MINISTRY OF FISHERIES
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MIXED SHRIMP-MANGROVE FARMING PRACTICES

A MANUAL FOR FARMERS

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"Mixed Shrimp Farming-Mangrove Forestry Models in the Mekong Delta"

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PREFACE

This manual has been prepared to assist farmers with techniques for improving yields and farm income in mixed shrimp farming-mangrove forestry farming systems in the Mekong Delta, Vietnam. It focuses mainly on simple, common-sense techniques that will allow farmers to make step-by-step improvements to production without taking unnecessary risks.

The techniques and recommendations covered in this manual are based on the experience of a 6-year collaborative research and development project between the Governments of Vietnam and Australia. It was supported mainly through the Fisheries Program of the Australian Centre for International Agricultural Research (ACIAR).

Assistance in evaluating and refining this manual was provided by extension officers in the southern provinces of Cần Thơ, Bac Liêu and Cà Mau in Vietnam, and by farmers in shrimp-mangrove farming enterprises in Ngọc Hiển district of Cà Mau Province. The editors gratefully acknowledge the assistance of Nguyễn Việt Hoàng, Lê Công Uẩn (farmers), Tiền Hải Lý (Bac Liêu Extension Center), Cao Phương Nam (Cà Mau Department of Science, Technology and Environment), Trương Hoàng Minh (Cần Thơ University), Nguyễn Thị Phương Lan (SUMA Project), Đặng Công Bửu (Cà Mau Wetland Forest Research Center), Nguyễn Văn Duyên (Cà Mau Department of Fisheries), Đỗ Văn Hoàng (Cà Mau Sub-Institute for Fisheries Research) and Ngô Văn Hải (Cà Mau Sub-Institute for Fisheries Research).

Freehand illustrations were drawn by Lý Cao Tấn, and photographs and computer illustrations were provided by Danielle Johnston, Barry Clough and Vũ Anh Tuấn.

Contents

WHY PLANT AND PROTECT MANGROVE FORESTS?

Mangrove forests protect houses, shrimp ponds and rice fields

- Mangrove forests provide protection from storms.
- Mangrove roots hold the soil together, and help to reduce erosion.

Mangrove forests support many products for our life

- Food, including fish, shrimp, crabs, and clams.
- Wood for building, furniture, charcoal and fuelwood .

Mangrove forests are a habitat for many useful animals

- Nursery and feeding grounds for shrimp, crab, fish, and other aquatic animals.
- Shelter for many birds, and other terrestrial animals.

If mangrove forests are destroyed!

- ***Houses, shrimp ponds, rice fields, and gardens are destroyed***
- ***Land along the sea and rivers is lost to erosion.***
- ***Aquatic resources such as crabs, fish, and other aquatic animals decline.***
- ***Our environment becomes a desert.***

How to Plant and Manage Mangrove Forests

Select the right species to plant

Rhizophora apiculata is often used for mangrove silviculture because:

- It has a fast growth rate.
- It is easy to grow and manage
- It has a higher economic value than many other species.

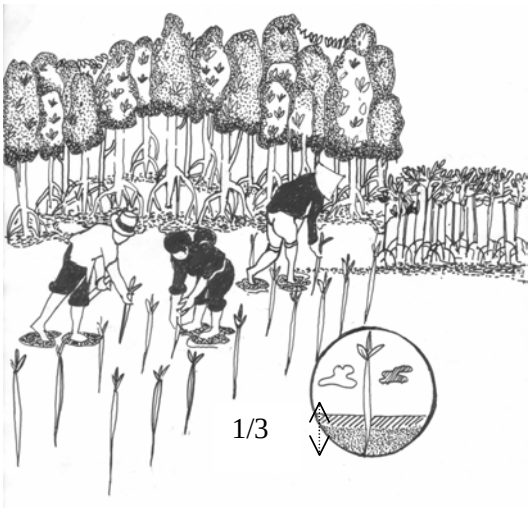
Site selection

- *Rhizophora apiculata* should be planted on sites that are flooded for 10-20 days per month.

Planting techniques

- **Seed selection**

  Select seed from big, healthy trees.



Planting *Rhizophora*

- **Storage**

  Store seeds in a shady, cool place. Prevent them from drying out. Do not store for more than 2 months.

- **Planting density**

  10.000 trees/ha: (a spacing between trees of 1.0m).

- **How to plant?**

  Put about one-third of the seed length into the mud.

Thinning

- **First thinning**

  Thin to a density of 5,000 trees/ha at 9-10 years of age.

- **Second thinning**

  Thin to a density of 2,000 -2, 500 trees/ha at 14 -15 years of age.

Harvesting

- Harvest at about 20 years of age. After harvesting, prepare to plant a new cycle.

Mangrove trees after the first thinning

NOTES ON PLANTING AND MANAGING MANGROVES

- Obtain permission from the Enterprise before planting, thinning or harvesting mangroves
- Do not place soil from pond construction or cleaning in mangrove areas, because *Rhizophora* trees do not grow well or may die on high land without flooding by the tide.
- Do not pump soil from pond construction or cleaning into waterways.
- Use soil from pond construction and cleaning to build up an area of high land for domestic use or where other crops can be grown.

How to Improve Shrimp Yields

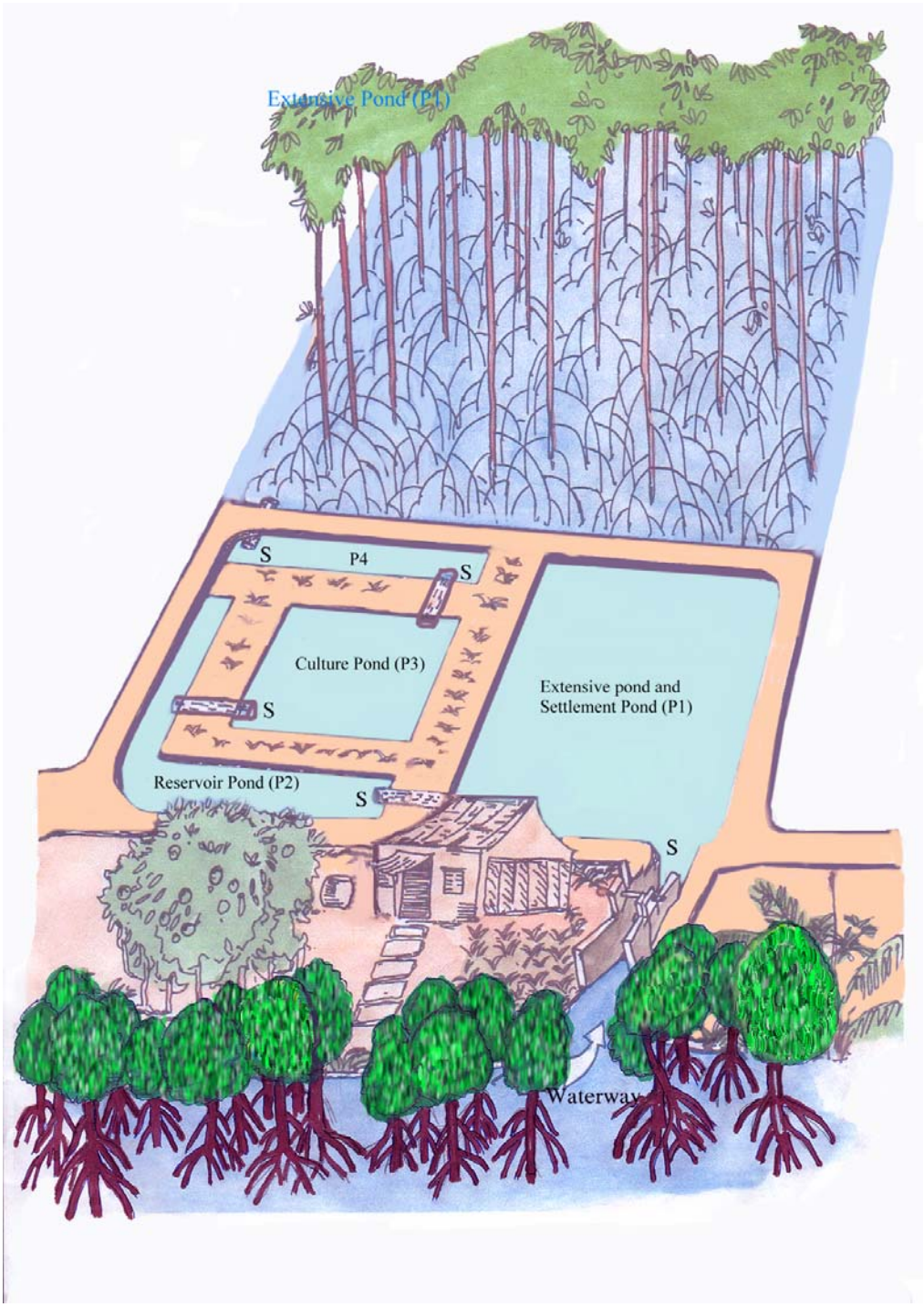
There are 6 key steps to improving shrimp yields: Page

Step 1. Farm Design

The main principles of design are the same for both separate and mixed models.

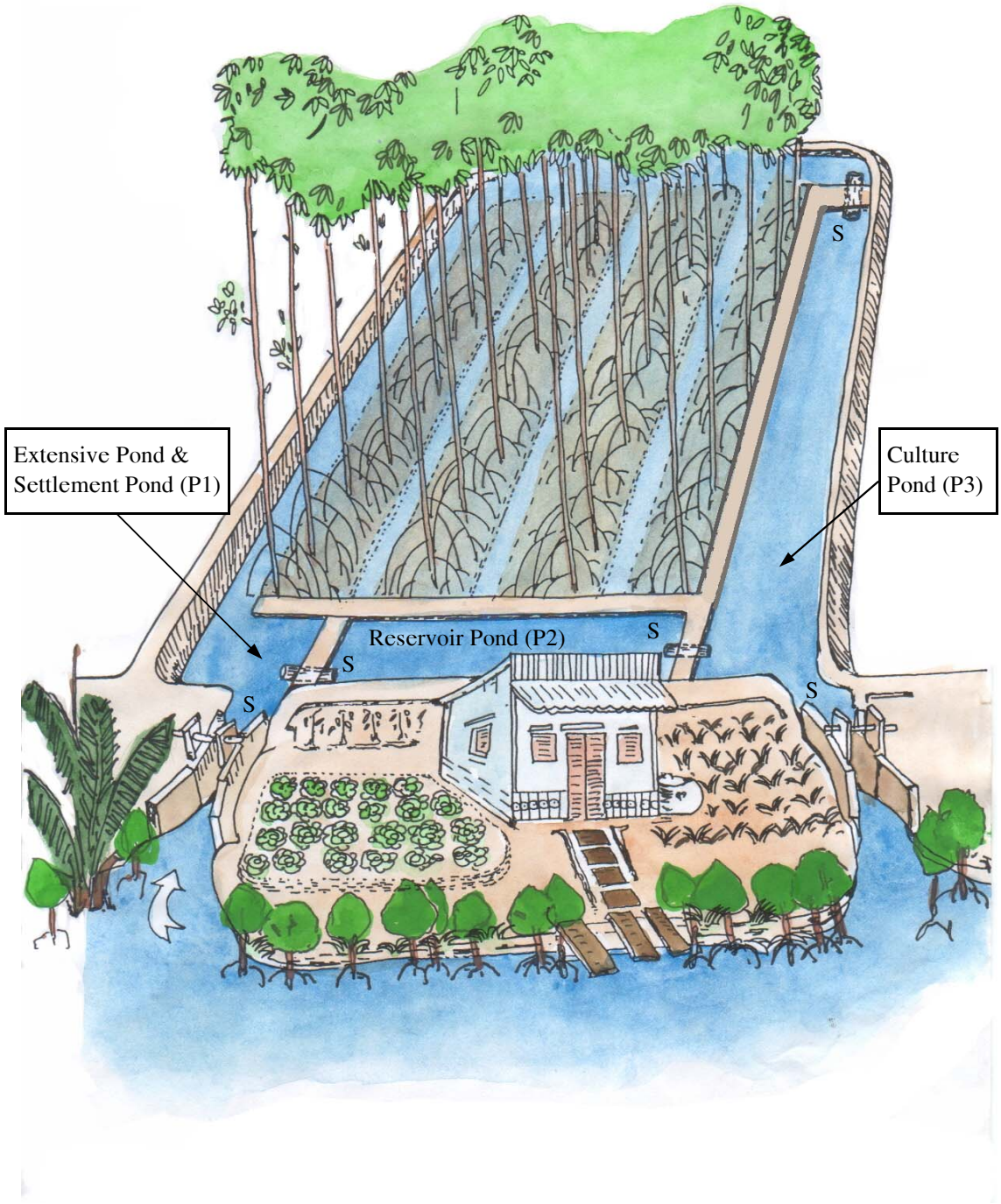
- All farm designs should be approved by the Enterprise..
- Plant a mangrove border at least 20m wide along the edge of the water-way to reduce erosion, and provide nursery and feeding areas for wild aquatic animals. Mangroves such as *Rhizophora, Nipa, Avicennia* and *Sonneratia* are suitable for this purpose.
- Use a separate growout pond for culturing *P. monodon.*
- Use a reservoir pond to keep water for refilling the culture pond.
- Use an extensive pond to culture wild shrimp and as a settlement pond. *P. monodon* can also be cultured in the extensive pond at low densities.
- Deepen all ponds to an average water depth of 0.8—1.0m.

A design for separate farms



- Plant mangrove trees along the waterway to reduce erosion and provide suitable habitat for aquatic animals.
- Use an extensive pond (P1) for culturing wild shrimp and as a settlement pond.
- Construct a reservoir pond (P2) to hold water to refill the culture pond.
- Construct a growout pond for *P. monodon* (P3).
- Construct a waste water treatment pond (P4)
- Sluice gates system (S).

A design for mixed farms



- Plant mangrove trees along the waterway to reduce erosion and maintain a suitable habitat for wild aquatic animals.
- Use most of the canal area in mangrove forest as an extensive pond (P1) and as a settlement pond.
- Use part of the outer canal as a reservoir pond (P2) to hold water to refill the culture pond.
- Build a growout pond for *P. monodon* (P3)
- Sluice gate system (S).

Step 2. Pond Construction

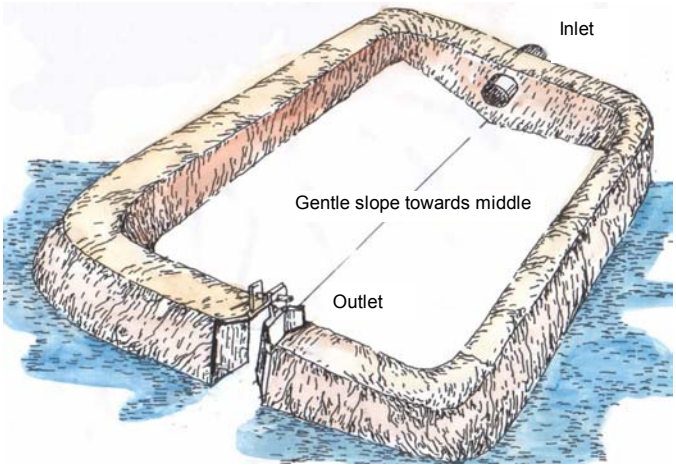
Growout pond for *P. monodon*

Benefits

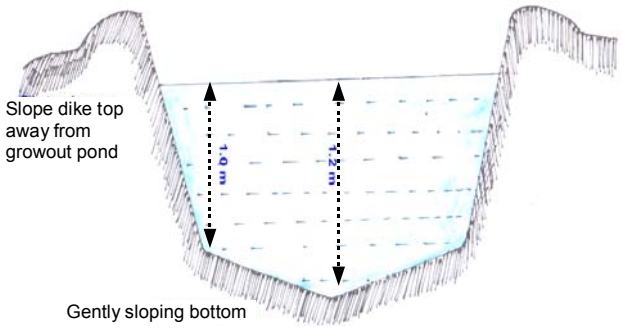
- Easy management.
- Easy to harvest all shrimp.

Construction

- **Area:** 3,000-5,000m^2
- **Sluice gates:** two separate sluice gates - one for an inlet and one for an outlet.
- **Water depth:** 0.8-1.0m.
- **Pond dike:** The dike should be at least 3 m wide. Slope the top of the dike away from the growout pond
- **Pond bottom:** Slope the pond bottom towards the centre of the pond. This will make the pond easier to clean, drain and harvest.



The growout pond



Dike, bottom and water level

Reservoir Pond

Benefits

- Provides a supply of clean water for exchanging water in the culture pond when necessary.

Construction

See pages 8—11 for suggested layout of reservoir ponds.

- The water surface area of the reservoir pond should be greater than 50% of the water surface area of the culture pond.
- The water depth of the reservoir pond should be greater than 0.6m.

Extensive Culture and Settlement Pond

Benefits

- Makes use of traditional farming techniques for wild shrimp.
- Provides a monthly income.
- Allows mud to settle out, and improves water quality before filling the reservoir pond.

Construction

See pages 8—11 for suggested layout of extensive culture ponds.

- Use the remaining water surface area not used for the reservoir and culture ponds.
- The water depth should be greater than 0.6m.

Step 3. Pond Preparation

How to prepare the pond bottom

1. Clean out the mud layer on the bottom of the culture pond, the reservoir pond, and the extensive pond after every cycle. (Applies to both mixed and separate farms).

2. On separate farms, lime the bottom of all ponds in the following steps:

   - Drain the pond completely.
   - Apply lime as follows:

     CaO: 50-70 kg/1,000 m^2

     $CaCO_3$: 100-150 kg/1,000 m^2

   - Dry the pond bottom for 10-15 days after liming, then re-fill it with water.

Liming and drying the pond bottom

How to improve water quality before stocking

1. Filling the extensive (settlement) pond

- Try to avoid filling the extensive pond when canal water is dirty or very turbid. Do not fill with water from neighboring farms or from waste drainage canals.
- Fill the extensive pond at the beginning or the end of spring tidal cycle. Following the lunar calendar, fill the pond on days 11-13 and 18-20 of the mid-month spring cycle ("Ram") and on days 27-29 and 4-7 of the end-of-month spring cycle ("Ba Muoi").
- Fill water when the tide begins to ebb after the tidal peak.
- Screen the water gate to prevent fish entering the extensive pond.
- Fill the reservoir pond after it has been in the extensive (settlement) pond for 3 days.
- Refill the extensive pond from the main supply canal.

2. **Filling the reservoir pond**

- Use a fine screen to prevent wild shrimp and other aquatic animals entering the reservoir pond.
- Allow water to stand in the reservoir pond for 3 days before filling the culture pond.

3. Filling the culture pond

- Fill the culture pond to as fully as possible from the reservoir pond.
- Repeat this cycle of filling the extensive, reservoir and culture ponds until the water surface level is the same in all 3 ponds.
- Use a cloth filter bag (described below) to filter water when filling the culture pond from the settlement pond.

Cloth filter bag at the water gate between the reservoir pond and the culture pond.

The cloth filter bag

The cloth filter bag is used to prevent disease hosts, such as wild crab seed, wild shrimp juveniles and Acetes from entering the culture pond.

- The filter bag is made with "vai Tam" or "vai Ka-te" materials.
- The mounting frame for the cloth bag should fit the water gate closely.
- Generally, the cloth bag should be 6-7 m in length for cement water gates (see figure).

How to kill predators in the culture pond?

Keep a high water level in the culture pond to kill eels and gobies that might be sheltering in holes along the dike.

- Use wet derris roots at the rate of: 7-10kg/1.000m^3.
- Use tea seed cake at the rate of: 10-15kg/1.000m^3.

Stimulating phytoplankton before stocking

Phytoplankton only need to be stimulated in the culture pond and the extensive pond.

Use a Secchi disk (see photo on page 23) to check water transparency 2 days after killing predators. If the transparency is greater than 40 cm then apply fertilizer as follows:

- Use NPK fertilizer (N:P:K=20:20:0).
- Application rate: 1-2 kg/1,000 m^3
- To apply, mix and dissolve the fertilizer with a small amount of pond water before spreading over the water surface.
- The pond is suitable for stocking when the transparency is 35-40 cm and the water has a "tea colour" similar to that shown in the photograph to the right.

Good water color

Note. *Fertilizer must be dissolved in water before it is applied to the pond, otherwise the heavy fertilizer granules sink to the bottom quickly. This will stimulate rapid growth of bottom algae. When the bottom algae die, the water quality will be poor.*

Step 4. Seed Selection and Stocking *P. monodon*

How to select good PL

Visual assessment

- Choose big PL with open tails and a length of more than 1.3 cm at PL_{15}.
- PL should be uniform in size and colour.
- Most PL should swim strongly against a water current, and should not concentrate in the center of basin.
- PL react quickly in response to noise and light.

Good PL swim against a water current

Testing PL

Add 100 PL to a basin containing 10 litres of seawater. Add 2 ml of good quality formalin. Check the PL after 1 hour without aeration. If less than 5 PL are weak or dead, then the PL can be regarded as healthy.

Transporting PL

- Do not pack more than 1,500 PL per litre water.
- Transport in the early morning or late afternoon to avoid high temperatures.

Stocking Density

	Maximum stocking density (con/m^2)	
	Growout Pond	Extensive Pond
Separate farming system	7	1-2
Mixed farming system	5	1-2

Acclimatizing and Releasing PL

- **First method**:

  Gently empty the bags and PL into large dry basins and aerate. Then slowly add pond water to the basins. Gently release PL into the pond after 30-60 minutes.

- **Second method**

  Float the bags containing the PL on the surface of the pond for 1-2 hours. Then slowly fill the bag with pond water while gently releasing the PL into the pond.

Acclimatizing PL before stocking

Step 5. Pond Management

Stimulating Natural Food in Extensive Ponds

- Use a Secchi disc (see page 23) to monitor water transparency. If the transparency is greater than 40 cm then apply fertilizer to stimulate phytoplankton growth, as follows:

  Fertilizer: N:P:K=20:20:0. Dissolve 1-2 kg NPK /1,000 m^2/time in pond water before spreading over the pond water surface.

  Maintain Secchi disc transparency at 30-35 cm (see page 23).

Feed Management in the Culture Pond

Stimulating natural food for the first 25 days after stocking

- Use a Secchi disc (see page 23) to monitor water transparency. If the transparency is greater than 40 cm then apply fertilizer to stimulate phytoplankton growth as described above for the extensive ponds.

Feeding from 25 to 50 days after stocking

- Feed at the rate of 0.5 kg per 10,000 PL per day
- Feed 1/3 of the total daily feed equally at 8:00 am, 6:00 pm, and 9:00 pm.

Feeding after 50 days from stocking

- The feeding rate depends on the average shrimp body weight as shown in the table on page 20.

Feed Quality

- Make sure that feed is stored in a sealed package.
- Make sure that feed has been stored in a dry, clean area.
- Make sure that the feed is not wet or contaminated with fungus.
- Make sure that feed is marked with a use-by date, and do not use feed that is past its use-by date.

Average body weight (X) (g)	Feeding Rate (R) (% body weight)
3-5	3.0%
5-10	2.5%
10-20	2.0%
> 20	1.5%

Using a cast net to sample shrimp

Calculating how much to feed:

- Every 10 days use a cast net to sample shrimp in at least 3 different parts of the pond.
- For each cast, count the number of shrimp caught in the net and measure their total weight.
- Calculate the total number of shrimp in the pond:

$$\text{Total number} \quad (C) = S \times \frac{N}{M \times n}$$

- Calculate average shrimp body weight:

$$\text{Average body weight} \quad (X) = \frac{K}{N}$$

- Calculate total shrimp body weight:

$$\text{Total body weight} \quad (A) = C \times X$$

C = Total number of shrimp in pond (con)

S = Pond water surface area (m^2)

M = Surface area of the cast net (m^2)

n = Number of casts with the cast net

N = Number of shrimp caught after n casts with the cast net

K = Total weight of shrimp after n casts with the cast net (g)

X = Average body weight (g/con)

A = Total shrimp body weight (g)

R = Feeding rate (% body weight) in table above

F = Daily feed requirement (g)

- Calculate the daily feed requirement:

$$\text{Daily feed } (F) = A \times \frac{R}{100}$$

- Feed 1/3 of the daily feed requirement three times a day (8:00 am, 6:00 pm, and 9:00 pm).

Example feed calculation

Use a cast net to estimate the total daily feed requirement at 60 days from stocking in a pond of 3,000 m^2. Results from the cast net are:

• Area of the cast net (*M*)	5 m^2
• Number of casts with the net (*n*)	3
• Total number of shrimp caught in 3 casts (*N*)	60 (con)*
• A total weight of N con (*K*)	600 (g)

* con = animals or individuals

We can estimate**:**

• A total number of shrimp (C)	(3,000 × 60) / (5 × 3) = 12,000 (con)
• Average body weight (X)	600 / 60 = 10 (g/con)
• Total body weight	12,000 × 10 = 120,000 g = 120 kg
• Feed % body weight for X = 10g (from table on page 24)	2.0%
• Total feed per day	120 × 2.0 / 100 = 2.4 kg
• Amount to feed per feeding time	2.4 / 3 = 0.8 kg

Feeding

- Spread the feed in clean areas nearby the sides of the pond.
- Use 4 feed trays to check feed consumption in ponds of 3,000-5,000 m^2 in area.
- Feed trays may be round or square in shape, and should have an area of 0.5 to 0.6 m^2, with a lip about 10 cm high around the edge.
- Check feed consumption 2 hours after adding feed to the tray. Empty feed trays indicate that the shrimp are feeding well. If there is still feed in the trays after 2 hours then reduce the amount of feed added to the pond by half, or stop feeding for 1-2 days.

Using feed trays to manage feed

Note

- ***Do not overfeed because it will cause the water quality to degrade quickly.***
- ***Reduce the amount of feed by 1/2 or stop feeding altogether when shrimp are moulting or during heavy rain. Start feeding again after one or two days.***

How to manage water quality

Extensive pond

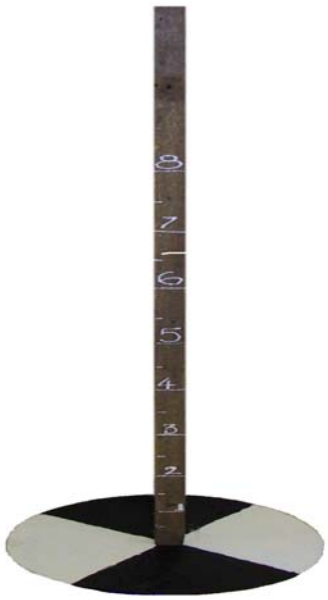
Top up water in extensive pond at the beginning or the end of the tidal spring cycle to avoid highly turbid water from neighbouring farms.

Reservoir pond

- Fill water from the extensive pond.
- Allow water to settle for 3-5 days before exchanging water in the culture pond.

Culture pond

- Use a secchi disc to monitor water quality between 2 pm and 3 pm**.**
- Exchange water when the transparency is less than 30 cm and dark in colour.
- Exchange 20-30% of water volume per time.



Secchi disc

Managing water quality during heavy rain

- Drain off surface water during heavy rain to reduce rapid changes in salinity, turbidity and pH.
- Spread lime ($CaCO_3$) at the rate of 2-3 kg / 10 m^2 on the top of dikes of extensive and culture ponds.
- If pond water becomes highly turbid after heavy rain, then apply 20-30 kg $CaCO_3$ powder per 1,000 m^2 of water surface. Dissolve the $CaCO_3$ powder in some pond water and then spread it evenly over the pond surface.

Daily checks for water leakage and lap lap

- Remove lap lap and other surface rubbish, especially from the corners of ponds.
- Check and control leakage around dike and water gates to maintain the water level in the culture pond at 0.8-1.0m and at least 0.6m in the extensive pond.

Liming the dike

Clean the pond daily

How to manage shrimp health

- Do not take in water from the supply canal during an outbreak of disease.
- Observe shrimp in the pond, especially at night using a flash light.

  Healthy shrimp have bright red eyes, react quickly and swim fast.

  Unhealthy shrimp have pale, glassy eyes, react slowly and move slowly close to the edge of the pond.
- Use a cast net or feed tray to catch shrimp for closer observation.

  Healthy shrimp have clean, naturally coloured bodies , clean gills, unbroken tails, intact appendages and full guts.

  Unhealthy shrimp often have a dirty body, discolouration (black gills, red body, white spots, etc), swollen tails and empty gut.

Check shrimp health with a feed tray

- Use formalin 3 times during a crop (30-35, 55-60 and 85-90 days after stocking) to disinfect the shrimp shell and stimulate moulting.

  Make sure there is enough water in the reservoir pond for water exchange.

  Avoid using formalin when shrimp are moulting.

  Dose: 10-15 litre per 1000 m^3.

  Add formalin to the pond at around noon on sunny days.

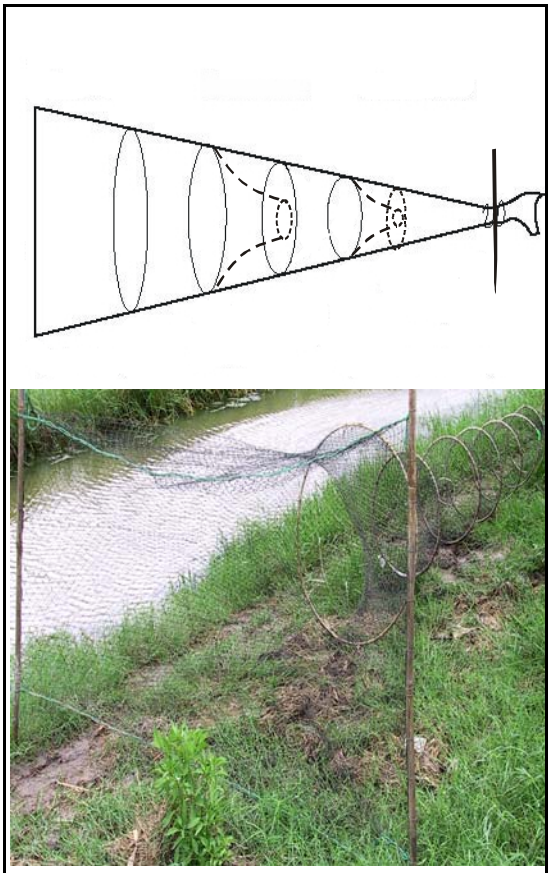
  One day after using formalin exchange 30% of the pond water.

Step 6. Harvesting

Extensive ponds

Against water current technique

Construct "lu nguoc" (against water current) nets as shown in the illustrations to the right



Design of "lu nguoc"

For harvesting wild shrimp

- Harvest at night on lunar spring tides, beginning 1 month after stocking.
- Use 1 cm mesh size for "lu nguoc" nets for wild shrimp.
- Place 1 net at the water gate, and 2-4 nets inside the pond near to the water gate.
- A lamp at the tail end of nets inside the pond may encourage shrimp to enter the net

For harvesting *P. monodon*

- After 2.5 months, begin harvesting larger shrimp (>30 g/con) using the "lu nguoc" (against water current) technique on lunar spring tides.
- Use 4.5 cm mesh size for "lu nguoc" nets for *P. monodon*.
- Use 10-15 nets for ponds of 5,000-10,000 m^2 in area.

Traditional harvest by draining the pond

- Ponds should not be drained for harvest until at least 3.5 months after stocking. Draining ponds before this will stress small shrimp and lead to a loss of seed.
- Use a net of 1.0 cm mesh size.

- Drain 40-50% of the water volume on the morning low tide of the lunar spring tide. Refill the pond on the following high spring lunar tide. Drain water again on the falling tide to harvest.

Harvesting *P. monodon* in culture ponds

Against water current technique

- Begin harvesting when shrimp begin to reach the size of 30 g/con, using “lu nguoc" nets.
- Use 4.5 cm mesh size for “lu nguoc" nets for *P. monodon*.
- Use 8-10 traps for ponds of 3,000-5,000 m^2 in area.

Note: *Do not drain, fill or exchange water in the culture pond when using this harvest method, in order to avoid the risk of introducing diseased animals into the pond.*

Harvesting by draining the pond

- Harvest when the average size of shrimp is greater than 30 g/con.
- Steps
  1. Set up a bag net at the water gate and drain the pond at night to a water depth of 40-50 cm .
  2. Next day, use a cast net or hand net to catch as many shrimp as possible, and then drain the pond completely with a bag net at the water gate.
  3. Finally, collect remaining shrimp by hand when the pond is empty.

Notes : *1) Try to harvest when the weather is cool.*

2) Prepare storage boxes, ice and labour before harvesting.

DIVERSIFYING FARM OUTPUT

Why diversify?

- Provides a more stable household income.
- Makes good use of family labour.
- Makes better use of land area.

How to diversify farm output

Crab culture in extensive ponds

- ***Stocking rate***
  - 10-20 con/1,000m^2 for seed sized 8-10 con/kg.
  - 30-50 con/1,000m^2 for seed sized 100-150 con/kg.
- ***Management***
  - Stock crab seeds at the beginning of the wet season.
  - Fence the dike with plastic sheet, stakes or netting to prevent crabs escaping.
  - **Do not stock crabs with *P. monodon* in the culture pond.**

Mud crab

Tilapia and mullet in the reservoir pond

- ***Stocking rate***
  - 1-3 con/m^2.
- ***Management***
  - Tilapia should be acclimated to salinity for 3-4 days before being released into the settlement pond.

Tilapia

Vegetables, fruit trees, and timber trees

Soil excavated during pond construction and pond cleaning can be used to built up higher land which, after 1-2 years to leach out the salt, is suitable for growing some fruit trees and cash crops.

- ***Vegetables:*** Chinese mustard, chilli, cassava, sweet tomato, etc.
- ***Fruit trees:*** Sapodilla, guava, pineapple, coconut, banana, tamarind, etc.
- ***Timber***: *Eucalyptus*, *Acacia.*

Sapodilla

Cassava

Tamarind

Chilli

Domestic animals

- Pigs, chickens, ducks, and possibly other domestic animals can be raised on high land to supplement household incomes.