



Mangrove Friendly Aquaculture

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Introduction

Mangrove-friendly aquaculture means farming aquatic animals in the mangrove forest without destruction by any means to the nature of the mangrove forest. (Destruction means cutting mangrove trees, and branches, blocking waterways, soil digging etc.)

Mangrove friendly aquaculture techniques

1. Mangrove cum Fish/Shrimp/Crab culture
2. Pen Culture
3. Floating cage culture
4. Posting/Hanging culture

Mangrove cum Fish/Shrimp/Crab culture

This is a type of aquaculture where mangroves are planted on elevated land within the pond and fishes/shrimp are stock into the rest of pond water area. This method is widely used in Vietnam and Thailand.

Pen culture Like cage culture, pen culture is the most suitable aquaculture business for fisherman and smallscale farmers who has no land ownership to build the pond. Basic principle of pen culture is the aquaculture of marine species in bigger cage-like mangrove area where there is tidal action into the low land area by means of fencing with net or screen in the area. Water quality, depth and tidal force should be considered when choosing the site selection for pen culture. The needs of the farmed species should also be considered. Water quality parameter such as salinity, pH, temperature, dissolved oxygen etc. should be appropriate for farm species. The recommended water depth is around 9 ft, bottom soil should not be too muddy. Water quality could be decrease rapidly when there is higher organic sludge. Location with water flow rate over 15 inch per sec should not be selected. Optimum flow rate is 4-8 inch per sec.

Floating cage culture

Floating cage culture method can be used either in small-scale or commercial scale aquaculture. Cage culture techniques Cage culture can be used either in small-scale or commercial scale aquaculture business. The size of the cage could be varying from very small cage to big cage. There are two types of cages – floating cage and submerged cage at the bottom of the pond floor. Floating cages are used in rivers where there is deep water and submerged

cages are used in shallow regions. The most important fact is mesh size of the net should be small enough to maintain the farmed fish from releasing and big enough to allow proper water flow. And the net should be strong not to be destroyed by big fishes or crabs. The net should be cleaned daily for good water flow. The size of the mesh should be adjusted as needed depending on the size of the farmed fishes.

Types of Cages

The size of the cages varies starting from the size of 3 sq ft and 3 ft depth with 1 ton water capacity to big cages with hundreds of water tons. Common shapes of the cages are circular and square shape. Components of the cages are as follows. **Cage Frame** This is the hard body part of the cage and can be constructed either in wood or iron. **Floating facilities for cages** This is the facilities used to support the cage to float on water. Generally, they used barrel, plastic tank, sealed PVC plastic pipe, plastic sponge etc. By systematically equipping the cage with these facilities, the cage can be float 1 ft above water surface. **Screen or net bags** The most common screen to put the fishes for farming are plastic net or nylon screen. Nylon screens are lighter, expensive but they cannot resist the damage caused by aquatic animals such as by turtle, crabs etc. When using nylon screen, it should be covered by strong plastic net with bigger mesh size from outside. The size of the mesh depends on the size of the farmed fishes. For e.g., mesh size of 1 cm (0.4 inch) has to use in farming 9 g (0.5 tickles) tilapia and mesh size of 2 cm (0.8 inch) has to use in farming 25 g (1.5 tickle) fishes. The main point is that the size of the mesh used in cage should be small enough to maintain the farmed fishes inside and should be big enough to allow proper water flow.

Cover of the cages

The cages should be covered with nylon or plastic screen to prevent the farmed fishes releasing and eating by birds. **Constructing feeding ground** To prevent the feed waste for floating feed by flowing outside the cages, starting from water surface of the cage until 1ft below should be covered with smaller mesh. When submerged feed are used, feeding should be done in feed tray submerged in the water of 1.5 ft depth to prevent feed waste. **Background technology for cage culture** Feeding is one of the critical practices in cage culture. In cage culture where there is limited natural food for fishes, sufficient feeding contributes good growth rate. In cage culture, the cost of feed could be about 60% of its total production cost. It is necessary to feed the fish twice, in the morning and in the evening. **Mangrove friendly shrimp culture**

Highly intensive fish/shrimp aquaculture may severely harm the environment for the following reasons.

- Termination of natural mangrove forest to conduct aquaculture activities.
- Water pollution from excessive usage of chemicals in intensive aquaculture.
- Mortality of fish due to oxygen depletion in water from excessive fertilization by fish/shrimp wastes
- Higher acidity in the topsoil layer Moreover, sustainability of livelihood for local coastal families may be threatened deeply due to the damages to the ecosystem and to the productivity of the mangrove system by the consequences of chemical wastes from

agricultural and capture fisheries. Growth and survival of farmed fish/shrimp is related to good water quality and environment.

- There are growing concern on sustainable activities and current market demands emphasizing on the environmental and social ethics.
- The role of mangrove forest is critical as it can reduce the effect of contaminated chemicals on the pond soil where there is residual feed, dead fish/ shrimp, residue from shredded skin and feces. It can create the situation to use chemicals and veterinary drugs for disease control. Primary factors for mangrove friendly aquaculture are –
 - Small amount of stocking is preferable to intensive farming
 - Production of suitable amount appropriate for aquaculture pond capacity
 - Nutrient absorption from the mangrove forest when the volume of mangroves covers 50% or more of the total pond area
 - Prevent depletion of water quality
 - Fish with the capacity of controlling the leaves and bottom sludge can be selected. Therefore, the existence of mangrove forest is essential in contribution for the support to food chains. The existence of herbivorous fish in intensive shrimp ponds without supplementary feeding can support the control of phytoplankton growth with the nutrients from mangrove forest.
 - In intensive farming, where there is no proper separation of herbivorous fish, the benefits of phytoplankton to control the excess nutrients of supplementary shrimp feed can be affected and eventually the quality of pond water deteriorates.
 - Sustainable mangrove system and shrimp farming There are conditions to consider not only for environment and production but also social and economic roles in mangrove forest and shrimp farming in terms of sustainability.
 - Shrimp farm should be protected from entering of sludges to the pond with the tidal water. Farm should be able to take out the water completely by using proper drainage system. Shrimp farm design should be prepared to get the best productivity with the existing mangrove forest. By doing so, mangroves tree can receive the optimum nutrients. In mangrove friendly shrimp farming, mangrove forest should be at least 50% of pond area. Pondwater should be in good quality and free from chemical residue which can contaminate the survival rates of fish/shrimp. Avoid using the contaminated water due to human activities.
 - Farm should be located in appropriate place where there is no production loss in grow out farming due to the flood. Pond dike erosion and storms could be protected by having green mangrove forest as medium in front of the sea to prevent from storms, massive wave, and strong wind.

Juvenile stocking rate for mangrove friendly shrimp culture

Shrimp species to be stocked	Stocking quantity per 3 sq ft
Tiger shrimp	0.5 – 1 piece
Vannamei shrimp	1 – 5 pieces
White shrimp	1– 5 pieces

Feeding management

In a grow-out farm of the mangrove friendly aquaculture, production of natural feed from mangrove forest should be upgraded. Checking feeding tray along the pond dike should be carried out to monitor growth rate and health of shrimp.

Mangrove and Mud crab farming

Mud crab can be spawned throughout the year despite some differences in quantity depending on the season, and the crab with larvae and marketed sizes can be collected easily from natural water as they have higher hatching rate. Farming can be easily done as any meat can be used to feed them.

Type of aquaculture species	Egg laying capacity
Freshwater adult female shrimp	From 80,000-100,000
Marine tiger shrimp	From 300,000-500,000
Adult crab	From 500,000-1,000,000

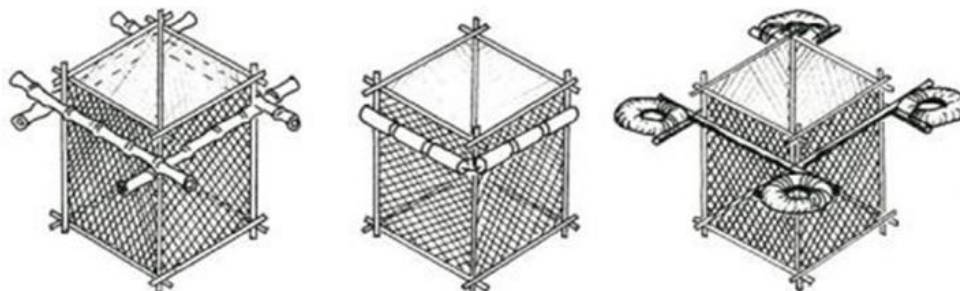
The life cycle of mud crab Mud crabs are normally spawned on the ocean floor with the salinity rate of 25 ppt, young crabs (with 0.8-4-inch carapace diameter) are habitat in mangrove forest after passing 6 larval development stages. Sub-adult crab (with 4-6-inch carapace diameter) are migrating into the outer coastal region. Mud crabs are high cannibalistic in nature. Soft-shelled crab during mating for the growth are being eaten by other hard-shelled crab. In aquaculture businesses, survival rates could be decreased as they eat each other when there is less feeding rate.

Fattening

Fattening is the culture of marketable crab in a short span of time. The soil should be clay type. Optimum water temperature should be between 23-32°C, salinity should be between 13-30 ppt and minimum dissolved oxygen should be at least 4 ppm and pH should be 8-8.5. Water depth should be 2.5-3.2 ft.

Fattening techniques

- Farming in earthen ponds
- Fattening in pens
- Fattening in floating cages



Different types of cages

Farming in earthen ponds:

The pond using this technique can be constructed in places where there is water salinity of 16-30 ppt and water exchange can be carried out with every tidal movement. However, it is necessary to avoid the places with waterway where there could be acute changes in salinity, for instance, a place nearby mountain torrent. Introducing male and female mud crab in shorter period for fattening. The height of the pond dike should be 3 ft and above of annual highest tidal level. In the middle of the pond, earthen platform should be constructed for mud crabs hiding. Always maintain the pond water depth at over 3 ft. Construct the pond floor to get harden texture. Vertically insert the bamboo mesh in 5 ft height, with 1ft inside bottom soil along the inner dike of the pond to prevent the mud crab escaping. Connect water inlet/outlet channel to the nearest creek or river for saving the cost. Exchange 30% of pond water in every high tide week.

Farming crab juveniles from hatchery

Crab juveniles of 0.6-1 cm in size can be farmed in 30-60 pieces per square meter. Crab juveniles can be fed twice per day with minced meat of less valued fish, mollusks, and crustaceans with the rate in 100-150% of total biomass of the crab. Mud crabs gain marketable size in 4 months after the beginning of farming.

Farming crab juveniles from nature

The stocking rate of male and female crab juveniles with the carapace diameter of 4.2-inch in length and less than 3.5-inch in vertical size could be 5-8 pcs per 3 sq ft. Feed such as disposed fishes and varieties of meat could be fed twice per day, especially in every morning and evening with the amount 5-10% of total biomass. Water exchange could be done twice per month in every high tide week

Feeding rate according to body weight

Amount of feed	Farming period (month)
10% of crab total biomass	First month
6-8% of crab total biomass	Second month
4-5% of crab total biomass	Third month
3% of crab total biomass	

Fattening in pens

This fattening culture technique in pens is one of the incomes generated business that do not cause damages to natural trees inside the mangrove forest. Since the technique itself is carried out in natural water inside mangrove forest, unlike pond



water, there is very few physical and chemical problems in cultured water.

The capacity of the pen for crab culture should be specified depending on financial investment, human resources and availability of land. Land area can be ranging from 30 ft x 30 ft for small scale to 1-2 acre and above for commercial scale production. While constructing the pen, if plastic sieve or net with ½ inch mesh size is used for fencing, thick plastic sheet is sewed together in top 1.5 ft for the net with 6 ft height. 2 mm plastic string must be fitted in top and bottom of the fence. Pillars for fence are inserted firmly throughout the area at least in every 9 ft distance. When fitting the net, channel of at least 6-inch depth must be dig throughout the pen bottom line to bury the bottom part of the net with 1-1.5-inch bamboo stick. Channel must be refilled with soil/mud by stepping force of the leg after inserting the net. Top and middle parts of the net must be tied in pillar to be fitted firmly. Construct 1-1.5 ft depth and 2 sq ft wide cells for crab shelter during the lowest tide in the pen with the rate of 1 cell per 10 sq ft. Pathway should be include in the structure for feeding and checking the crabs.



Fattening in floating cages

Crab fattening in floating cages is used by local crab traders and fisheries company. Culturing crabs in cage become popular for crabs fattening and it is convenient to wait while the market price is declining. As the culture is carried out in natural water, there are very few physical, chemical problems of water unlike in culture in the pond. Since the technique itself is carried out in natural water, unlike pond water, there is very few physical and chemical problems in culture water. Crabs could be cultured in creek or pond with weak flow rate where there is steady wind and waves by inserting individual crab in bamboo cages which contain cells of 6-8- inch wide and 1ft depth or 4–8-inch plastic baskets used in soft-shelled crab farming. Feeding crabs, taking in or taking out could be done easily.

Factors to be taken for the success of the culture practices

- Avoid the locations where there can be sudden heavy rain falls, water pollution, places with pH lower than 4. Select the places where there is salinity 10 ppt and above, places where the tide can reach 20-25 days in a month, places with shadow and trees and secure locations (security is important).

- Do not culture only female crabs. Adequately feed the crabs as they can be fed any meat, if not they will eat each other.
- Constantly monitor the site. Keep an eye on the security and condition of the crabs.
- Provide shelters inside for hiding place and to avoid from high temperature during shell changing.
- Record income, expenditure, stocking, harvesting, numbers of crab, weight, and period.
- Evaluate the profit of the business.
- Harvest should depend on the market price. Do not let the investment lose.

Oyster and mussel farming

- Types of species that access food by filtering out the particulates of food in the water
- Access to protein with low cost.
- Have 49 % production rate in global marine aquaculture business.
- Aquaculture of oysters and mussels does not need high investment and advanced technology.

Bio physiology of oysters

- ✓ Can attach to surfaces in nature.
- ✓ Difficult to differentiate whether male or female.
- ✓ Fertilization take place in the water.
- ✓ 24 hr. after hatching, spawn larvae can swim in the water independently.
- ✓ Larvae become spat after 2-3 weeks.
- ✓ Their main food includes planktons, diatom, bacteria, and organic particles.
- ✓ They have fast growth rate within 3 months.
- ✓ It takes 8-12 months to get marketable size (6 cm).

Site selection for oyster farming

- ✓ Must be the place where there is high larvae attachment rate and sufficient male and female for the collection of young larvae.
- ✓ Must be the place protective to waves and wind. Should not be the outside of the shore and there should be some supporting for the attachment before the larvae flowing into the sea. Choose the place where there is greenish color water as such water have high concentration of food and nutrition.
- ✓ Tidal movement should be sufficient to exchange old water. The higher the tide, the faster the growth.
- ✓ Flow rate of the tide should not be more than 2 cm per sec. When there is slow tidal flow, growth rate of oysters and mussels are slow.
- ✓ The site should not be too far from source to prevent decrease in salinity during raining season. Salinity could also decrease when it is too far from the sea.
- ✓ The site should be near to market or the route to the market.
- ✓ The site should not be with water pollution. Although water pollution could not affect the oysters and mussels, but their flesh become unfit for human consumption.

Oysters and Mussels farming techniques

Spat collection Oysters and mussels farmers should be aware the spatfall season within the region. Spat fall season could be forecast and depends on the following environmental conditions.

- Yellowish and itchy water
- Condition of brackish water
- Attachment of barnacles in spat collection utensils

Common oyster farming techniques

Bottom farming

- ✓ This is the simplest and cheap technique.
- ✓ Most commonly used attachment materials are
- ✓ Empty shell
- ✓ Old tires
- ✓ Stones
- ✓ Spread the materials for attachment in designated locations.
- ✓ Harvest the attached oysters and mussels after removing the materials for attachment



Conclusion

Mangroves are vital for ecosystem and water species like fishes, shrimps and crab. Mangroves gives the protection and also serving for nursery and breeding grounds. As well as convenient habitat in safety. A mangrove place of biodiversity and strengthens the ecosystems of rivers and lakes. This is an ideal place to fish farming it provides more benefits for all aquatic animals.