the water murky, allowing the prawns to hide and feel secure. Zooplankton is also a natural food for the prawns. When there is enough phytoplankton in the water to give it a green or brown colour, the water is said to have a plankton bloom.

Phytoplankton adds oxygen to the water during the daytime, but during the night it stops producing oxygen and starts using it. The plankton bloom can use so much oxygen during the night that prawns may die if the plankton bloom is too heavy. DO is at its lowest in the early morning (before dawn), so this is the most dangerous time for the prawns.

The bloom can be controlled by increasing plankton growth by using fertiliser, or reducing plankton by adding new water and thus washing some of the plankton out of the pond.

6.6.2 Water transparency

Water transparency can be measured by a Secchi disc (Fig. 16), which can be made by nailing a white plastic disc (for example, an ice-cream container lid) to the end of a metre-long stick marked with a centimetre scale. The disc is held underwater at the depth where it just disappears from view, and the depth at which it vanishes is read off the scale. Ideally, the plankton density should be such that a Secchi disc immersed in the water just disappears from view at a depth of 35 cm. If the Secchi disc disappears at a depth of 25 cm or less, the water is too murky or green with phytoplankton and water should be added to the pond to wash some of it out.



Figure 16. Measuring water transparency with a Secchi disc

A simpler method of making this measurement is to put your arm down to the elbow in the water. If you can see the tips of your fingers, the water is too clear. If you cannot see your palm, then the phytoplankton density is too high.



If the bloom is too heavy (Secchi value of less than 25 cm), perhaps due to hot dry weather with a lot of sunshine, the phytoplankton will use large amounts of DO at night. This can cause die-off of both prawns and phytoplankton. In such cases, the colour of the water will change from green to brown and even to black. Prawns will die at night from lack of oxygen and will be seen floating near the water surface. To avoid this, flush out the pond with water from the inlet. If there is a shortage of water and the pond cannot be flushed, then reduce the amount of feed being given or stop feeding the prawns, stop adding fertiliser, and take any fertiliser bags out of the pond. If these actions do not fix the problem, carry out a harvest.

6.6.3 Dissolved oxygen (DO)

Like all living things, prawns need oxygen to live. Oxygen dissolves into pond water in several ways: slowly from the air; from phytoplankton in the water during the daytime; by the action of waves created by wind; by adding new water to the pond; and by rain water splashing on to the surface of the water.

Most prawn farms use water exchange to keep DO levels high. Maintaining other water quality parameters is also important. Where the topography of the site allows, the DO levels of the incoming water can be enhanced by letting water fall into the pond from above the water level, thus creating more movement of water.

In Fiji Islands, aeration equipment (such as a paddle wheel) is not used in grow-out ponds. There is also very little equipment for use in an emergency, for example, in times of low oxygen. However, permanent water exchange or a good flow rate is now recommended because growers want to maintain higher stocking densities.

It should be noted that aeration is needed to increase the water quality necessary for maximum growth and survival if farmers want to increase the stocking density of grow-out ponds. In addition, aeration or pumped water is required for emergency use, especially after a partial harvest and long periods of cloudy weather.

Phytoplankton produces oxygen during the day and uses it at night, causing oxygen levels to be higher in the daytime and lower at night. For good growth of prawns, the DO level should ideally be above 3 mg/L in the early morning before dawn when DO levels are at their lowest. If the measured DO is too low, or if dead prawns are seen, some of the pond water should be flushed out by adding or pumping in large amounts of fresh water. This is important to maintain DO levels and should be carried out both at night (when DO levels are naturally low) and also in the daytime, when they can become low at the pond bottom where most of the prawns live.

6.6.4 Temperature

Prawns are cold-blooded animals and their body temperature depends on the temperature of the water. Below 22°C, prawns are less active and feed less. In cooler months, reduce the water depth and cut back shade around the pond to allow the water to be warmed by sunshine during the day.

6.7 Sampling

Every three weeks, a sample of 30–50 prawns should be caught from the pond and weighed, so that the amount of supplementary feed needed to keep pace with their growth can be calculated. To calculate the daily feed ration (DFR), which is the amount of feed to be given to the prawns in the pond each day, the total number of PL stocked in the pond initially must be known. The average body weight (ABW) of the prawns must also be estimated.

Various methods can be used to catch a sample of prawns for weighing, for example, a cast net or seine net. It is important to use a method that does not disturb the pond bottom excessively.



It is best to take samples in the cool of the morning or evening. The prawns should be weighed as soon as they are caught, then released. They can be weighed individually or altogether.

To weigh juveniles, two buckets are required, one with holes and one to hold water (Fig. 17). The bucket with holes is weighed, then placed in the second bucket and filled with water. The prawns are netted and transferred to this bucket. After the prawns have been added, the bucket with holes is lifted gently, allowing the water to drain into the second bucket. Allow time for the water in the bucket to drain as much as possible while gently shaking the bucket. Weigh the bucket using a spring balance that can weigh accurately in the 0–1 kg range, or a top-loading balance. Use a top-loading balance to weigh individual juvenile prawns or prawns that have been in the pond for two months.

The weight of the prawns in the bucket is the difference between the weight of the empty bucket and the weight of the bucket containing the prawns. The ABW is calculated by dividing the weight of the sample of prawns by the number of prawns in the sample:

$$ABW = \frac{\text{Total weight of a random sample of 30–50 prawns}}{\text{Number of prawns in the sample}}$$

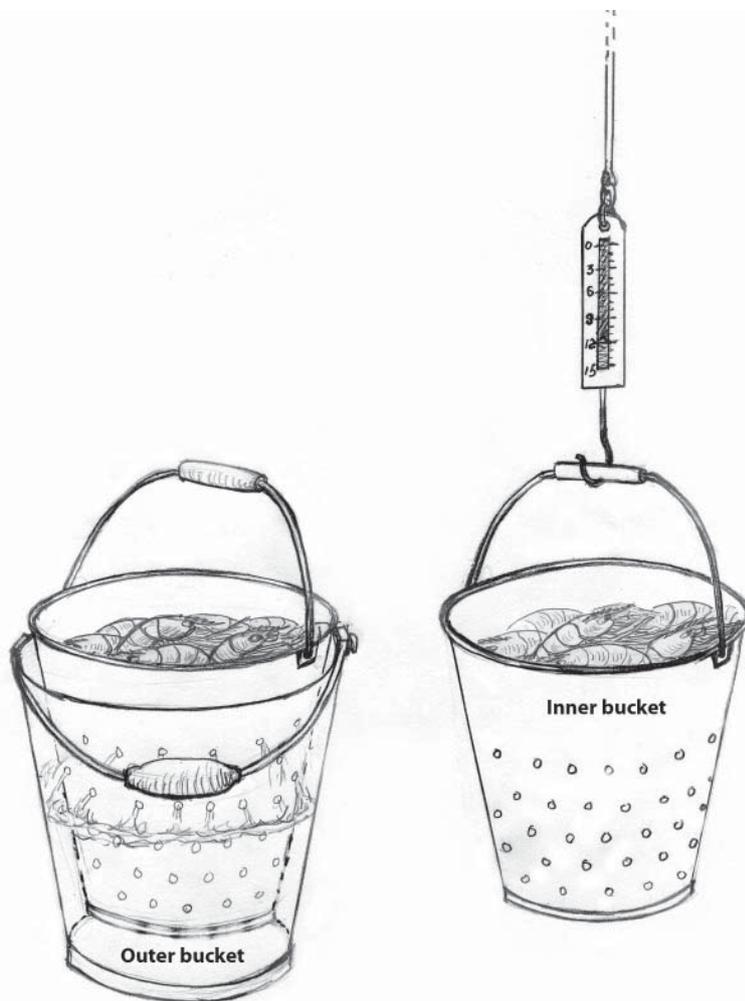


Figure 17. Weighing a sample of prawns

6.7.1 Daily feed ration

The amount of food given daily is calculated from the amount of food required by one prawn each day (feeding rate per day), expressed as a percentage of prawn body weight. The feeding rate varies depending on the size and age of the prawn. Table 5 provides a guide for feeding different sizes of prawns using high-quality formulated feed.

Table 5. Guide for feeding prawns at different sizes

Prawn size	Feeding rate per day	No. of feeds per day
PL	20–50%	4–6
2–3 g	10–15%	4
4 g to adult	5%	2–3

The daily feed ration (DFR) is calculated by multiplying the estimated total weight of prawns in the pond (number of PL stocked in the pond initially multiplied by the ABW of the prawns sampled) by the feeding rate appropriate for the prawns at their current size.

$$\text{DFR} = \text{feeding rate per day} \times \text{ABW} \times \text{total number of prawns}$$

The total daily amount of feed is then divided into several feeds a day. For example, for a daily feed amount of 2 kg for small prawns being fed four times a day, divide 2 kg by 4 feeding times. In other words, give 500 g of food at each feeding time, four times a day.

Worked example of daily feed ration (DFR)

What will be the total amount of food needed each day by 5000 PL with an average body weight (ABW) of 0.02 g?

$$\text{Total weight of PL in the pond} = 5000 \text{ PL} \times 0.02 \text{ g} = 100 \text{ g}$$

At a size of 0.02 g, the PL should be fed at a rate of 20–50% of their body weight daily. If we take a value of 50%, then:

$$\text{DFR} = 0.50 \times 100 \text{ g} = \mathbf{50 \text{ g}}$$
 of food per day.

PL of 0.02g should be fed 4 times per day, so:

$$\begin{aligned} \text{Amount of feed at each feeding time} &= \frac{50}{4} \\ &= 13 \text{ g feed} \end{aligned}$$

6.7.2 Total feed requirement

The total feed requirement (TFR) is the total amount of feed needed for a whole pond cycle from stocking to harvest. The TFR is found by calculating the amount of feed given from one sampling date to the next (by multiplying the DFR by the number of days that a particular DFR was given), then adding together the amounts calculated for each period between samplings.

Recording this in the logbook will give operators a guide on how much feed to buy in future and how much money should be set aside to buy feed during a pond cycle.



Worked example of total feed requirement (TFR)

A pond was stocked with 5000 juvenile prawns at a size of 1 g. At the initial feeding rate of 20%:

$$\begin{aligned} \text{DFR}_1 &= 0.20 \times 5000 \times 1 \text{ g} \\ &= 1000 \text{ g of food per day} \end{aligned}$$

After 21 days, the prawns were sampled and the ABW was 5 g. Assume that the number of prawns is reduced to 4800, a mortality rate of 2% over the 21 days. At the new feeding rate of 5%:

$$\begin{aligned} \text{DFR}_2 &= 0.05 \times 4800 \times 5 \text{ g} \\ &= 1200 \text{ g of food per day} \end{aligned}$$

After another 21 days, prawns were again sampled and ABW was 10 g. Assume there are now only 4700 prawns. Still at the feeding rate of 5%:

$$\begin{aligned} \text{DFR}_3 &= 0.05 \times 4700 \times 10 \text{ g} \\ &= 2350 \text{ g of food per day} \end{aligned}$$

The prawns were fed for another 21 days before sale. What is the TFR over this period?

$$\begin{aligned} \text{TFR} &= (\text{DFR}_1 \times 21 \text{ days}) + (\text{DFR}_2 \times 21 \text{ days}) + (\text{DFR}_3 \times 21 \text{ days}) \\ &= (1000 \text{ g} \times 21) + (1200 \text{ g} \times 21) + (2350 \text{ g} \times 21) \\ &= 21,000 + 25,200 + 49,350 \\ &= 95,550 \text{ g} \end{aligned}$$

A total of 95,550 g (95.5 kg) of prawn feed was fed over this 63-day grow-out period.

6.7.3 Food conversion ratio

The food conversion ratio (FCR) is the amount of food used to produce one kilogram of fish. Calculating the FCR shows whether the prawns are being overfed or underfed. For example, if prawns are fed according to the suggested guidelines but seem to be growing rather slowly and the FCR value is low, then this indicates they need more food to speed up their growth. On the other hand, a high FCR value can indicate overfeeding.

The FCR over one pond cycle is calculated from the TFR and the total weight gain (TWG) of the prawns. The TWG is the difference between the total weight of prawns harvested and the initial weight of PL or juveniles stocked. It can be calculated from an estimate of the ABW at the time of harvest multiplied by the number of prawns harvested, or taken directly from records of prawn sales.

$$\text{TWG} = (\text{final ABW} \times \text{number}) - (\text{initial ABW} \times \text{number})$$

$$\text{FCR} = \frac{\text{TFR}}{\text{TWG}}$$

Note: an FCR value of 3 means that 3 kg of feed was needed to produce 1 kg of prawns.

For semi-intensive culture, FCR values of 2.5–3.5 are considered good. In intensive systems, higher FCR values of 3.0–3.5 are likely because there will be very little natural food available in the pond.

If the FCR value is very high (for example, 5), then it is likely that not all the feed is being eaten, and so some is being wasted. Another explanation is that the feed is of low quality, so the prawns have to eat much more of it to grow.



6.8 Harvesting

Prawns can be harvested 3–5 months after the pond is stocked with PL and juveniles. Usually, pond-reared prawns reach a size of 25–50 g within 4–6 months, depending on the stocking rate, feed quality and quantity, water temperature and DO level. The exact time chosen for harvesting is determined by factors like the preferred market size for prawns and by opportunities to achieve good sales volume and prices.

All the requirements for harvesting must be prepared in advance including aeration, inflow of clean water, holding tanks, buckets, seine nets and scoop nets. The substrate or shelters should also be taken out of the pond to avoid getting them tangled in the seine net.

Pre-planning is needed to ensure that the quantity of prawns seined can easily be sorted or taken out without causing unnecessary stress to small prawns. Many small prawns die when there are too many prawns in the seine net or when the net full of prawns is lifted out of the water.

6.8.1 Partial and complete harvesting

All harvesting operations should be carried out as early as possible in the morning when it is cooler to avoid high temperatures and low DO levels, which will result in numerous prawn deaths before harvesting is completed.

Basically, two types of prawn harvesting are practised: (1) partial harvesting, sometimes referred to as cull harvesting, and (2) complete harvesting, sometimes called drain harvesting.

Partial harvesting

During a partial harvest, market-size prawns only are caught at intervals of 2–3 weeks after 3.5–4.0 months of stocking. Partial harvesting is usually carried out by pulling a seine net through the pond. A cast net may be used if only a few kilograms of prawns are required.

In rectangular ponds, the seine net is usually held at each end and pulled lengthways down the pond. The bottom of the seine (lead line) must be kept on the bottom of the pond by pressing it down by hand in shallower water or by using the feet in deeper ponds. The float line should always be kept on the surface of the water to prevent prawns escaping. Where ponds are irregular in shape or too wide to harvest by pulling each end of the seine net, only a portion of the pond is seined. This is usually done by keeping one end of the seine net stationary and pulling the other end around in a circular way or by cutting the corner of the pond.

The number of people required to pull a seine net depends on the size of the pond to be seined. In a 25 m-wide pond, it is preferable to have two to three people on each bank pulling the lead and float line, and six to ten people inside the ponds, pressing the lead line on to the bottom of the pond, keeping the float line above the water surface and at the same time pulling it (Fig. 18). The net should be set up at the deep end of the pond and dragged along the pond towards the shallow end (inlet end). The prawns can then be sorted out at the inlet end where there is plenty of clean water coming into the pond.

Once the net has been pulled through, the prawns should be gathered into one area of the net. There, they must be kept under water while clean water is allowed to pass through them to clean them and ensure high survival of undersize prawns.

Market-size prawns can then be selected and transferred into a holding tank or other suitable container. Undersize prawns should be returned to the pond or put into another pond. This operation should be carried out quickly to avoid prawn deaths.

After partial harvesting has been carried on several occasions (and prawns have been reared for 7–8 months), seine the pond 3–4 times while reducing the water level. Then, completely drain the



pond and collect the remaining prawns. The undersize prawns can be kept in aerated containers or transferred immediately into another pond. Further details on how to handle harvested prawns are given below (section 6.8.2).

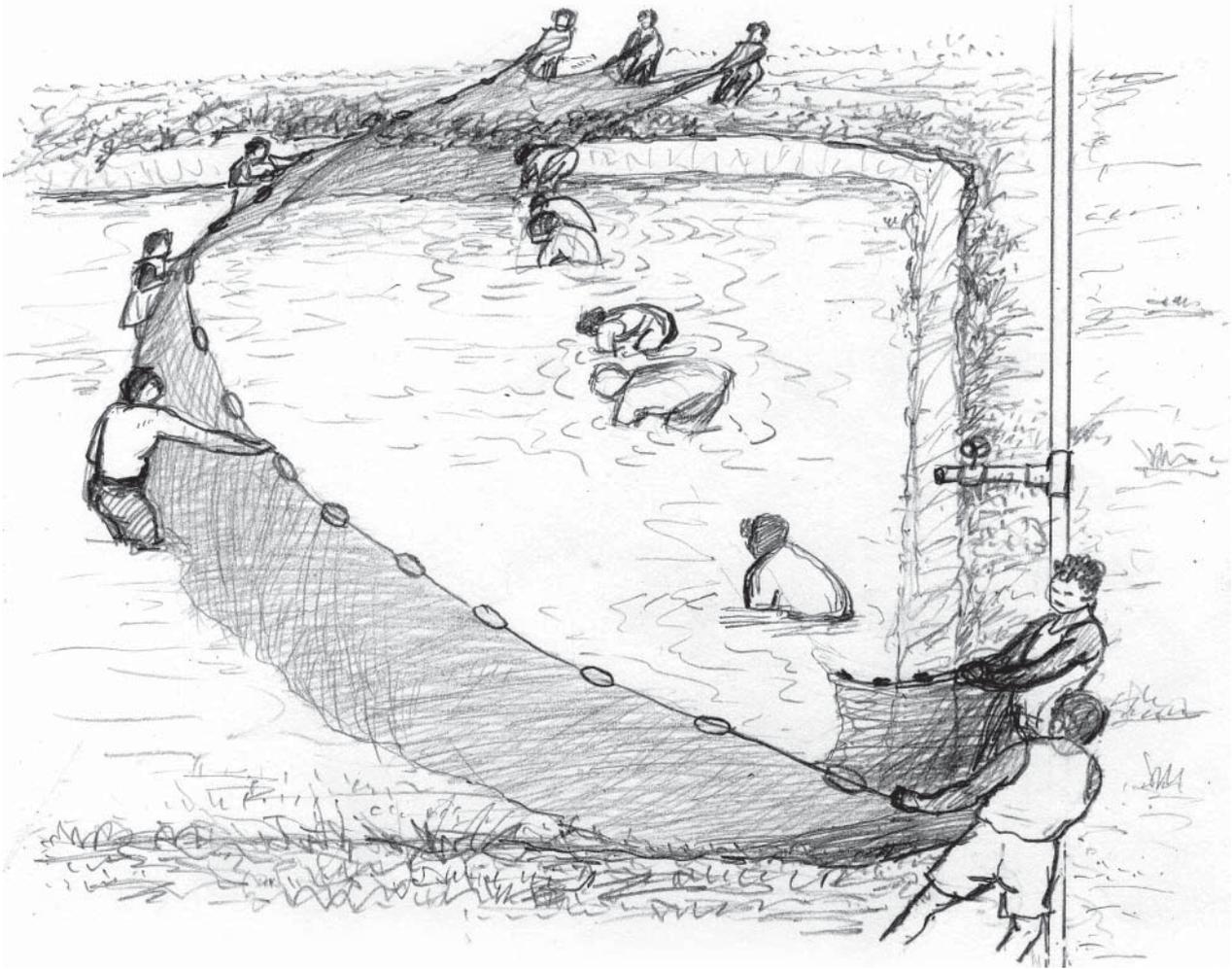


Figure 18. Using a seine net to harvest prawns

Complete harvesting

A complete harvest is usually carried out after 4–5 months of grow-out. The prawns are caught by multiple seining (as in partial harvesting) while the pond is draining. When the pond is almost empty, the remaining prawns can be collected by hand and by scoop nets. Important details on how to handle harvested prawns are given below (section 6.8.2).

6.8.2 Handling of harvested prawns

Special care and attention is required to minimise damage to the prawns, and ensure they stay in good condition and keep as fresh as possible.

The prawns should not be allowed to die from asphyxia simply by leaving them out of water. The harvested prawns should be washed immediately and killed in a solution of water and ice. The prawns should then be transferred into suitable containers (Fig. 19) with alternate layers of ice and prawns, with ice as the first and last layers.





Figure 19. Prawns are placed in suitable containers after harvest

When the harvesting is completed, the prawns can be sorted into different sizes to suit market demand (large: over 20 g, and small: 15–20 g) before being weighed and packed into 1–2 kg plastic bags.

The prawns can be refrigerated for a short period at 0°C and sold as fresh prawns within 3–5 days of harvest.

If the prawns are not going to be sold as fresh prawns, then they must be frozen immediately. The recommended freezing temperature is below minus 10°C (ideally between minus 20 and minus 30°C).

6.8.3 Harvest records

Farmers should record all the details of each harvest by writing down the number, weight and value of the prawns (including those harvested for family use). This includes:

- how many prawns were put in the pond
- how many were harvested
- total weight of all the prawns harvested
- value of the prawns

Farmers can carry out the simple calculations below to check the overall yield:

(a) Survival rate = number of prawns harvested, divided by number of prawns put in pond, times 100

For example, if you stocked 1000 prawns and harvested 800:

800 prawns divided by 1000 prawns x 100 = 80%. A good survival rate is 80% or more.

(b) Average weight = total weight of prawns harvested, divided by number of prawns harvested

For example, if you harvested 500 prawns and their total weight was 15 kg:

15 kg divided by 500 prawns = 0.03 kg or 30 g. This is about how much one prawn weighs. Some will weigh a little more, others a little less.



Usually, in cool water ponds in the Fiji highlands, an average weight of 25 g or more and a survival rate of 80% would be considered a very good result. In lowland ponds with warmer water, for example on the Navua flats, an average weight of 30–40 g and survival rate of 80% would be considered good.

(c) Number of prawns in one kilogram = total number of prawns harvested, divided by the total weight of all the prawns

For example, if you harvested 600 prawns and they weighed 20 kg:

600 prawns divided by 20 kg = 30 prawns/kg.

Like the average weight, the number of prawns per kilogram differs according to growing conditions. The following results would be considered good:

- Highland area with cooler water: 50 prawns/kg
- Lowland area with warmer water: 25–30 prawns/kg

6.9 Marketing

For marketing, prawns can be graded according to size, packed in 1 kg or 2 kg plastic bags, kept on ice and transported to market. They can also be sold to wholesalers. There is usually higher demand for larger prawns (in Fiji, 20–30 g, or around 30–40 prawns/kg) and they fetch almost twice as much as smaller prawns. However, there is still good demand for smaller prawns (10–15 g or around 60–100 prawns/kg).

To get the best prices, timing of the harvest and preparation and presentation of the prawns are all important:

- Plan a harvest before special holidays such as Christmas when there may be high demand for prawns.
- The prawns should look and smell very clean and fresh.
- Make sure the prawns are kept on ice while they are being transported and awaiting sale.
- If the prawns are being sold at the farm, advertise the place and date of the sale in advance along with prices per kilogram. Put up signs to direct people to the place of sale.
- As well as being sold fresh, prawns can be cooked and sold at the market or at fairs as take-away food.

6.10 Record keeping

Prawn farming is a business and good records must be kept of all expenditure and income; that is, keep records of all items that are purchased, labour costs, electricity costs, and so on, and all money made from prawn sales. This will help with budgeting and planning. For example:

- knowing how much feed and fertiliser cost for one grow-out will enable farmers to set aside the amount needed to purchase supplies for the next grow-out
- the prices charged by various suppliers of goods and services can be compared
- total profit can be calculated by subtracting expenditure from income.

Further reading

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