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SEPTEMBER 2000

SEAFDEC
SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER

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ASSOCIATION OF SOUTHEAST ASIAN NATIONS

Environment-friendly schemes in intensive shrimp farming

Dan D. Baliao

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ENVIRONMENT-FRIENDLY SCHEMES IN INTENSIVE SHRIMP FARMING
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Message

On 4 March 1999, the first meeting of the ASEAN-SEAFDEC Fisheries Consultative Group (FCG) was held in Bangkok, Thailand. During that meeting, it was agreed that the promotion of mangrove-friendly aquaculture in Southeast Asian countries be placed under the FCG collaborative mechanism as one of three initial programs with financial assistance from the Government of Japan.

It is with great pleasure that we now present one of the fruits of our collaboration. We hope that the result of this effort will guide shrimp producers throughout the ASEAN region in producing shrimps sustainably. The outputs of the other collaborative programs will be published as soon as they become available.

Through the FCG, the two regional organizations will continue to collaborate to make the member countries globally competitive in the field of fisheries. More programs will likely be added as new problems and new challenges arise.

PANU TAVARUTMANEEGUL
Secretary General, SEAFDEC

RODOLFO C. SEVERINO, JR.
Secretary General, ASEAN

Foreword

Wherever shrimp culture developed as an important industry, decline had always followed rapid growth. In some cases the decline has become irreversible such as for instance, in Taiwan. In other cases decline was arrested, followed by consolidation and realignment in the industry such as for instance, in Thailand.

In all instances the decline has been traced to pollution generated by the industry itself. As culture intensified, the amount of effluent generated also grew in direct proportion until it reached a level beyond the ecosystem's natural capacity to degrade into basic and harmless substances. With an unhealthy environment, shrimp health also suffers and diseases ensues leading to mass mortality. While such a situation may be corrected by drastically lowering production targets through lower stocking densities, the economic viability of the venture also suffers so that ultimately it also becomes unsustainable. This is the case in the Philippines.

The ideal solution then is to reduce or even completely eliminate self-generated pollution without drastically reducing stocking density. This is the approach taken by SEAFDEC AQD. Towards this end the Department's Technology Verification and Extension Section (TVES) has already obtained encouraging and consistent results using a system where pond discharge has been minimized while maintaining high production and profitability levels. The Fish Health Section and the Central Analytical Laboratory provided technical support in terms of monitoring of water quality and bacterial population.

This guidebook is issued in response to insistent demand from the industry that has grown impatient over the extended doldrums even as the technology is being refined and work on a zero-discharge system is still in progress. Thus the method described in this guidebook cannot by any means be considered the final word on shrimp culture. Nevertheless, It is hoped that the release of this guidebook can assist shrimp farmers to once again enjoy the former productivity levels they have enjoyed in the past.

ROLANDO R. PLATON, PhD
Chief, SEAFDEC/AQD

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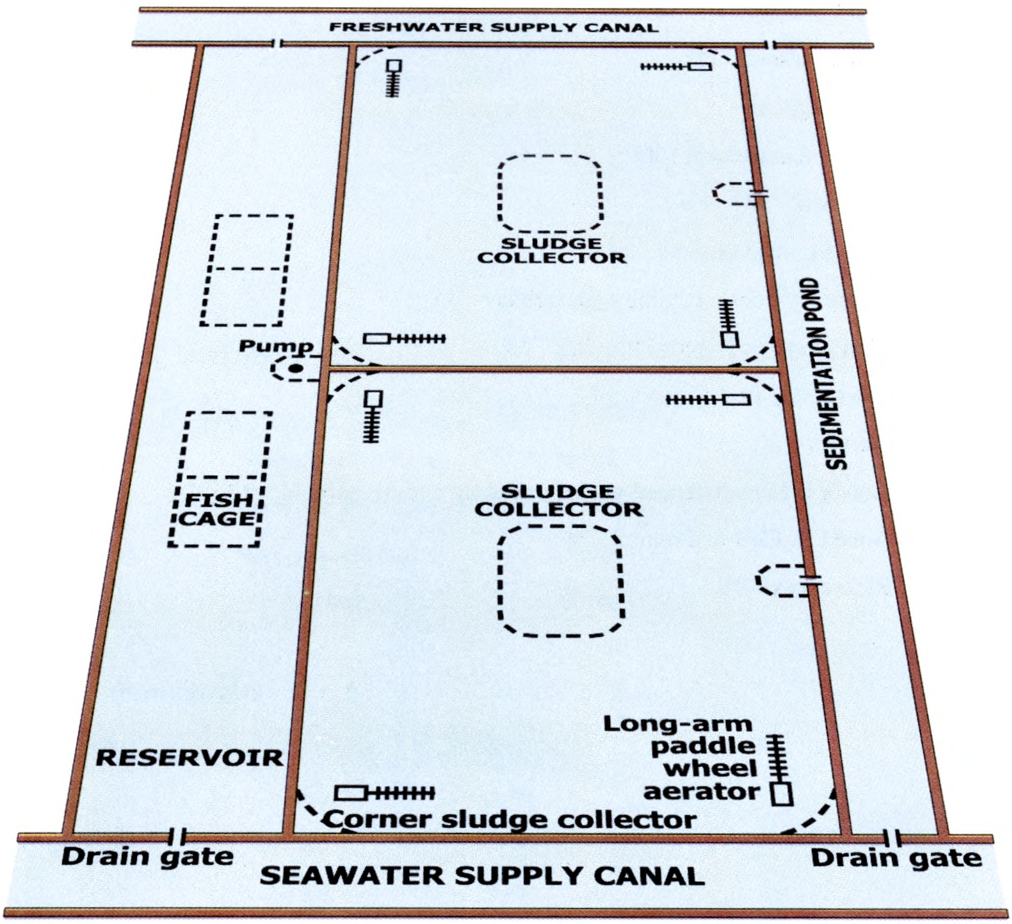

SUGGESTED POND LAYOUT

Environment-friendly schemes in intensive shrimp farming

The black tiger shrimp, *Penaeus monodon*, has been successfully raised by the SEAFDEC Aquaculture Department, Technology Verification and Extension Section at its Dumangas Brackishwater Station. The approaches in the culture method employed in the series of verification runs in the brackishwater station are documented below to serve as an interim guide for shrimp growers while these are still being further refined and standardized.

Basic considerations for intensive shrimp farming

Shrimp farming requires adequate preparation of the physical facilities. The following preliminary steps are essential:

1. Set aside one or two ponds as reservoir where all incoming water must be temporarily stored for at least one week before being used in the grow-out ponds. The reservoir pond area should be at least 25% of the shrimp grow-out pond area. If only one pond is used, it is better to subdivide it into two compartments that can be used alternately.
2. Set aside another pond to serve as a tail pond to hold the drained water. Where the main drain canal is wide and deep enough, this can also serve as the tail pond. However, it should have a control gate to prevent the water drained from the ponds from flowing freely into the natural drainage area until such time that most of the suspended solids have settled.
3. Use long-arm paddle wheels to provide adequate aeration and water circulation. Short-arm paddle wheels aerators may be used for smaller ponds.
4. Stock the reservoir with fish. Either tilapia or milkfish have been found to help condition the water and substantially produce green water.
5. Repair the dikes, gates, canals and other pond facilities as required so that the ponds can hold a minimum depth of 120 cm. A depth of 150 cm is ideal.
6. Install filters with a mesh size of 0.5 mm in all water inlets. The filter can either be a bag or a box.
7. Be properly equipped with basic tools of the trade such as a refractometer (to measure salinity), a thermometer and if possible a pH meter. Having a dissolved oxygen (DO) meter will also be advantageous. However, it is expensive because it requires frequent calibration and maintenance. It also breaks down easily. Under normal conditions, the DO levels in a pond goes up

and down predictably during each 24-hour period so that critical levels can be anticipated and remedial measures initiated accordingly.

8. Have a standby generator to operate the paddle wheels and pumps during brown-outs.

Pond preparation

The primary purpose of pond preparation is to establish optimal condition of the pond soil for growing shrimps, and in the case of old ponds, to remove undesirable materials left from previous runs. Soil with the following characteristics have been found desirable:

pH	–	7.0-8.5
OM	–	< 3%
Iron	–	< 400 ppm
Color	–	Brown

In order to attain these soil characteristics, the following steps are recommended:

1. Dig peripheral canals that slope towards the drainage gate to properly drain and dry the pond bottom.
2. Dry the pond until the bed cracks.
3. Scrape the excess black soil on the pond bottom and place them on top of the dike.
4. Flush the pond by letting water in up to 30 cm and draining it completely after holding it for a minimum of 24 hours.
5. Apply lime. Either agricultural lime at 2.0 tons/ha or hydrated lime at 0.5-1.0 ton/ha is sufficient for this purpose.
6. Till the pond bottom to mix the lime thoroughly with the top soil and oxidize the upper 10-20 cm layer of the pond bottom.
7. Compact the pond bottom either with a manual compactor or a roller. Compaction can also be achieved by using the pressure exerted by the water column. Raise water to the maximum level and hold it for at least one week. Then drain the water and dry the pond bottom. This is less laborious but requires a longer time.
8. Install a sludge collector consisting of two 10 x 10 m net cages inside a net pen at the center of each grow-out pond (Fig. 1). For the net cages, use mesh 22 knotless polynet. For the net pen, use a fine-mesh netting material (regular hapa net with mesh size of 0.5 mm). Remove the net pen 60 days after stocking of the shrimp fry when these have grown larger than the mesh of the net cage.

Fig. 1. Sludge collector (above) stocked with finfishes as biomanipulators. Sludge collectors may also be installed at the pond corners (right).

Water culture

Water culture is undertaken to achieve good plankton bloom as soon as possible. It is a means of preventing the growth of benthic algae including *lablab*. Water with the following parameters is ideal for stocking:

Salinity	–	25-30 ppt
pH	–	7.5-8.5
Temperature	–	28-32 °C
Alkalinity	–	above 80 ppm
Transparency	–	35-45 cm
Water Color	–	Brownish green

The following steps are suggested to prepare the water for stocking:

1. Install 4 units of 2-hp paddle wheel aerators per hectare of pond area. Use units with a minimum of 4 impellers. For better circulation, position them 5 m from the dike and a minimum of 40 m from each other (Fig. 2).

Fig. 2. Long-arm paddle wheels

Fig. 3. Reservoir pond stocked with fish biomanipulators

2. Transfer water from the reservoir (Fig. 3) to the grow-out pond through filter screens to prevent the entry of extraneous organisms. Pumping may be necessary when the reservoir and the grow-out pond are of the same level.

3. At an initial depth of 30 cm, apply tea seed powder at 50 kg per hectare during sunny days and 100 kg when it is cloudy. Fill the pond to a minimum depth of 100 cm using water from the reservoir pond.

4. Apply dried chicken or cow manure at 300 kg/ha.

5. Install a "teabag" of manure in front of each paddle wheel. To make a manure "teabag," fill an empty sack (such as a recycled feed sack) with 25 kg of dried manure. Securely tie the mouth of the sack to prevent the manure from spilling. Remove the teabags as soon as a stable algal bloom has been achieved.

6. Apply urea (46-0-0) at 18 kg per hectare. Broadcast it evenly through-out the pond. "Tea bags" with urea may also be used to gradually release the nutrients to maintain a good plankton bloom.
7. Replace 20 to 30% of the pond water if algae do not bloom and apply urea again at 10 to 15 kg per hectare. If an adjacent pond has a good plankton bloom, use water from this pond to replace the released water.
8. Stock the net cages with bangus or saline-tolerant tilapia. It is preferable to use fully-grown fish so that there will immediately be a standing fish biomass of at least 2,000 kg per hectare of grow-out pond. If the pond water salinity can be maintained at 15 ppt or lower, use the Nile tilapia, *Oreochromis niloticus*, or all-male Mozambique tilapia, *O. mossambicus*, or a salt-tolerant hybrid if higher than 15 ppt. Milkfish can be used in both low and high salinity environment.
9. Apply probiotics to both the grow-out ponds and the reservoir at 5 kg per hectare. Use only probiotics which are known to work in saline environment.

Stocking

The shrimp is most vulnerable during the fry stage. Even with the best pond preparation the shrimp can suffer heavy mortality during stocking if the fry is not healthy, the stocking time is not ideal or if the condition of the fry transport water and that of the pond water varies widely from each other. The stocking density should not exceed 30 per square meter (300,000 per hectare).

Before making a commitment to purchase fry, make certain that the fry has the following characteristics (Fig. 4):

Fig. 4. Checking fry samples

a. Swims against the current when basin water is stirred and reacts to tapping on the side of the basin and to passing shadows;
b. Swims in a horizontal position and not vertically as if grasping for breath;
c. Have straight bodies;
d. Have relatively uniform sizes;
e. Measures at least 12 mm in length at PL-18 stage;
f. Have clear abdominal muscle;
g. Have full gut;
h. Have gut muscle ratio of 1:4;
i. Certified free from white spot virus by PCR-equipped diagnostic laboratory.

Schedule the stocking early morning when the temperature is between 27 to 31°C.

Request the source hatchery to pre-acclimate the fry to the salinity of the receiving ponds prior to packing and transport.

Prepare implements for acclimation (basins, pails and fry scoops) for the arrival of the fry. Install two survival nets (1 x 1 m) in each pond.

Upon arrival of the fry:

a. Allow the unopened plastic bags with the fry to float in the pond where the fry are to be stocked;
b. Select two to three plastic bags for counting and pour the contents of each plastic bag into a basin;
c. Check the temperature, salinity, and pH of the transport water;
d. Count the fry in each basin and obtain the average of the three counts;
e. While the fry from the three sample bags are being counted, open the rest of the plastic bags and slowly add pond water using a small scoop or manually splash pond water into the plastic bags;
f. Check temperature, salinity and pH every 15 minutes;
g. Continue adding pond water slowly until the salinity, temperature and pH of the water inside the transport bags have stabilized or are the same with that of the pond water.
h. Allow the rest of the fry to swim out of the bags after stocking 100 fry in each survival net.

A Note On Acclimation: Extend acclimation if there is a big difference between hatchery and pond water parameters.

a. As a guide, allow 15 minutes of acclimation time for every 1°C, 1 ppt and 0.1 difference in temperature, salinity and pH respectively.
b. Always use the widest difference as the basis for determining acclimation time. If the temperature difference is 2°C but the salinity difference is 4 ppt and the pH difference is 0.1 the total acclimation time shall be: 15 x 4 = 60 minutes.
c. As a rule, do not extend acclimation time beyond 2 hours so as not to unnecessarily stress the fry. This means, if the pond salinity is more than 8 ppt, lower the hatchery salinity. It is best to pre-acclimate the fry at the hatchery prior to packing and transport.

d. Acclimation may also be done in tanks, stocking boxes and basins.

Check one survival net after fifteen days and the second after thirty days. Compute the average of the two counts and use it to estimate the total shrimp biomass.

Water management

Good water management is essential to maintain the water quality at optimum levels for good growth of the shrimps. *All intake or fill-in water must come from reservoir where finfish are stocked as biomanipulators* (Fig. 5).

Good water quality means an adequate level of dissolved oxygen and minimal levels of metabolites as detailed below:

a. *Water Depth* : The water depth should be maintained at at least 100 cm but the deeper the water level, the better for the shrimps. The ideal water depth is 150 cm.
b. *Color* : Brown green and golden brown and light green indicates good plankton bloom.
c. *Dissolved Oxygen* : Dissolved oxygen is the single parameter that affects growth and production through its direct effect on the feeding and metabolism of shrimps and other environmental conditions. Toxic metabolites produced by bacterial activity causes DO depletion that weakens the shrimps and may cause mortality. Operate the paddle wheel aerators when DO falls below the ideal 5 ppm level.
d. *pH* : The ideal pH is 7.5 to 8.5. Values lower or higher than 7.5 and 8.5 will affect growth. Fluctuations greater than 0.5 is detrimental to shrimps. Change water and apply dolomitic or agricultural lime at 150 to 300 kilos per hectare when pH is lower or greater than the ideal values.

Fig. 5. Water management

e. *Salinity* : Ideal salinity is 15-25 ppt. However when luminous bacteria proliferates, gradually reduce salinity to 8 ppt until harvest. Low salinity can reduce the luminous bacteria population to a less harmful level. Reduce salinity at about 3.2 ppt per month.
f. *Temperature* : Ideal temperature is 28-32°C. Stable temperature is observed in ponds with deeper water.
g. *Ammonia* : Make sure that ammonia level is not more than 0.1 ppm. Increase DO level through aeration and water exchange.
h. *Hydrogen Sulfide* : Hydrogen sulfide should not be greater than 0.02 ppm. Hydrogen sulfide is produced by organic metabolism in the absence of oxygen. Hydrogen sulfide does not normally occur in well-oxygenated water.
i. *Transparency* : A good plankton bloom provides ample shading which prevents the growth of benthic algae and stabilizes the temperature. The optimum transparency range is 35 to 45 cm with the water having a golden brown or brownish green color.
j. *Bacterial Count* : Make sure that the *vibrio* bacteria count does not exceed 10^2 cfu (coliform forming units).

The schedule of water change depends on the water quality which can be determined only through regular monitoring.

Monitor the bacterial count once every two days. If the count exceeds 10^2 cfu, change 20-30% of the water immediately even if the water color and transparency is within optimum limits.

Base water change on transparency and color if bacterial count cannot be done regularly. Change at least 20% of the water when transparency is less than 35 cm.

Continue the application of probiotics in both the grow-out and the reservoir ponds once every week or every two weeks during the first 60 days of culture and subsequently each time after water has been changed to help maintain water quality.

Aeration

A one-hectare pond can support only 1,800 kg of shrimps without aeration, so in semi-intensive and intensive culture systems where stocking is as high as 100,000 to 300,000 fry per hectare, aeration is a must.

The most commonly used aerator is the paddle wheel. It is not only efficient in increasing the dissolved oxygen in the pond but also moves the water around the pond, enough to gather the sludge that settles on the bottom to concentrate at the center of the pond (Fig. 6). Paddle wheels also perform the following functions:

a. create a homogeneous pond environment in terms of temperature, salinity, DO and phytoplankton distribution;
b. dissipate into the atmosphere, toxic gases produced in the pond;
c. hasten the effect of organic and in-organic fertilizers on phytoplankton bloom;
d. hasten the effect of tea seed and other inputs applied.

The paddle wheels are used according to the following schedule:

Days of Culture (DOC)	6:00AM to 6:00PM	6:00PM to 6:00 AM
Pre-stocking	100%	100%
1 - 20	1 - 2 units	2 units
21 - 40	2 units	4 units
41 - 60	2 units*	4 units
61 to harvest	4 units**	4 units**

* Increase paddle wheel operation during daytime under the following situations:

a. The sky is overcast;
b. Rainy days;
c. There is phytoplankton die-off
d. Feeding drops below normal level
e. Shrimps show signs of disease

** Except during feeding.

Fig. 6. The long-arm paddle wheel provides aeration and circulation

Feeding management

Since feeding constitute about 40-50% of the total production cost in intensive culture, feeding should be efficiently managed. Use good quality feeds, with high protein content. Feeds with a high degree of stability allow a more accurate monitoring of the actual consumption by the shrimps. Shrimps may be trained to feed with commercial feeds during the first week of intensive culture although natural food are assumed to be abundant during that period. With "blind feeding scheme" some feed may be introduced at 1kg per 100,000 fry.

There are two ways of adjusting daily feed computation:

a. By projecting the ideal feed consumption based on assumed survival, assumed average daily weight gain, ABW, and percent feeding rate (Refer to Feeding schedule on page 21).
b. By feeding according to demand. Demand feeding involves the actual monitoring of feed consumption by putting 10 % of the feeds in the feeding trays. The subsequent feeding rate is based on the consumption and the ABW (Table 1, Feeding guide on page 19).

Factors affecting feeding management

1. *Water temperature* : Shrimps do not feed well when the temperature is relatively hot or cold, i.e., above 34°C and below 25°C. Optimum water temperature for shrimps is from 26°C to 33°C.
2. *Dissolved oxygen (DO)* : Maintain DO above 4 ppm. Reduce feeding when DO level drops below 4 ppm.
3. *Diseases* : Infected shrimps either do not feed well or stop feeding.
4. *Moulting* : Moulting is a normal growing process of shrimps. Reduce feeding by 25% when massive moulting is observed. Resume normal feeding after two to three days.
5. *Phytoplankton die-off* : Phytoplankton collapse can cause the excessive release of ammonia to the environment. This condition is very stressful for the shrimps, resulting to loss of appetite.

Monitoring and record keeping

In order to maintain optimum conditions for growth, monitor the water parameters regularly. These shall be the basis for water management and other treatments.

1. Monitor the water depth, temperature, salinity and pH twice daily. The first from 6:00-7:00 AM and second from 2:00-3:00 PM.
2. Monitor the luminous bacteria count once every two days by collecting water samples using clean and sterile bottles. Bring immediately to the nearest diagnostic laboratory for analysis.

Fig. 7. Feeding and monitoring

3. Monitor feed consumption by installing four to eight feeding trays (.75-1 m^2) in each 0.5 to 1 ha pond (Fig. 7).
4. Using the same feeding trays, monitor the condition of the shrimps based on their physical appearance. Physical defects may be signs of stress or may cause stress and eventual mortality.
5. Monitor the size of the shrimps and their average body weight (ABW) obtained to determine whether the cultured animals are growing and whether the quantity of feeds given daily need to be adjusted.
6. Keep a record of all the parameters being monitored. This is needed for immediate and easy reference for the next cropping and is essential in troubleshooting problems.

Emergency procedures

During the culture period, certain developments may occur that will necessitate the implementation of procedures that deviate from the daily pond management routine. Some of the more common occurrences and their suggested corrective procedures are as follows:

1. *Excessive and rapid plankton bloom* : (Change 20 to 30% of the water).
2. *Plankton die-off* : If the plankton bloom is not properly maintained, the water will suddenly become clear due to the collapse of plankton stock (normally referred to as plankton die-off). To restore the color and transparency of the water to the optimum level, apply urea at 18 kg/ha and 8 "tea bags" each containing 30 kg of chicken manure.
3. *Occurrence of floating benthic and filamentous algae* : Manually remove floating masses of algae from the water surface using long-handled scoop nets. Take care not to include shrimp juveniles.

4. *Occurrence of extraneous fish which may prey on or compete with the shrimps* : Remove the fish stock used for bio-manipulation from the net cages and temporarily transfer to net cages set in an adjacent pond. Lower water depth to 60 to 80 cm depending on the load of shrimp stock. Apply tea seed powder at 100 to 150 kg per hectare during sunny days and 200 to 300 kg per hectare during overcast days. Operate paddlewheels fully during tea seed application. After the piscidal effect of the tea seed has dissipated, (2 to 3 days after application), remove the dead fish and return the stock of biomanipulators to their original net cages.

Harvest

Harvest of the stock depends on market demand. Exporters usually dictate the size and volume. Controlling production cost is the lookout of the grower.

1. Check the soft shell count of the stock two to three days before the scheduled harvest. The soft-shell count should not be more than two percent of the total harvest. Harvest should be done three days after moulting.
2. To harvest, drain the pond two to three hours after high tide.
3. Soak harvested shrimps directly in the chilling tanks with temperature kept within 0°C with the use of crushed ice. Soaking shrimps in very cold water instantly kills them, delays rigor mortis and preserves freshness.
4. Sort and weigh the shrimps immediately.
5. Pack weighed shrimps in styrofoam or insulated fiberglass boxes with ice for transport. Shrimps are packed by alternating layers of ice and shrimps from bottom to top (normally the buyer does the sorting, weighing and packing).

Fig. 8. Harvesting, chilling and sorting of shrimps

Annex I. Recommended guide in feeding and monitoring

ADJUSTING DAILY FEED BASED ON DEMAND

Table 1. Feeding Schedule

ABW	Feed Type	Feeding Freq.	Feeding Distribution					Monitoring Time
			6AM(%)	10AM(%)	2PM(%)	6PM(%)	10PM(%)	
0.01-0.70	PL	2X	50				50	4 hrs
0.70-2.00	Starter	3X	40		40		20	4 hrs
2.00-4.00	Starter	4X	30	20		30	20	3 hrs
4.00-5.00	Mixed	4X	30	20		30	20	2.5 hrs
5.00-8.00	Grower 1	5X	25	10	10	35	20	2.5 hrs
8.00-10.00	Mixed	5X	25	10	10	35	20	2.5 hrs
10.00-18.00	Grower 2	5X	25	10	10	35	20	2 hrs
18.00-20.00	Mixed	5X	25	10	10	35	20	2 hrs
22.0-up	Finisher	5X	25	10	10	35	20	1 hrs

Table 2. Percent feed per feeding tray per area per ABW range

AREA (Ha)	ABW (gms)		
	1.0–10.0	11.0–20.0	21.0–UP
0.4–0.6	0.50	1.00	1.25
0.7–0.8	0.40	0.80	1.00
0.9–1.5	0.30	0.60	0.75
1.6–UP	0.25	0.50	0.70

Assumptions:

1. No. of feeding trays: 8
2. Size of feeding tray: 0.5 x 0.5 to 0.7 x 0.7 meters
3. Lesser than 10% left considered consumed
4. More than 10% left considered excess

Feeding Tray Monitoring	Feed Adjustments
8/8	+15%
7/8	+10%
6/8	+5%
5/8	maintain
4/8	maintain
3/8	maintain
2/8	-5%
1/8	-10%
0/8	-15%

Table 3. Daily feed adjustments

DOC	Increase/Day/100,00 Fry	Survival Estimate (%)
01-07	150 Grams-250 Grams	100.00
08-15	250 Grams-350 Grams	80.00
16-22	350 Grams-450 Grams	70.00
23-30	500 Grams	60.00

Table 4. Feeding rates

ABW (g)	Feed rate (%)	Monitor (Hrs)
2	6.0	3 hrs
5	5.0	2.5 hrs
10	4.0	2.5 hrs
15	3.0	2.0 hrs
20	2.5	1.0 hrs
25	2.5	1.0 hrs
30	2.0	1.0 hrs
35	2.0	1.0 hrs

Table 5. Estimated growth rate

ABW (g)	GR/DAY (g)
2.0–5.0	0.1–0.2
5.0–10.0	0.2–0.25
10.0–15.0	0.25–0.3
15.0–20.0	0.3–.035
20.0–25.0	0.35–.038
25.0–30.0	0.38–0.4
30.0–UP	0.4–.045

ADJUSTING DAILY FEED BASED ON IDEAL FEED PROJECTIONS

The best way to explain this method is by giving an example.

Assumption: Original Stock – 100,000 pcs
Percent Survival – 90%
ABW at DOC 30 – 2 grams
Average Daily Wt. Gain – 0.15 grams

Formula: Ideal Feed = Stock x % Survival x ABW (gm) / 1000 x % Feed Rate

DOC	ABW	%Feed Rate	Ideal Feed per Day
30	2.00	7.29	13.12 kg
31	2.15	7.13	13.80 kg
32	2.30	6.79	14.05 kg
33	2.45	6.63	14.62 kg
34	2.60	6.46	15.12 kg
35	2.75	6.29	15.57 kg
36	2.90	6.20	16.18 kg
37	3.05	6.10	16.74 kg

Annex II. Cost and return

Low-discharge and environment-friendly method of intensive shrimp farming Cost and return data

Pond no.	9	11	13
Area	8,786 m^2	8,782 m^2	9,027 m^2
Total stock	219,650 pcs	219,550 pcs	369,835 pcs
Date harvested	September 19, 2000	October 9, 2000	October 10, 2000
Stocking density	25 pcs/m^2	25 pcs/m^2	40 pcs/m^2
DOC at harvest	139 days	159 days	144 days
ABW	25.5 g	27 g	25 g
Biomass	4,465 kg	5,379 kg	5,626 kg
Survival rate	79.70%	90.70%	61%
Ave. price per kg	₱ 308.00	₱ 273.87	₱ 277.77
Gross Sales	₱ 1,375,474.00	₱ 1,473,170.00	₱ 1,562,705.65
Expenses			
Fry	57,109.00	57,109.00	96,157.00
Feeds	324,729.50	374,729.50	407,205.00
Salaries/wages/OT	80,500.00	80,500.00	113,605.30
Pond preparation	14,277.00	14,277.00	17,515.84
Lime	7,500.00	7,500.00	10,000.00
Biomanipulators	3,000.00	3,000.00	6,000.00
Probiotics	14,025.00	14,025.00	16,500.00
Power/lights/water	138,187.60	188,187.60	190,433.88
Fuel/lubricants	12,963.33	12,963.33	3,647.79
Sludge collector/cages	10,339.44	10,339.44	14,850.00
Feding bridge/tray	10,000.00	10,000.00	10,000.00
Laboratory analysis	2,500.00	2,500.00	2,500.00
Depreciation	68,419.75	68,419.75	68,419.75
R&M ponds/dikes/equip	49,091.07	49,091.07	51,300.00
Communications	1,580.76	1,580.76	1,470.64
Transport & travel	9,420.58	9,420.58	663.50
Total expenses	₱ 803,643.03	₱ 903,643.03	₱ 1,010,268.70
Net profit	₱ 571,830.97	₱ 569,526.97	₱ 552,436.95
Investment requirement	₱ 1,452,250.00	₱ 1,561,348.28	₱ 1,667,973.95
Return on investment	39.4%	36.6%	34.3%
Payback period	3 croppings	3 croppings	3 croppings

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Mr. Baliao graduated from the University of the Philippines in the Visayas College of Fisheries with a masters degree in Fisheries major in Aquaculture in 1978. His bachelor's degree in Biological Science was also earned at the same university.

About SEAFDEC

The Southeast Asian Fisheries Development Center (SEAFDEC) is a regional treaty organization established in December 1967 to promote fisheries development in the region. Its member countries are Japan, Malaysia, the Philippines, Singapore, Thailand, Brunei Darussalam, the Socialist Republic of Viet Nam, Myanmar and Indonesia.

Representing the member countries is the Council of Directors, the policy-making body of SEAFDEC. The Chief administrator of SEAFDEC is the Secretary-General whose office, the Secretariat, is based in Bangkok, Thailand.

Created to develop fishery potentials in the region in response to the global food crises, SEAFDEC undertakes research on appropriate fishery technologies, trains fisheries and aquaculture technicians, and disseminates fisheries and aquaculture information. Four departments have been established to pursue the objectives of SEAFDEC.

- The Training Department (TD) in Samut Prakan, Thailand, established in 1967 for marine capture fisheries training
- The Marine Fisheries Research Department (MFRD) in Singapore, established in 1967 for fishery post-harvest technology
- The Aquaculture Department (AQD) in Tigbauan, Iloilo, Philippines, established in July 1973 for aquaculture research and development
- The Marine Fishery Resources Development and Management Department (MFRDMD) in Kuala Terengganu, Malaysia, established in 1992 for the development and management of the marine fishery resources in the exclusive economic zones (EEZs) of SEAFDEC Member Countries.

About ASEAN

The Association of Southeast Asian Nations is a regional organization formed in 1967. Its member nations are: Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam.

The member nations of ASEAN cooperate to promote growth and stability in the region. The organization's policies are formulated by the countries' foreign ministers at annual meetings. Projects are recommended to the ministers by committees dealing with economic affairs, culture, science and social development.

The ASEAN Secretariat is located in Jakarta, Indonesia. It is the central administrative organ of ASEAN headed by a Secretary-General.

The Secretariat has four bureaus taking care of trade, investments, industry, tourism and infrastructure; economic and functional cooperation; finance and program coordination and external relations.

The Secretariat has about 40 professional staff members openly recruited from member countries.