Soft-shell Mud Crab Farming

Emilia T. Quinitio

May Myat Noe Lwin
CNN

FOREWORD

Farming of soft-shell mud crab has been practiced for some time now in a number of Asian countries. Because of its profitability, there is an increasing interest to engage in this aquaculture business venture. Crabs collected from the wild are the major source of stocks for farming. However, the use of hatchery-reared crabs is encouraged so as not to deplete the wild population. Although communal rearing of crabs for soft-shell crab production in cages or in tanks is also practiced, this manual describes the individual rearing of crabs in boxes based on experience in Ranong, Thailand. The techniques can be modified depending on the site.

Training courses which involve lectures and actual practice have been provided by some agencies and private sector like CNN Soft-Shell Crab Farm (Ranong, Thailand). However, a written step-by-step procedure is not readily accessible if not lacking. This manual provides a section on the biology of mud crab that includes species identification, molting, and autotomy and regeneration which discloses important information related to the management of soft-shell crab farming. This is followed by a detailed discussion on the setting up and management of the farm for soft-shell crabs. The basis for the computation of cost and return analysis is included under the section on Profitability. Cost of materials and labor varies in each country hence only the materials needed and other technical assumptions are listed as basis for computation.

We hope that this manual will benefit prospective investors, operators and technical people.

Emilia T. Quinitio

May Myat Noe Lwin

TABLE OF CONTENTS

INTRODUCTION

The mud crabs, *Scylla* spp., are a highly priced commodity in local and export markets throughout Asia and Australia. Commercial mud crab farming engages mostly in short-term fattening (30-45 days) of lean crabs and long-term grow-out (3-5 months) of crabs to produce marketable size crabs. In recent years, soft-shell crab farming has become popular because it is a profitable business. The crabs used are mostly wild-sourced *Scylla* species and blue swimming crabs, *Portunus pelagicus.* Production of soft-shell crabs is done by allowing the hard-shelled crabs held individually in perforated plastic boxes or communally in big cages in ponds or in tanks to molt. In the communal rearing, the limbs of the crabs are removed to prevent cannibalism.

The soft-shell crab can be eaten whole when cooked; carapace and all limbs. Thailand, Myanmar, Vietnam, Malaysia, Indonesia, and recently the Philippines are producing soft-shell crabs. The greatest number of soft-shell crab farms is in Ranong, Thailand, where farmers can market the crabs daily at the numerous seafood processing plants in the area. Income is generated daily from the harvest of soft-shell crabs. Processed crabs are sold to local restaurants and exported to Hongkong, Singapore, South Korea, Japan, Taiwan, Europe and the United States.

BIOLOGY

Identification of mud crab species

There are four species of mud crab namely; *Scylla serrata* (giant or king crab), *S. tranquebarica* (purple mud crab), *S. olivacea* (orange mud crab) and *S. paramamosain* (green mud crab) (Keenan et al., 1998) (Fig. 1). The major morphological structures used to distinguish the different species are as follows:

- Color of shell and markings on legs
- Shape and height of front spines or teeth
- Number and height of spines on the chelipeds

Molting

In order to grow, mud crabs molt or shed the hard shell several times during their life cycle. The number of days between molts increases with size. The major stages of the molt cycle are:

- Postmolt

  The newly molted crab is soft and inactive. The crab expands its body and limbs by taking in water before the new shell hardens. Feeding may start when part of the shell becomes hard.

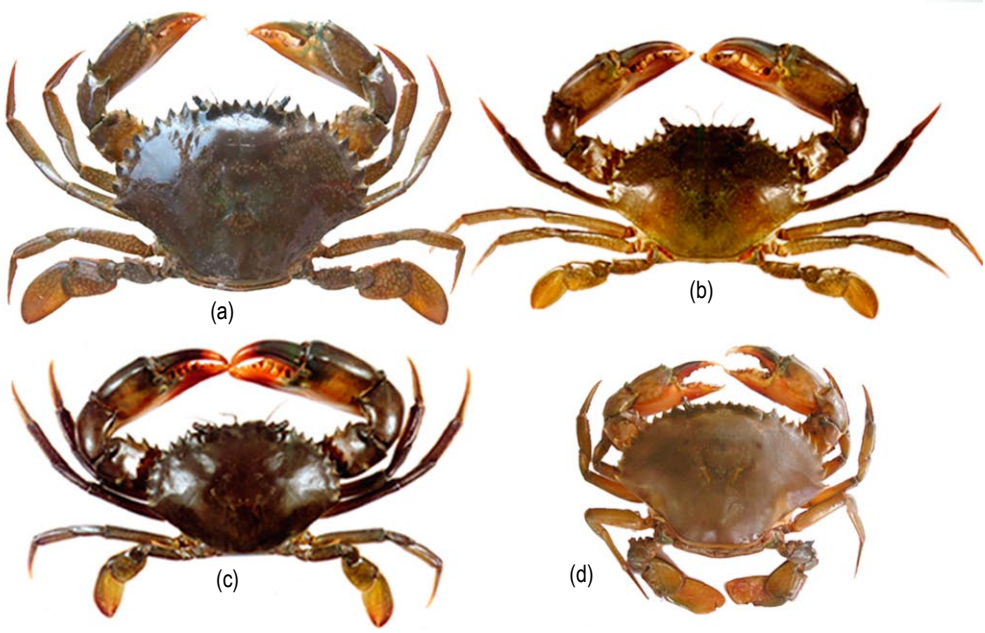

Fig 1. Mud crab species: *S. serrata* (a), *S. tranquebarica* (b), *S. olivacea* (c), *and S. paramamosain (d)*

- Intermolt

  At the early part of the intermolt stage, the carapace is almost hard but the walking legs are still flexible depending on the crab size. The shell hardens completely after several days. The intermolt stage is the longest among the molt stages.

- Premolt

  The shell becomes papery. The outer hard layer of the shell separates from the membranous layer and causes an evident mottled appearance of the old shell. Activity is reduced and feeding stops as the crab loses its muscle insertions.

- Ecdysis

  The crab gets out of the old shell (Fig. 2) and takes up water rapidly. This is the most stressful part of the molt cycle. The crab usually increases in size by 30-50%.

Fig. 2. The crab withdraws from the old shell

Autotomy and regeneration

Autotomy is the voluntary shedding of a limb by snapping it off at the base. Crabs autotomize limbs which are badly damaged or seized by an attacker. The claws are autotomized more frequently than any other limb. Wound healing occurs immediately after autotomy followed by limb growth where limb buds appear (Fig. 3). The soft limb buds become darker and bigger in size. All the muscles of the new limb are completed and all the nerves become functional yet the bud remains quite small. Growth immediately preceding the shedding of the exoskeleton is the final stage of limb regeneration. The loss of chelipeds and or many walking legs hastens the onset of the next molt and may promote the regeneration of lost limbs. Immediately after the molt, the regenerated limb unfolds and expands but is still somewhat smaller than the other limbs (Fig. 4). It regains its full size after the next molt.

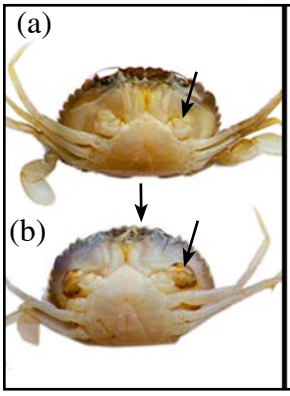

Fig. 3. Small limb buds appear after autotomy (a); buds become darker and bigger (b)

Fig. 4. Limbs regenerate after a molt

SETTING UP THE FARM

Pond site

A typical brackishwater earthen pond for fish or shrimp farming can be used for farming of soft-shell mud crab. The criteria of a suitable pond site are the following:

- Site
  The site should be protected from typhoon, flood and siltation.
- Accessibility
  The farm should be near the roads, source of crab supply, processing plant and market.
- Soil
  The pond soil should be clay or clay-loam to retain the water.

- Seawater / brackishwater supply

  Adequate supply of clean seawater or brackishwater should always be available.
- Availability of electric power

  Electricity is important in managing the farm especially during daily harvest where soft-shell crabs are held in buckets with aerated freshwater, Freezer for storing the feeds and crabs, light for monitoring soft shell crabs at night and other activities.
- Freshwater supply

  This is used for holding of soft-shell crabs, washing of plastic containers, and domestic use.

The pond area for soft-shell farming may range from 0.5 to 1.0 ha. The three sides of the pond should have at least 3 meters free space from the dikes. The fourth side where the gate (water inlet/outlet) is situated should have at least 5 meters free space from the dike for better water circulation. Fish should be stocked in the pond to maximize the area. A 0.5 ha farm can accommodate at least 56 pontoons that can hold a total of 36,288 crab boxes.

Pontoons or floating platforms

Fig. 5. Pontoons made of PVC pipes

Pontoons support the plastic boxes where crabs are held (Fig. 5). A pontoon of polyvinylchloride (PVC) pipes (4 cm in diameter) is constructed with 8 units of 4 m length pipes connected to each other forming 4 columns (Fig. 6). Both ends of the pipes are covered with PVC cap to prevent the entry of water (Fig. 7). The length of the pontoon depends on the pond size. The pontoon is divided into several sections measuring 110 x 110 cm each, separated by a narrow piece of wood (2.5 cm width x 2.0 cm thickness x 110 cm length) (Fig. 6) or PVC

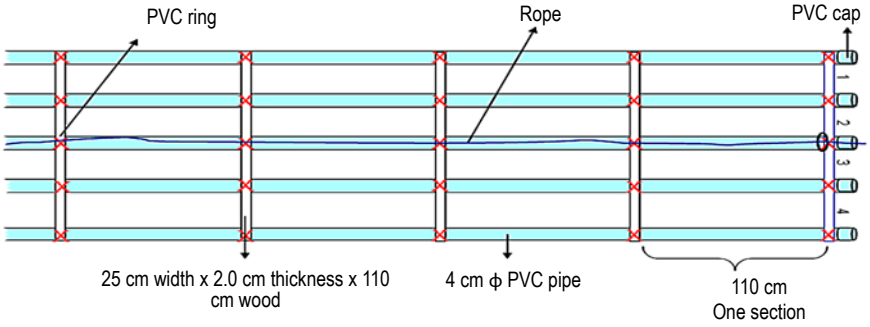

Fig. 6. Diagram of pontoon (top view) showing details of measurements. The pontoon has four columns (numbered 1 to 4)

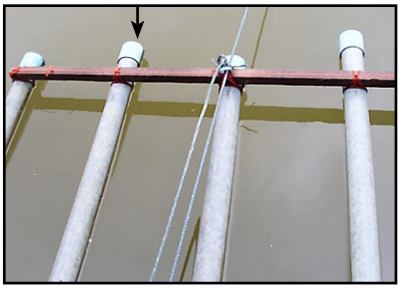

Fig. 7. End PVC pipe covered with cap (▼) and polyethylene rope positioned in the mid section of pontoon

Fig. 8. Rope tied to the pole

pipe with smaller diameter tied across the main PVC pipes. One section can hold 24 boxes arranged in 4 rows, that is 6 boxes in each column. One pontoon may have 27 sections that can hold 648 boxes depending on box size. More than 4 rows in each section are not advisable since it is difficult to inspect the boxes across at one glance.

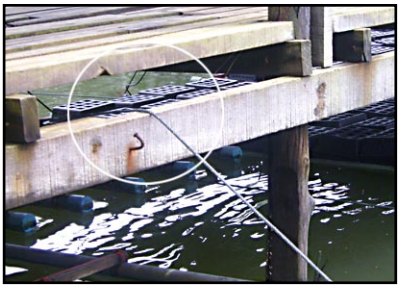

Fig. 9. Polyethylene rope inserted under the floor of the roofed bridge

Polyethylene rope is tied to a wooden pole and inserted in the rings installed in the mid section of the pontoon (Fig. 8). The other end of the rope is tied to the opposite pole. Rings to guide the rope for pulling are installed every 4-5 compartments in the mid section of the pontoon. Another rope is tied from the end of the PVC pipe and inserted under the floor of the wood that support the bridge going to the opposite end of the pontoon (Fig. 9).

Roofed bridge

A roofed bridge is constructed in the middle of the pond to gain access to the pontoons (Fig. 10). The wooden or bamboo floor is at least 150-180 cm wide. The length depends on the width of the pond. The floor is elevated 12-15 cm above the water surface and the pontoons pass under the bridge to go to the other side during crab inspection and feeding.

Fig. 10. Roofed bridge

Crab boxes

Crabs are held individually in perforated plastic boxes (Fig. 11). The base of the box measures 215 x 155 x 90 cm while the detachable cover measures 215 x 155 x 25 cm. The cover is tied securely with the base after putting the crab. The top of the cover has bigger holes to facilitate feeding and inspection of molted crabs without opening the box.

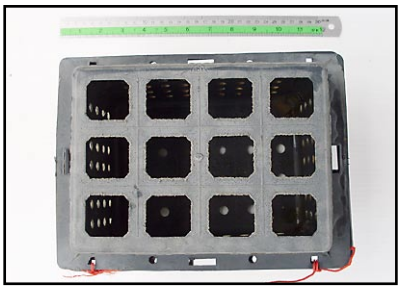

Fig. 11. Plastic box to hold crabs

Other facilities and equipment

Other important facilities and equipment that are needed in the operation of the soft-shell crab farm are as follows:

Facilities

- Working area for weighing, acclimation, holding of newly collected soft-shell crabs in aerated freshwater, etc (Fig. 12)
- Small room for holding the soft-shell crabs in trays and freezer
- Roofed area with freshwater source for preparation of food items especially for chopping of fish and a shallow cement tank for soaking and washing of used boxes
- Living quarters of staff

Fig. 12. Working area connected to the roofed bridge

Equipment

- Magnetic air compressor, 90 li/m
- Submersible pump
- Freezer
- Generator, speed nominal 3000r/min
- Weighing scales, 50 kg and 500 g capacity
- Refractometer

Other supplies

- Perforated plastic trays for holding soft-shell crabs
- Basins (50 li), pails (10 li) and dippers
- Bamboo baskets and plastic containers
- Thermometer
- Plastic tubing, aeration control valve and airstones

- High density polyethylene rope, 1.5 mm; straw for tying
- Chopping boards and knives
- Scissors
- Brushes and other cleaning implements
- Cotton cloth
- PVC pipe with hook for retrieving the cages (Fig. 13)
- White board, pens and record book

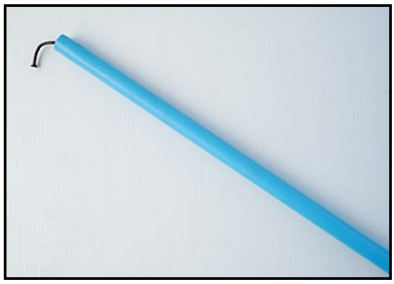

Fig. 13. PVC pipe with hook for pulling boxes

POND AND WATER MANAGEMENT

Pond preparation

Pond preparation ensures that the crabs are provided with a clean pond bottom and suitable water quality. Before the ponds are used, the following activities are carried out:

1. Drain the pond completely and dry for at least a week.
2. Make all dikes watertight and seal the gates with soil.
3. Install screens to prevent entry of undesirable animals.
4. Remove wastes or scrape black soil. Level the pond bottom.
5. Apply a small amount of lime mixed with topsoil and till pond. Tilling brings the nutrients at the bottom soil to the surface soil layers.
6. Dry for a minimum of one week. Drying eliminates waste products and obnoxious gases resulting from organic matter decomposition.
7. Flood and flush pond up to 30 cm to remove toxic substances from organic matter decomposition. Hold water for 1-2 days.
8. Drain pond completely and repeat drying process.
9. Apply organic pesticides.
10. Apply lime at 1-2 tons calcium carbonate/ha or 200-300 kg calcium oxide/ha on pond bottom and dikes. Allow several days prior to application of fertilizer.
11. Apply fertilizer at 1-2 tons manure/ha + 25 kg/ha urea (46-0-0) and 50 kg/ha ammonium phosphate (16-20-0) when fish are stocked in the pond.
12. Admit water into the pond.

Maintenance of water quality

Pond water deteriorates due to accumulated wastes, hence it is important to maintain good water quality.

1. Maintain water depth of 80 cm and water parameters as follows:

Parameter	Value
Temperature	27-32°C
Salinity	16-30 ppt
Dissolved oxygen	≥5 ppm
pH	7.5-8.5
Transparency	30 cm
Organic matter	1-10%

2. Change 70-80% of the total water volume for 2-3 days during spring tide.

Stocking of fish

To maximize the space in the pond, herbivore (siganid or milkfish) or omnivore (tilapia) fish are stocked. Mud crabs occupy the surface area while fish swim in the water column. The fish can serve as 'aerators' and eat the excess algae in the pond.

1. Stock fish (≥4 cm) - tilapia, siganid or milkfish at ≤0.1 pc/m^2 or a combination of two types of fish at ≤0.05 pc/m^2 for each species.
2. Maintain the growth of natural food by placing chicken manure inside a perforated bags.
3. Collect marketable size fish 3-4 months after stocking during water exchange. Fish go against the current and may be collected using a scoop net or seine near the gate. Select marketable size fish and return small fish back in the pond.
4. Harvest all fish when pond is drained completely and emptied of crab boxes for pond preparation.

Record Keeping

Application of inputs such as lime, fertilizers and pesticides during the pond preparation, the amount of food items given every feeding, water condition and other relevant observations should be recorded. The recording of the number of soft-shell and dead crabs retrieved after each inspection is important. These information are needed to evaluate the efficiency of farm management.

STOCKING OF CRABS

Sources of crabs

Mud crabs from mangroves are sold by collectors to traders who sell the crabs to the farmers. In countries where the quantity of the desired size for soft-shell crab farming is a problem, crabs may be obtained from ponds in which seed stock comes from the hatchery .
From the hatchery, crablets less than 1.0 cm carapace width (CW)* are grown in nursery cages or pens for 3-4 weeks, then in grow-out ponds for another 1-2 months before they could be used for soft-shell crab farming.

1. Select 60-130 g body weight (BW) of any mud crab species (Fig. 14).
2. Select immature hard-shelled female and male crabs.

Fig. 12. S. *olivacea* seedstock form mangroves

Acclimation

Acclimation is the process by which crabs are introduced gradually to the new environment to reduce stress that may cause mortality. Acclimation may take some time when there are thousands of crabs.

1. Transfer some crabs from the weaved basket or perforated plastic containers to another container to thin out the crabs. Remove dead crabs.
2. Sprinkle pond water on the crabs (Fig. 15).
3. Put the containers with the crabs in basins (Fig. 16) and add pond water slowly for 10-15 min. Provide aeration.

Fig. 15. Sprinkling pond water on newly arrived seedstock

Fig. 16. Seedstock in aerated basin

*CW - measured as the distance between the bases of the front spines

Stocking the crabs

The total crab requirement for the farm should be completed within 1-3 weeks depending on the availability of crabs and the total number required. Stocking is done regularly to replace dead crabs and those that had molted and transferred for processing or selling.

1. Prepare the plastic box by tying the base to the cover on one side (Fig. 17).
2. Remove the tie or string around the crabs with knife or pair of scissors.
3. Put each crab in the box (Fig. 18) and tie the top cover (Fig. 19).

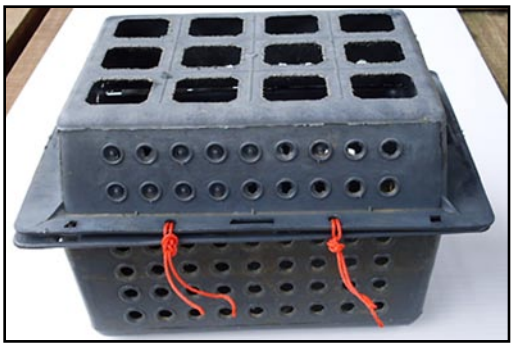

Fig. 17. Cover of box is closed by tying

Fig. 18. Untied crab stocked in plastic box with the base and cover tied together with string

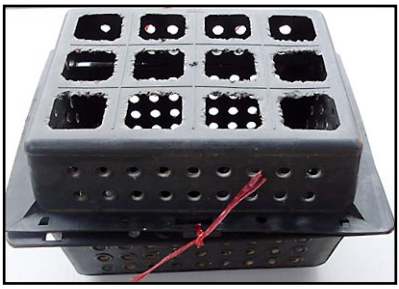

Fig. 19. The cover is tied to the base of the opposite side of the box

4. Position each box unto pontoons (Fig. 20).

Fig. 20. Positioning of crab boxes unto pontoons

FEEDING OF CRABS

In soft shell crab farming, feeding is not done daily because it is laborious and expensive. When crabs are fed daily, many boxes contain uneaten food which needs to be removed to prevent organic load. Removal of excess food is laborious and time consuming.

1. Feed the crabs early morning or afternoon once every 2-3 days.
2. Feed the crabs in each container with fish, fish ball or other cheap protein source at 8% of the biomass using the formula:

$$\text{Amount of food (g)} = \frac{\text{average body weight (g)} \times 0.08}{\text{20,000 crabs}}$$

$$\text{Example: } \frac{80\text{ g} \times 0.08}{\text{20,0000}} = \text{128,000 g (6.4 g per crab)}$$

3. Wash the food items and chop to size according to ration.
4. Put the food items through the holes of each crab box (Fig. 21).
5. Remove the uneaten food during the inspection of molted and dead crabs.

Fig. 21. Feeding of crabs with fish

INSPECTION OF CRABS

Majority of the crabs molt during the night and early morning. The peak of molting for 80-100 g crabs in the intermolt stage is normally within the 3rd week after stocking. The newly molted crabs must be retrieved immediately after molting because the shell starts to harden in less than 5 hours. Once the shell hardens, the crabs cannot be sold to the processor. The next molting will take longer since crabs have grown bigger.

1. Inspect crabs every 3 or 4 hours.
2. Pull the pontoon toward the roofed bridge.
3. Inspect each container through the holes for molted and dead crabs (Fig. 22). A crab has molted if an empty shell is

Fig. 22. Inspection of each box for molted and dead crabs

seen inside the box. Check if crab is dead or alive. Live crabs have moving antennae even when the body is immobile.
4. Remove uneaten food.
5. Retrieve the boxes with dead and molted crabs.
6. Discard the dead crabs and old shell in a sump pit away from the pond site. The shells can be processed as fertilizer for agricultural use.

HANDLING AND TRANSPORT OF SOFT-SHELL CRABS

The soft-shell crabs retrieved after every inspection are stored in a cool place until a big volume is collected to be taken to the processor usually the following day. The soft shell crabs survive in moist condition for 3 days.

A. Handling and storing of soft-shell crabs
1. Get the molted live crabs from the box (Fig. 23) and transfer to a basin with aerated freshwater (Fig. 24).
2. Place the fresh dead soft-shell crabs individually in disposal transparent plastic container and store in freezer (Fig. 25).
3. Return extremely soft crabs to a basin with pond seawater and aeration and keep there for 30 min to one hour .
4. Keep the molted crabs in aerated freshwater for 30 min to one hour.
5. Get the molted crabs from the freshwater and arrange them with the ventral side flat on a perforated tray (Fig. 26). Avoid overcrowding.
6. Dip the clean cotton cloth in freshwater and use this to cover the crabs in the perforated tray (Fig. 27).
7. Place the trays in a cool place and sprinkle the crabs with freshwater every 5-6 hours.

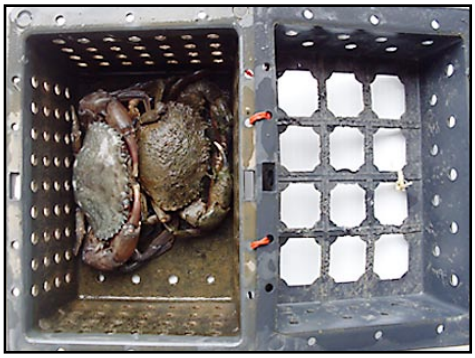

Fig. 23. Newly molted crab with the old shell

Fig. 24. Newly molted crabs held in aerated freshwater

Fig. 25. Newly dead soft shell crabs are packed in plastic containers

Fig. 26. Newly molted crabs arranged in perforated platic tray after holding in freshwater

Fig. 27. Wet cotton cloth used to cover crabs

Fig. 28. Weighing of crabs in trays

Fig. 29. Crabs in trays for disposal

B. Packing and transport of soft-shell crabs for processing plant

1. Arrange the crabs in a slightly vertical position (inset in Fig. 28) in the tray to maximize the space and weigh (subtracting the weight of the tray) (Fig. 28). Cover each crab in the tray with clean wet cloth.
2. Load trays in the vehicle and bring to processing plant (Fig. 29). If duration of transport is more than one hour, the trays are placed inside a big cooler to avoid desiccation of crabs.

PROCESSING AND PACKING OF CRABS

In Thailand where soft-shell crab farming is well established, many seafood processing plants buy the soft-shell crabs directly from the farmers. It is very convenient for the small-scale farmers to bring the products to these processing plants. In other countries, big farms set-up their own freezing facilities.

Soft-shell crabs are sorted and processed prior to packing based on the requirements of the buyer. Crabs may be packed whole, or without one or more body parts (eyes, mouth parts, gills and abdominal flap). Sorting of crabs is based on the following size ranges:

Classification	Size range (g)
Extra Large or jumbo	over 200
Large	151-200
Medium	101-150
Small	50-100

PROFITABILITY OF SOFT-SHELL CRAB FARMING

Soft-shell crab farming is profitable but labor intensive. The advantage of this business venture is that income can be generated daily. The market price depends on the size and condition of the soft-shell crab. The highest priced are the largest crabs complete with legs (over 200 g). Lowest priced are crabs that lack legs regardless of the size, and crabs with slightly hardened shell. Farmers in Ranong are paid Baht 250 (US$ 7.3) for one kilogram (8-10 pcs/kg) of soft-shell crabs. Soft-shell crabs are marketed locally or exported to Hongkong, Singapore, South Korea, Japan, Taiwan, Europe and the United States. The cost ranges from US$ 7.5 – 10 /kg (5-15 pcs/kg).

A 0.5 ha farm with 30,000-37,000 crabs require at least six regular staff and two laborers hired on a daily basis that wash the plastic boxes and assist in the stocking of crabs. Since inspection is done every four hours, two work shifts (night and daytime) are necessary. About 50% of the initial investment goes to boxes.

The following should be considered in the computation of costs and returns analysis:

- Size of pond compartment - 0.5 ha pond compartment is easy to manage
- Cost of seed stock (60-130 g) for stocking and market value of soft-shell crabs

- Molting percentage - 40-50% of the crab stock per month
- Mortality rate - 10-20% of the crab stock
- Feeding of fish - 8-10 times per month at about 8% of the crab biomass
- Staff - Six regular staff (including one supervisor) and two laborers to be hired only when necessary for a pond size of 0.5 ha
- Crab boxes - seven years economic life for good quality plastic boxes
- Facilities, equipment and other items for the initial investment (see page 9-10) and economic life
- Marketing expenses

ACKNOWLEDGEMENT

We thank Drs. Doris Bagarinao and Fe Dolores P. Estepa, both Scientists of the SEAFDEC/AQD, for their critical review of the manual and Joana Joy de la Cruz for the line drawing and Christopher Phillips for the support.

REFERENCES

Keenan C., Davie P.J.P. and Mann D.L. 1998. A revision of the genus *Scylla* de Haan, 1833 (Crustacea: Decapoda: Brachyura: Portunidae). Raffles Bulletin of Zoology 46:217-245.

Hopkins, P.M. 1989. Ecdysteroids and regeneration in the fiddler crab *Uca pugilator*. Journal of Experimental Zoology_ 252-293.

Ng, P.K.L. 1998. Crabs. In: The Living marine resources of the Western Pacific Volume 2, p. 1046-1128, Carpenter K.E. and Niem V.H. (eds). Food and Agriculture Organization of the United Nations, Rome.

Quinitio, E.T. and F.D. Parado-Estepa. 2008. Biology and Hatchery of Mud Crabs *Scylla* spp. Aquaculture Extension Manual No. 34. 2nd edition, SEAFDEC/AQD, Iloilo, Philippines. 45 pp.

Quinitio E.T., E.M. Rodríguez and F.D. Estepa. 2009. Nursery and grow-out of mud crab. In: Training Handbook on Rural Aquaculture. Chapter 4.4. p. 87-95, Publication Review Committee (ed). SEAFDEC/AQD, Iloilo.

Smith, L.D. 1990. Patterns of limb loss in the blue crab, *Callinectes sapidus* Rathbun, and the effects of autotomy on growth. Bulletin of Marine Science 46(1):23-36.

www.tradekey.com
www.alibaba.com
www.indonetwork.net

ABOUT THE AUTHORS

Emilia T. Quinitio *(Right in the photo)* is a Scientist of the Aquaculture Department (AQD) of the Southeast Asian Fisheries Development Center (SEAFDEC), where she joined in 1976. She finished Doctor of Fisheries Science at the Hokkaido University, Hakodate, Japan. Her expertise includes shrimp reproductive physiology, shrimp & crab breeding & seed production, and mud crab nursery & grow-out culture, including aquasilviculture. She has learned the operation of soft-shell crab farming at her co-authors' farm. She has published 50 refereed scientific journals, manuals, book chapter and technical reports as main author and co-author. She has been adviser and critic of graduate students, and resource speaker/technical lead person in training courses. Likewise, she has contributed her services as a consultant on all aspects of mud crab culture. Currently, she is involved in the domestication of mud crab (*Scylla spp*.) and shrimps (*P. monodon, P. indicus and P. merguiensis* and in enhancing the adoption of mud crab culture (hatchery, nursery and grow-out technology) through collaborations and training courses with various sectors in the Philippines and other Asian countries.

Address:
SEAFDEC/AQD
Tigbauan, Iloilo 5021
Philippines
etquinit@seafdec.org.ph
etquinit@yahoo.com

May Myat Noe Lwin (Noe Noe) *(left in the photo)* is completing her Masters Degree in Education at the Assumption University Bangkok, Thailand. She personally manages the CNN Soft-Shell Crab Farm in Ranong, Thailand. She also owns the Aquaculture Supply Company under CNN. She initially gained her knowledge on mud crab culture at SEAFDEC/AQD, Iloilo, Philippines. She is consistently producing soft-shell crabs through a technology that she has practiced and constantly improved. Her experience in this business was presented at the INDAQUA 2009 in Orisa, India. Since then she has been conducting training courses in her own farm and giving lectures in other Asian countries.

Farm Address:
CNN Soft-Shell Crab Farm
118/5, Mu 5, Tambon PakNam
Amphae, Ranong, Thailand
noenoeinbk@hotmail.com