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TABLE OF CONTENTS

GENERAL	1
Distribution	1
Season.	1
Price in the Market	2
FOOD VALUE OF MUSSEL MEAT	2
CHOOSING A SITE FOR A MUSSEL FARM	2
RAFT CONSTRUCTION	2
COLLECTION OF SEEDS AND SEEDING	5
Seed availability	5
Seed Collection Method	5
Transplanting and Seeding Techniques	7
FARM MAINTENANCE	8
HARVESTING	9
PACKING OF TRANSPLANTED SPAT OR HARVESTED MUSSELS FOR TRANSPORT	9
ECONOMICS	11
PROSPECTS	11

RAFT CULTURE OF MUSSELS
BY H. S. SITOY, A. L. YOUNG & M. Y TABBU

GENERAL

The species of mussel suitable for culture in the Philippines is the green mussel, *Perna viridis* L. (= *Mytilus smaragdinus* Chemnitz). It is known to grow to a marketable size of 40 to 60 mm in 4 to 6 months (see Fig. 1).

Green mussel is locally known as "tahong." In Ilocos, they are called "daligdig" or "saytil," while in the Western Visayas, they are known to the people as just "green shells." The shell of this species, as implied by the name, is a bright green on the outer margin, becoming darker towards the center.

The green mussel should not be confused with the brown mussel (*Modiolus metcalfei*), locally known as "amahong" or "abahong." The brown mussel is distinguished from the green mussel by its hairy appearance, brittle shell, and brown coloration.

Distribution

Perna viridis has a restricted distribution in the Philippines. Once they were mainly found in Bacoor and Manila Bays in Luzon. Now, they occur in bays and inlets along the northern coast of Panay Island, in western Negros Island, and in Maqueda, Jiabong, Samar. It is possible they also occur in other places.

Season

The best time to eat mussels is when their meat is still full, that is when large amounts of glycogen are still stored. This period is usually just before the beginning of the spawning season when the mussels are in the resting phase of their reproductive cycle. In Himamaylan, Negros Occidental, mussels are in prime condition during the months of July to September, and January to March.



Fig. 1. Close up of the green mussel, *Perna viridis*.

Price in the Market

Mussels are sold in local markets by heaps ("tumpok" in Tagalog or "pundok" in Visayan). Each "tumpok" or "pundok" usually averages one kilogram in live weight and sells from P1.50 to P2.75 depending on locality and supply.

FOOD VALUE OF MUSSEL MEAT

Mussels are highly nutritious. Its meat has a protein value comparable to common food items like beef, pork, chicken, shrimps, and other seafoods. The meat is rich in protein (10-20%), fats (15%), and carbohydrates (20%). The amino-acid composition of mussel meat is also comparable to that of local shrimps and high-quality fishmeal. It contains minerals such as calcium, phosphorus, iron, copper, and small amounts of thiamine, riboflavin, and niacin. The shell contains 90% calcium, which could be incorporated directly into feed suitable for laying chickens.

CHOOSING A SITE FOR A MUSSEL FARM

There are several factors that affect the selection of a good mussel farm site. Among these are availability of spats in the area; protection from strong winds; availability of natural food in the water; and adequate tidal current. Technically, for best results, grounds suitable for mussel culture are those with food concentrations (mostly phytoplankton) ranging from 17 μg to 40 μg Chlorophyll α /liter of seawater; currents ranging from 0.17 to 0.25 m/sec at flood tide and 0.25 to 0.35 m/sec at ebb tide; and with primary hourly production ranging from 73 to 100 μg carbon/ m^3 . The farm site should also be pollution-free.

If there is a BFAR or SEAFDEC station near the area, one may obtain information from technicians who would be just too willing to extend assistance on this regard.

RAFT CONSTRUCTION

A mussel raft consists of two compartments: 1) a rigid framework or lattice structure from which the collectors or growing ropes are hung; and 2) buoys to keep the framework afloat.

For the framework, bamboo is recommended since it is cheap and widely available. At SEAFDEC, styrofoam blocks for buoys have been found to be efficient and they last for more than three years (see Fig. 2).

The standard size of raft recommended for culture is 8 m long and 6 m wide. The materials and cost of construction are given below:

Cost of Constructing a Mussel Raft Unit (8 m x 6 m size)

Items

- | | | |
|----|---|-------|
| 1. | 19 pcs. bamboo poles for lattice structure; 13 (8 m long); 6 (6 m long) at P12/pole | P 228 |
| 2. | 10 pcs bamboo poles for anchor at P12/pole | 120 |

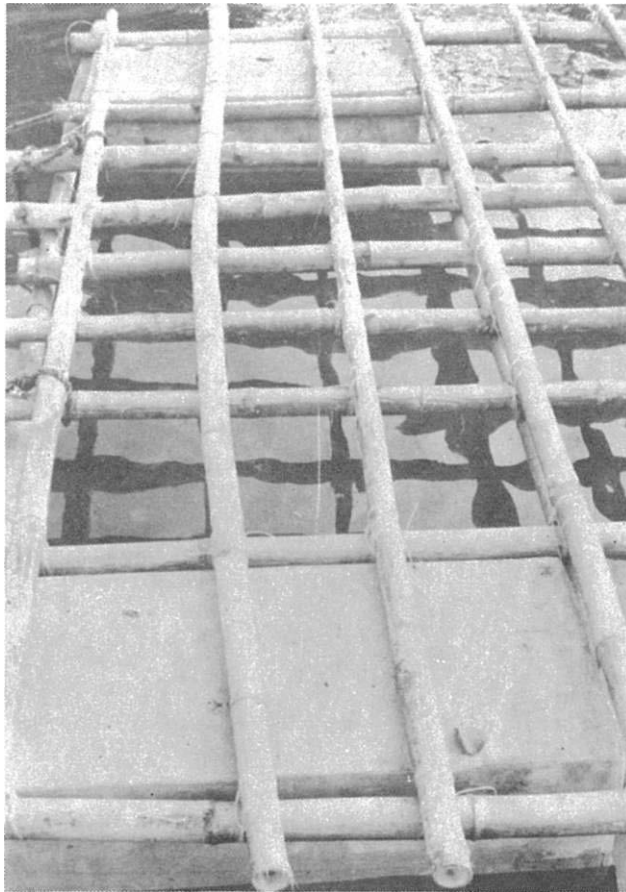


Fig. 2. Perspective view of raft lattice and styrofoam buoys.

3.	6 pcs styrofoam, ferro-concrete coated buoys, (4 ft x 8 ft x 4 in), including medical gauze, fish netting and other requirements	1,200
4.	2 kg monofilament nylon twine, no. 180 at P 45/kg	90
5.	4 rolls polypropylene rope of 12 mm diameter at P600/roll	2,400
6.	4 bags cement for coating buoys and use in anchors at P 50/bag	200
7.	30 cubic meters fine sand for weights and anchors at P30/cubic meter	60
8.	3 sacks coconut husks at P 5/sack	15

Labor

1. Construction of raft (2 laborers at P 30/day for 2 mandays	P 120
2. Fabrication of 6 buoys and of anchors	90
Total	P 4,523

A basic raft design is illustrated in Figure 3.

Several rafts may be tied together then laid out in a series, 3 to 4 meters apart with an anchor at each end of the line. The rafts should be laid out parallel to the direction of the current in areas where they do not obstruct navigation or Fishing. In shallow areas, the rafts may be moored to stakes.

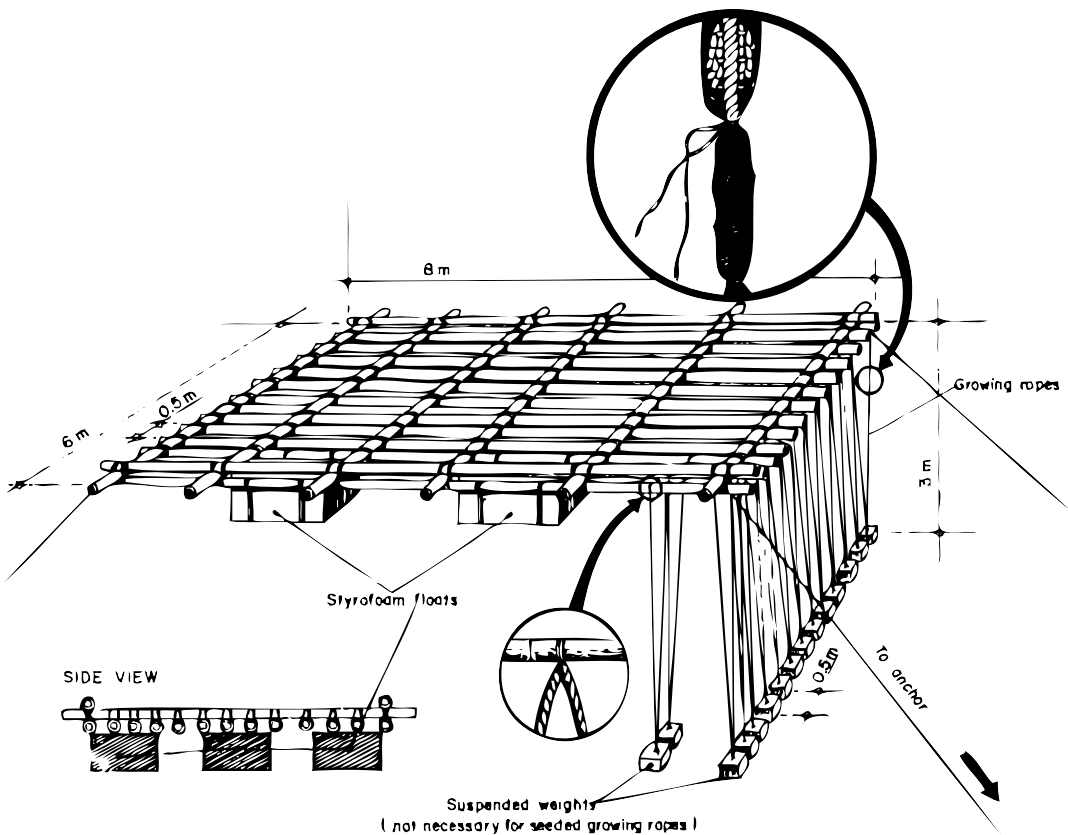


Fig. 3. Diagram of a mussel raft unit.

COLLECTION OF SEEDS AND SEEDING

Seed Availability

Mussel seeds or "spats" settle on any convenient suitable substrate after floating in the water column for 17 to 20 days from spawning. Newly settled spats are about the size of a sand grain and they rapidly grow to collectable size (about the size of the thumb) (see Fig. 4).

As mussel farming depends largely on the efficiency of collecting seeds or spats, a mussel farmer would do well if he knows the right time to set out spat collectors. If the spat collectors are set out very much earlier than the spawning period, large numbers of barnacles and other harmful organisms will attach to the collectors, making it unattractive to the young mussels. On the other hand, if the collectors are set out too late, only very few spats will be collected. In general, spats collectors should be installed not earlier than February but not later than March to catch the first spatfall, which is usually the heavier one. For the second spatfall, collectors should be laid during September to November.

The spatfall seasons of the green mussel are generally irregular. Spatfall may occur in March and November in one year and a month earlier or later the next year. Spatfall seasons also vary depending on locality so each collecting ground should be monitored to determine the best time to set out spat collectors. In established natural grounds, like Bacoor Bay, seeds may be obtained during March to May, and August to November; in Sapián Bay, Capiz, they are collected during February to March, and September; in Himamaylan, Negros Occidental, during July to September, and January to March.

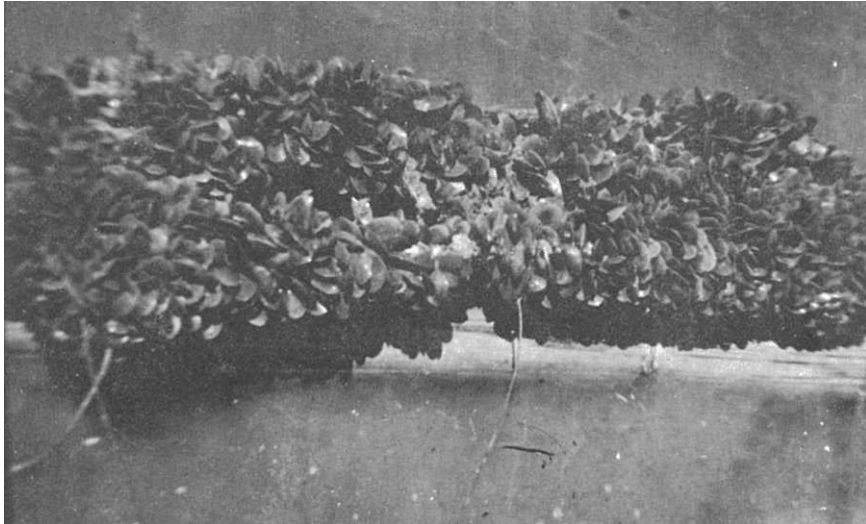


Fig. 4. Mussel spat on collector rope ready for transplantation.

Seed Collection Method

In Himamaylan, seeds are collected from fishtraps and bamboo pilings. The seed is carefully scraped off with a sharp instrument so that the byssal threads are not destroyed. Damaged byssal threads will cause some seeds to die.

In Bacoor, the seed is collected from bamboo poles and grown to marketable size on the same collecting material without thinning. This method is less laborious but the growth is slower due to overcrowding and competition for food.

In the hanging culture method, young mussels or spats are collected with collector ropes and are later re-laid or transplanted to growing ropes. This method ensures uniform growth and enhances better survival during grow-out.

Aside from knowing where and when to place spat collectors, one should also use the right collecting materials. Mussel larvae are usually attracted to filamentous objects and later move on to more solid substrates. So far, the only material that satisfies this requirement most is the coconut husk. The only difficulty in using coconut husk is that it does not last long in the water, so that spat or seeds must be transplanted before the material decays.

To make the collector ropes (see Fig. 5), pieces of coconut husk are inserted into the lay of the polyethylene or polypropylene rope (12 to 20 mm in diameter) at 5 to 6 cm intervals. Bamboo pegs, 1.5 cm wide and 15 cm long, are inserted into the lay of the rope between husk segments to prevent clusters of mussels from slipping off the ropes during bad weather or when the ropes are lifted for inspection or harvest. These ropes are hung on the raft, spaced about 0.5 m apart, with weights tied to the ends of the rope to keep them vertical.

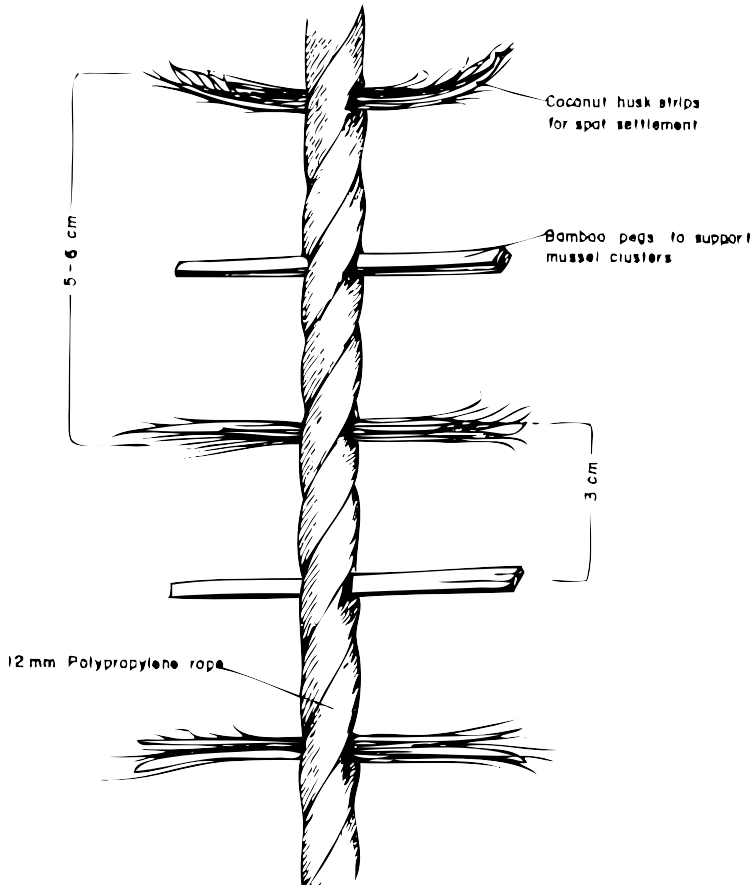


Fig. 5. Detail of collector rope.

Transplanting and Seeding Techniques

Collector ropes with heavy spat settlements must be thinned out to prevent overcrowding once they have grown to a length of 2 to 3 cm. The mussel spats are transplanted to growing ropes where they are reared until ready for harvest. Most suitable for use as growing ropes are *cabo negro*, abaca, polyethylene, and polypropylene ropes. For added strength, the *cabo negro* and the abaca growing ropes could be treated with tar. If this is desired, the pegs must be inserted into the lay of the rope before treatment (see inset of Figure 3).

To thin out the collector ropes, clusters of 10 to 20 young mussels are gently detached from the clump. A maximum of only 300 mussel spat should be bound per meter of growing rope to allow sufficient space for growth.

Normally, two persons are needed for seeding the growing ropes. One sort and declusters the clumps of mussels, while the other person fixes and binds the clusters with strips of medical gauze or other suitable material (see Fig. 6). The gauze deteriorates in a few days while the mussels have already attached themselves to the growing rope.

During transplantation, mussel seeds must be protected from the heat of the sun and wind while they are out of the water. A convenient way of doing this is by building a small hut on the raft.

The length of the rope to be hung on growing rafts depends on the depth at low tide. In deep water (3 to 5 meters), growing ropes may be suspended individually from the bamboo frame. Growing ropes must not hung too close to each other (only about 0.5 to 1.0 m) as this will result in slower growth of the mussels. However if the water current is fast and if there is rich food supply, the ropes may be hung closer to each other.

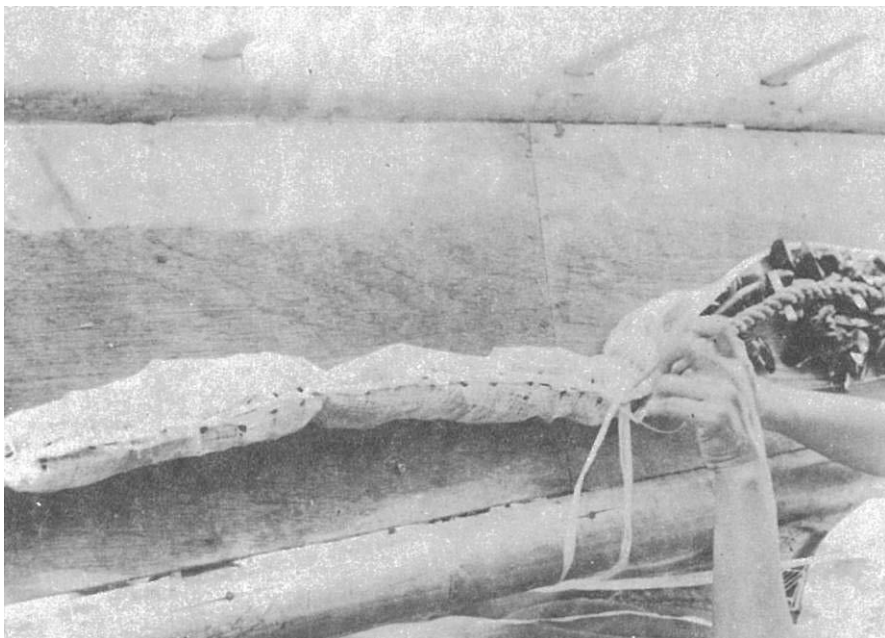


Fig. 6. Binding spat to growing rope with medical gauze.

FARM MAINTENANCE

A mussel farm need not be large. The size can be scaled down to fit one's financial capability. A family of six can easily handle three rafts of 8 m x 6 m each with an aggregate surface area of about 124 square meters.

During the grow-out period, the farm must be closely watched and regularly inspected to check on the condition of the mussels and the stability and preservation of the rafts. As mussels grow, the growing ropes become heavier so that the raft may go below the water surface. Predators, foulers and silt must be regularly removed as they add to the weight of the raft. As the raft settles, the growing ropes may sink into the mud and bury the mussels, so make sure that there is sufficient clearance from the bottom.

The growing ropes are shaken to remove any accumulated silt and are lifted up for inspection (see Fig. 7). Predators such as crabs and starfishes are driven off or are pried loose. Fouling organisms such as barnacles and sponges that may smother the mussels are scraped off with a knife. Any loose or rotten bamboo pegs must be replaced. If there are exceptionally large clusters, it is advisable to wear gloves to avoid injuries in one's hands.

The mussel-filled ropes may be exposed for a short period during the early morning or late afternoon when sunshine is not too intense to kill off some foulers and to condition the mussels for transport after they are harvested.



Fig. 7. Lifting growing ropes for regular maintenance and cleaning.

HARVESTING

Transplanted young mussels can be harvested after 4 to 6 months' growth. By this time, the mussels should be about 50 to 60 mm long. The growing ropes are lifted from the raft and the mussel clusters are carefully separated from the ropes. Mussels should be harvested and transported in clusters so as to conserve their moisture and keep them alive longer (see Fig. 8).

When detaching mussels from the ropes, care must be taken that the byssus or "beard" by which mussels attach themselves is not pulled out. This protruding organ is part of the mussels' muscular structure and the mussels will die and spoil in a few hours when it is wrenched out during harvesting. For this reason, the mussels may be scraped off with a knife or better yet, the byssal threads may be cut with scissors (see Fig. 9). Another way to detach them is by grasping their byssus before pulling them off the ropes.

When they are ready to be displayed for market, mussel clusters are broken up with a sharp knife or a pair of scissors. Foulers may be scraped off the shells to make the mussels attractive.

PACKING OF TRANSPLANTED SPAT OR HARVESTED MUSSELS FOR TRANSPORT

For transport to nearby places, mussels are transplanted in moistened jute sacks which protect them from exposure to heat and dry air. During transport, the mussels should not be placed in direct sunlight to prevent mortality.



Fig. 8. Mussel clusters ready for packing and transport.



Fig. 9. Close up of mussels being scraped or cut away from cluster.

Transport of mussels to distant places involving long hours of travel requires packing them in styrofoam boxes (see Fig. 10). If the mussels are to be air transported, they must be placed in sealed polyethylene bags without water. The bags are then packed in styrofoam boxes. About 2 kg of ice sealed in plastic bags are packed around the mussels to lower the temperature inside the boxes. There must be no contact between the ice and the mussels. To have minimum mortality during transport, the mussels must reach their destination or be returned to seawater within 24 hours.



Fig. 10. Packing mussels for land transport.

ECONOMICS

Farming mussels using rafts made of bamboo, styrofoam buoys and polypropylene ropes is more economical and efficient than using bamboo stakes. Although it requires a higher initial investment than the staking method, the sustainable and net yields are higher and the raft will last longer and can be used for several crops. With good maintenance, a high percentage of spat will survive to harvestable size. The rafts can be set up in deeper waters, thus using more of the water column to support a larger crop.

In culture of mussels using ropes hung on rafts, a meter of growing rope produces 5 to 15 kg of mussel. Thus, a raft measuring 6 m wide and 8 m long and with 636 meters of collector/growing ropes can yield 3.2 to 9.5 tonnes per crop or 6.4 to 19 tonnes annually. On the other hand, a 100 square meter mussel farm using 50 bamboos for the traditional stake method can at most produce only 250 to 1,500 kg (production of 2.5 to 15 kg/m of pole).

While a mussel raft will cost more to put up and maintain, in the long run it will provide a higher income per year for the farmer. A mussel raft can provide a net income of about P5,197 for the first year and P8,586 for every succeeding year (price of mussel per kg = P1.50; maintenance cost for the second year = 10% of initial investment).

PROSPECTS

Raft culture of mussels has several advantages. The distinction between seed collection and the grow-out stages enables the farmer to collect the maximum number of spats on his ropes and later to be able to make them all grow at a faster rate and with higher survival. The close arrangement of growing ropes utilizes all the available water volume for the mussels' feeding. The transplantation and thinning out prevent overcrowding and enables more uniform growth so that the farmer is able to estimate his harvestable crop.

The raft system makes it less laborious to collect, transplant and harvest the larger number of mussels grown. Inspection and maintenance of growing ropes is easier than with bamboo poles. Also, the materials can be used over and over again for several years. Predation is minimized on the suspended mussels while fouling can be kept at a low level by regular cleaning. Furthermore, the hanging ropes do not accumulate silt and make the area shallower as do the close-set bamboo stakes.

With regular maintenance and good management, a mussel farmer and his family can expect continued harvests from his rafts for many years.

FOR FURTHER INFORMATION AND ASSISTANCE, WRITE DIRECTLY TO:

The Program Officer Molluscs and Seaweeds Program SEAFDEC Aquaculture Department Tigbauan, Iloilo	or	The Fish Farmers' Assistance Unit Training and Extension Division SEAFDEC Aquaculture Department Tigbauan, Iloilo
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OR COURSE REQUEST THRU:

External Affairs Office Suite 901, State Financing Center Ortigas Ave., Mandaluyong Metro Manila	or	Iloilo Liaison Office B and C Square Building Iloilo City
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