state of the art series
NOVEMBER 2000
SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER
ASSOCIATION OF SOUTHEAST ASIAN NATIONS

Closed-recirculating shrimp farming system

Siri Tookwinas

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CLOSED-RECIRCULATING SHRIMP FARMING SYSTEM
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ISBN 971-8511-48-2

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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 Govenment 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

In recent years, the clearing of mangrove forests to make way to shrimp ponds has abated due to the growing public awareness and realization among growers that intertidal mangrove areas are, after all, not the ideal site for high density shrimp culture.

However, discharges from shrimp farms continue to be a threat to both the mangrove and marine ecosystems often with disastrous results to the coastal poor who often rely on the coastal resources for their sustenance. Effluent discharges also threaten the sustainability of shrimp farming itself.

SEAFDEC and ASEAN came up with a collaborative project in 1998 which will run until 2002. The Government of Japan provides some financial assistance. Specifically, the project aims to develop sustainable shrimp culture technology packages to address problems in shrimp culture, including the one cited above. This guidebook is the first installment in the shrimp techno-packages. It is based upon a series of successful operations conducted by the Marine Shrimp Research and Development Institute of the Department of Fisheries in Thailand.

It is our hope that the world at large, and the industry in particular, would become aware and adopt this "green" technology being pursued by SEAFDEC and ASEAN members.

ROLANDO R. PLATON, PhD
Chief, SEAFDEC/AQD

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Closed-recirculating shrimp farming system

Shrimp farmers now aim not only for disease-free shrimps with high growth rate and high yield, but also on resource conservation. By minimizing and even avoiding altogether the discharge of organic matter and nutrients from the grow-out into the natural waters, the adverse environmental impacts often associated with intensive shrimp farming is completely avoided. This can be achieved only through a closed culture system where waste water is treated and returned to the growing ponds.

Pond sizes and layout

The model shrimp farm in Thailand upon which this guide is based consists of a 2 rai (35x90m) grow-out pond and a 0.5 rai (30x27m) treatment pond. A third pond is required to serve as reservoir for new water for the initial filling as well as to compensate for losses due to evaporation and possible seepage.

The grow-out pond and the treatment pond are connected in such a way as to allow the water to circulate from one pond to the other as shown in Figure 1.

Pond preparation

GROW-OUT POND

Drying: After harvest, the pond must be dried as soon as possible to induce oxidation in the soil and accelerate the decomposition of waste materials in the pond without removing or draining the bottom sludge.

Liming: Lime (quicklime or CaO) is applied at the rate of 100 kg per rai (625 kg per ha) to raise the soil pH to 7.0 or higher which accelerates the decomposition of organic matter in the bottom soil and is the optimum pH for growing shrimps.

Bottom aeration system: Oxygen deficiency in the pond bottom usually occurs during the culture period. A pond bottom aeration system increases the oxygen supply from the pond bottom up to the entire water column. This consists of PVC pipes (10 mm Ø) perforated with a row of tiny holes, and laid down evenly spaced at 10 m to cover the entire pond bottom area (Figure 2). The pipes are connected to a 2 HP blower.

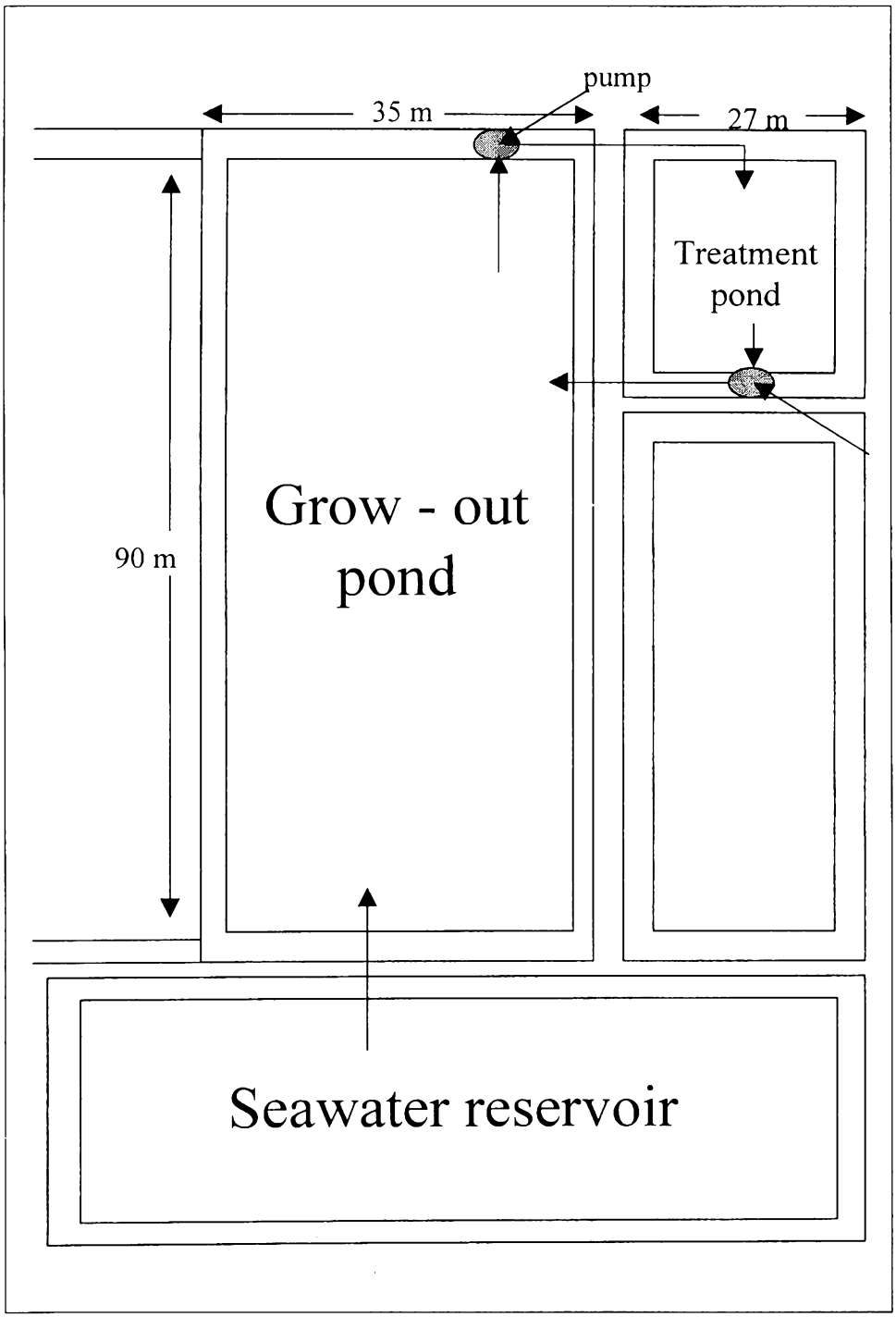

Figure 1. Layout of recirculating shrimp farm

TREATMENT POND

Drying: The pond is drained and sun dried for about 2-3 weeks.

Liming: Hydrated lime is applied at approximately 200 kg per rai (1,250 kg per ha) to raise the soil pH to at least 7.0 and accelerate the decomposition of organic matters by bacteria.

Sand filter system: In the treatment pond, a filter box with a capacity of 0.7-1.0 ton is installed (Figure 3). The filter box is perforated at the sides and bottom and filled with bags containing sand, shells or pieces of broken coral. The inlet of the water supply pump is set in the middle of the bags of filter media. During operation, the treated water is pumped through the filtered tray into the grow-out pond when refilling of water is required. The treatment pond should be efficient so that the sediment reduction and water quality improvement should be at least 20-50% better than that of an untreated pond.

Water preparation

GROW-OUT POND

Quality of the inlet water (initial): The incoming water for the grow-out pond should ideally come from a reservoir with the water quality parameters within the following ranges:

- pH: 7.5-8.5
- salinity: 10-35 ppt
- alkalinity: >80 ppm
- not contaminated with heavy metals or toxic chemicals.

Filling up of water in the grow-out pond: The grow-out pond should be filled with water up to a depth of 140 cm. Tea seed cake at 25 kg/rai (156 kg per ha) is added to eliminate the larvae of fishes and other aquatic animals. The pond is left under this treatment for approximately 1 week. For areas where outbreak of viral diseases has occurred, such as the white spot syndrome virus (WSSV) and the yellow head viral disease (YHV), the water should be treated to disinfect and eliminate possible disease carriers, such as certain species of shrimps, crabs and other crustaceans.

Preparation of the color of the water: After adding tea seed cake for one week, if the water transparency has increased by more than 10 cm within 3 days so that the transparency is lower than 80 cm, then the nutrients in the water resource is adequate and it is no longer necessary to add fertilizer. In case the desired water color can not be attained, then artificial fertilizers need to be added to accelerate the growth of phytoplankton. The fertilizers to be used in this case are:

- Urea (40-0-0) : 2.0 kg/rai (12.5 kg per ha)
- Phosphate fertilizer (16-20-0) : 1.5 kg/rai (9.4 kg per ha)
- Or fertilizer formulated (10-46-0) : 1.0 kg/rai (6.25 kg per ha)

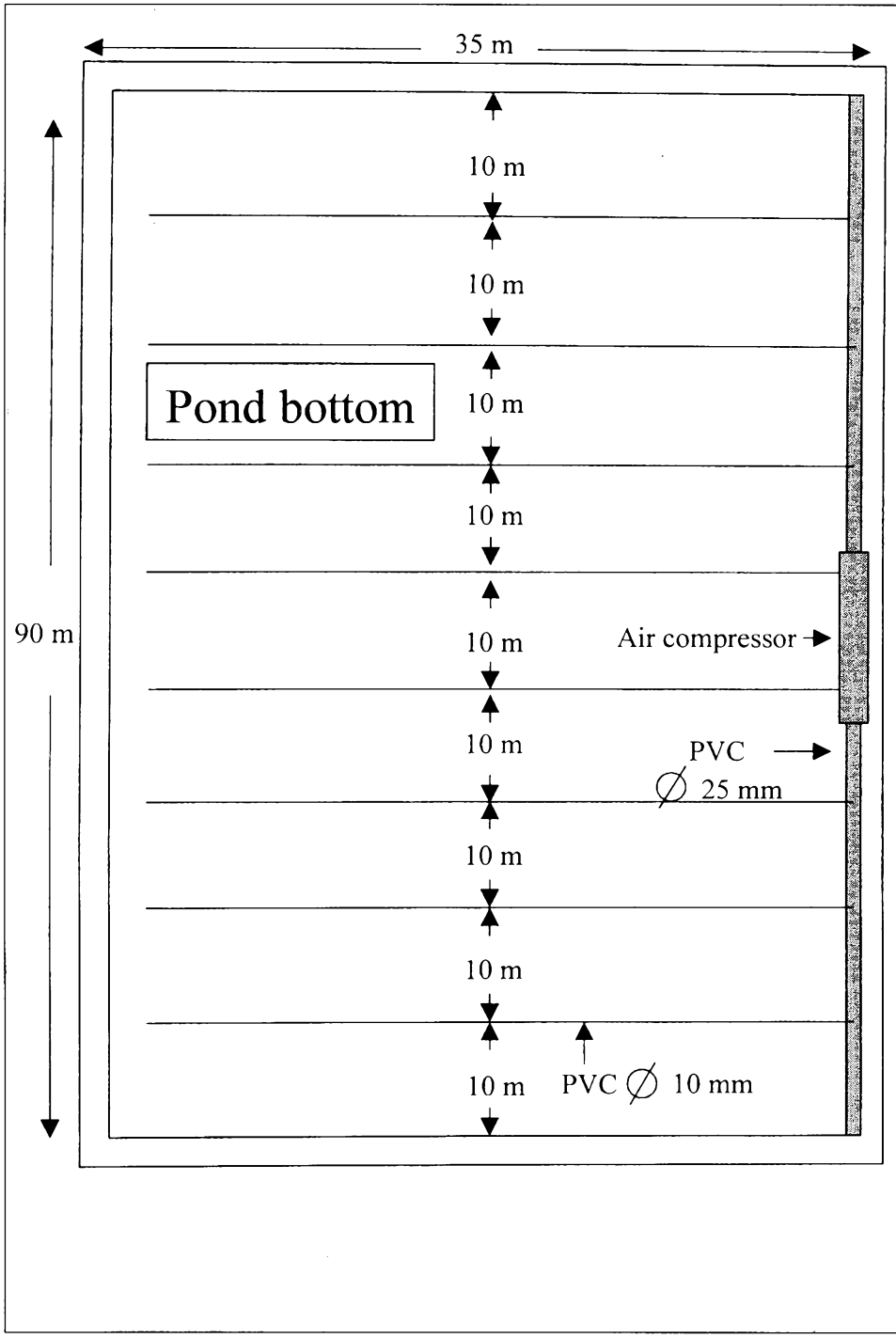

Figure 2. Bottom aeration set-up in the grow-out pond

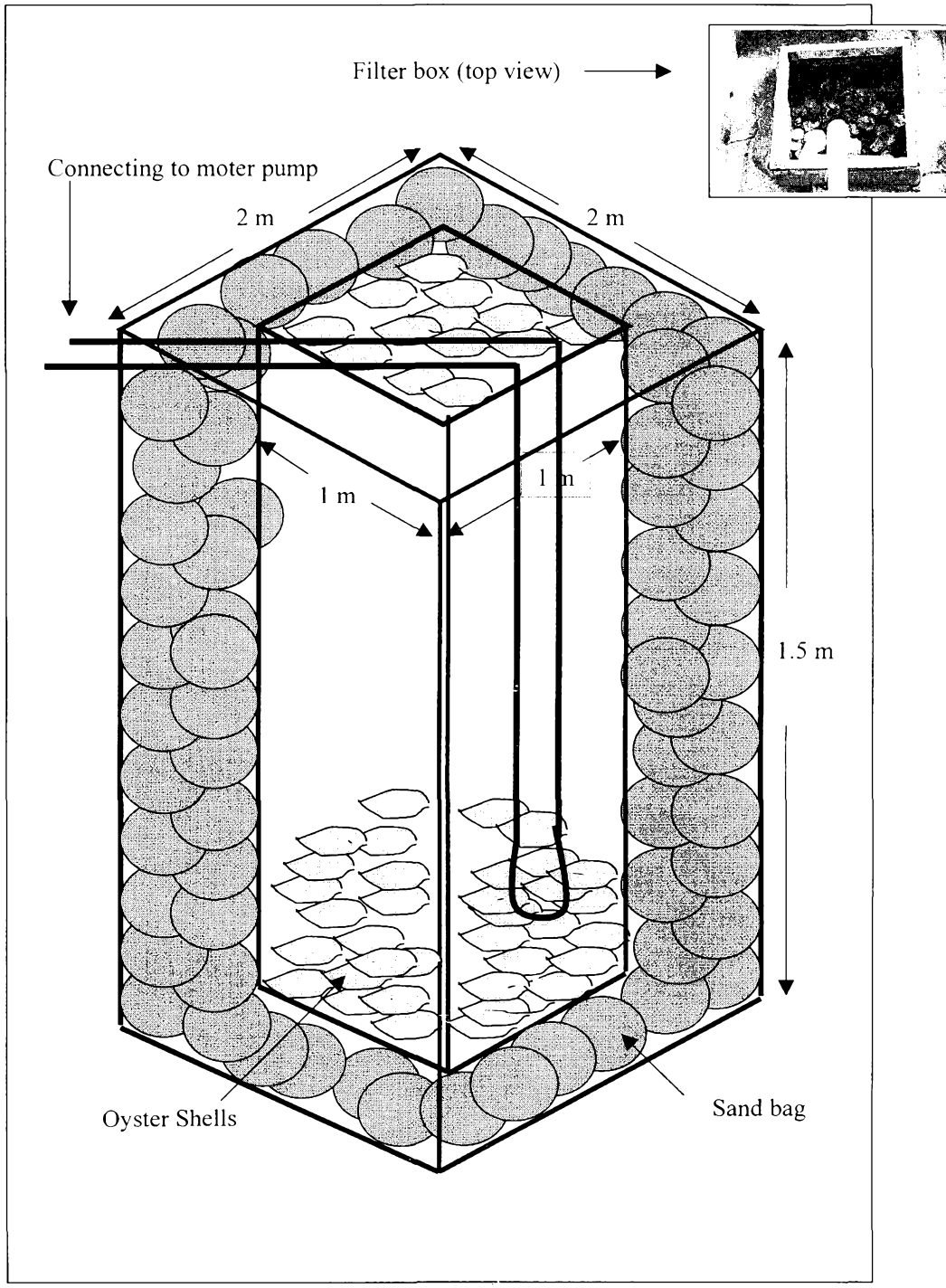

Figure 3. Filter box installation in treatment pond

Adding these fertilizers should make the water transparency in the level of 50-80 cm, which is already good for shrimp fry stocking.

TREATMENT POND

Filling up of water: The treatment pond is filled with water from a reservoir to a depth of 150 cm. It is important that the quality of the water used be the same as that of the water in the grow-out pond.

Recirculation of water: Water from the grow-out pond is treated by passing it through the biological filter. Plastic sheets are set to serve as waterway. The circulation of water is controlled by means of underwater airjet which facilities the increase of oxygen in the water (Figure 4). Water that flows through the filter unit to the end of the waterway can be recirculated continuously up to the original source of the waterway.

Types of aquatic animals and plants in the treatment pond

- **Fishes:** Release the fishes and allow them to live and feed all over the pond. The types of fishes released are those that feed on sediments and organic detritus at the bottom of the pond, such as the red nile tilapia, dwarf goby, etc. The total biomass of the fishes must not exceed 50 kg.
- **Aquatic plants:** *Gracilaria* spp. and other seaweeds species are used to absorb the nutrients that dissolve in the water. They are usually placed at the end of the waterway in the treatment pond.
- **Plankton:** Allow phytoplankton to grow naturally in the water. These organisms will help in absorbing dissolved nutrients in the water.

Stocking of shrimp fry

PROPER WATER QUALITY FOR STOCKING

When the appropriate color of the water has been attained, water quality must be rechecked to ensure its readiness for the stocking of shrimp fry.

The following parameters are recommended.

Parameter	Level
Salinity	10 to 35 ppt
pH	7.8-8.5
Alkalinity	>80 ppm
Ammonia and nitrate	<0.5 ppm
Nitrite	<0.1 ppm
Color/Transparency	50-80 cm

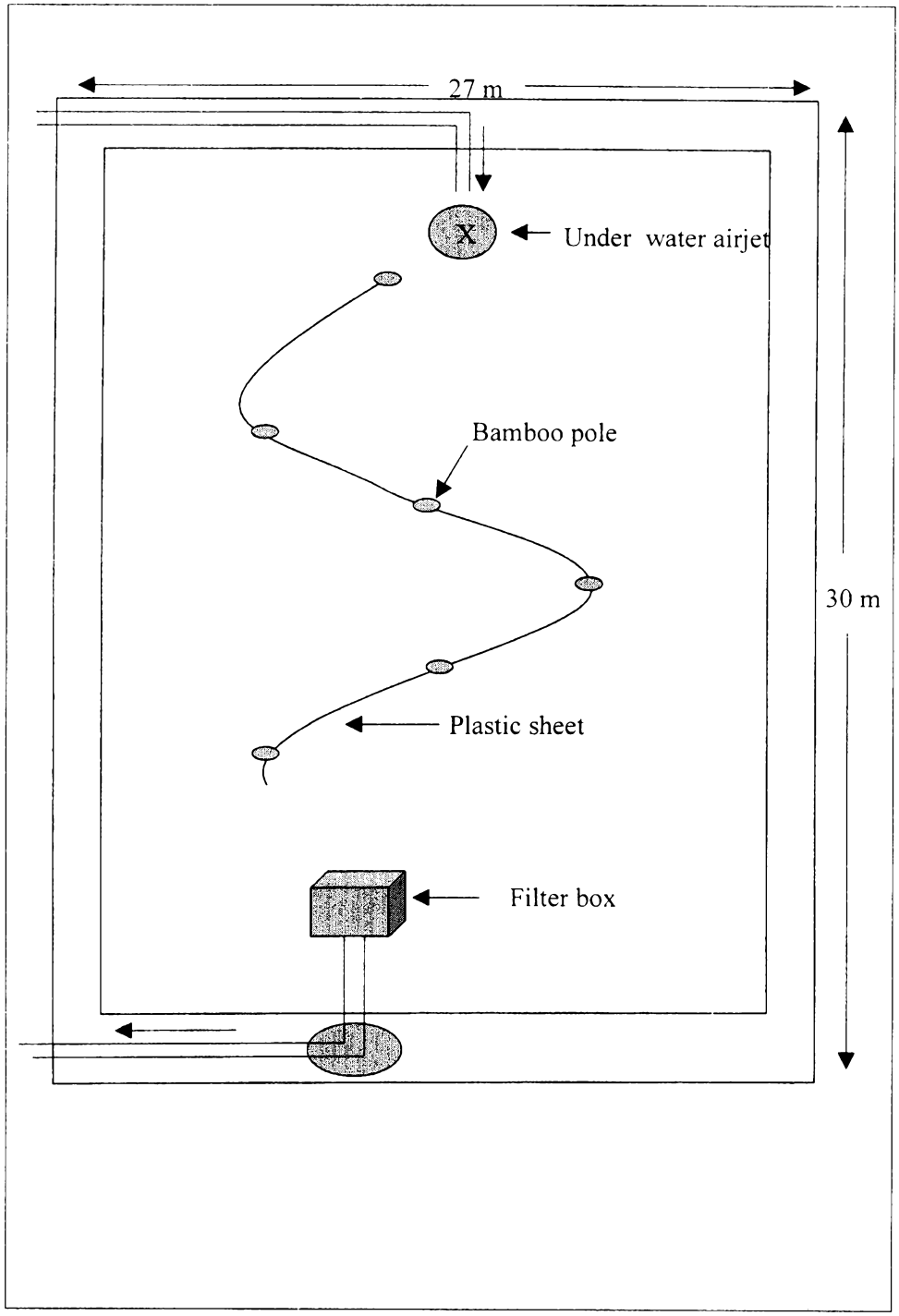

Figure 4. Water flow inside treatment pond showing location of underwater airjet (top view)

Operate the paddle wheel aerators for about 24 hours to mix the water in the grow-out pond totally, before the shrimp fry are released.

STOCKING DENSITY

Stock the shrimp fry (P15-18) at a density of 100,000 fry per rai (about 62 fry/m^2).

SHRIMP FRY QUALITY DETERMINATION

Healthy shrimp fry can be determined from their high survival rate during transport from the hatchery to the grow-out pond. But prior to purchase, the following criteria can be used in selecting strong and healthy fry:

Body long and muscle transparent;

Food in the gut should appear brown in color and can be seen along the body.

Body appearance normal and external organs complete without the following characteristics:

- deformed cephalothorax;
- crinkled body;
- cramped tail appearance;
- not torn appendages and uropod;
- no black dot or black patch at the dorsal part.

When swimming, tail must be fully opened;

Antennae are straight, long, and close to each other;

Color of the body is brown or gray, without red color;

No dirt or debris attached to the appendages;

No white opaque color on the body;

Body not appear crooked when resting;

Fry almost uniform in size.

TEST FOR STRONG SHRIMP FRY AT THE FARM SITE

The test is performed by putting the shrimp fry into a large bowl and stirring the water with a hand making a slow circular motion.

The healthy shrimp fry will swim against the current or attach to the bottom.

When the current stops, the shrimp fry will swim actively at the rim of the bowl.

Fry that accumulate at the middle of the basin are classified as weak fry.

The number of healthy fry must be more than 95%.

DISEASE DIAGNOSIS OF SHRIMP FRY

Pathological examination of the shrimp fry should be conducted before releasing them into the pond.

This includes examination of parasites or fungus under a microscope, and detecting MBV virus and WSSV.

TRANSPORTATION OF SHRIMP FRY

Use 60 x 20 cm plastic bags and fill with approximately 2-3 liters of water.

Place shrimp into the bags at approximately 2,000-3,000 fry/bag depending upon the size of the fry.

Fill bags with oxygen and then close the bag tightly. This method is used when the fry is to be transported within a short distance not exceeding one hour.

For long distances, the plastic bags are placed into a styrofoam box at 2-3 bags per box. Two bags of ice are placed inside the box.

ACCLIMATION OF SHRIMP FRY PRIOR TO STOCKING

Prior to packing and transport adjust the pH and salinity of the nursery water to approximate grow-out pond water condition.

Install nursing pens inside the grow-out ponds (see Figure 5).

Put four 500-liter plastic or fiberglass tanks with conical bottom at the side of the grow-out pond. Fill the tanks with up to 30% of its capacity with grow-out pond water and aerate.

Allow the bags of shrimp fry to float inside the grow-out pond in order for the water temperature in the bags to be close to that of the grow-out pond. Retrieve the shrimp fry bags from the pond, open and release the fry into the prepared 500 liter tanks at about 40,000 fry per tank.

Stop the aeration in the fry tank and stir the water to create a swirling movement in order to separate the strong shrimp fry from the weak. Remove the fry that have settled on the bottom of the tank by opening the center drain.

Get a sample of strong shrimp fry at approximately 100 fry/tank and test for survival within 24 hours in a laboratory aquaria using water from the grow-out pond.

Release the strong shrimp fry into the nursing pen.

After 24 hours estimate the total shrimp fry released into the grow-out pond, calculate the actual stocking density, and use as basis for the shrimp culture program.

Feeding management

The aim of the feeding management is to limit the FCR to less than 1.5 taking into consideration the normal growth rate of the shrimps. The total number of shrimps in the pond, growth rate, and FCR must be monitored at weekly intervals.

CALCULATION OF FEED QUANTITY

During the first month, feed the shrimps at the rate of 1 kg/100,000 shrimps. At this initial stage of culture the use of the nursing pens (1,000 micron mesh) increases the feeding efficiency.

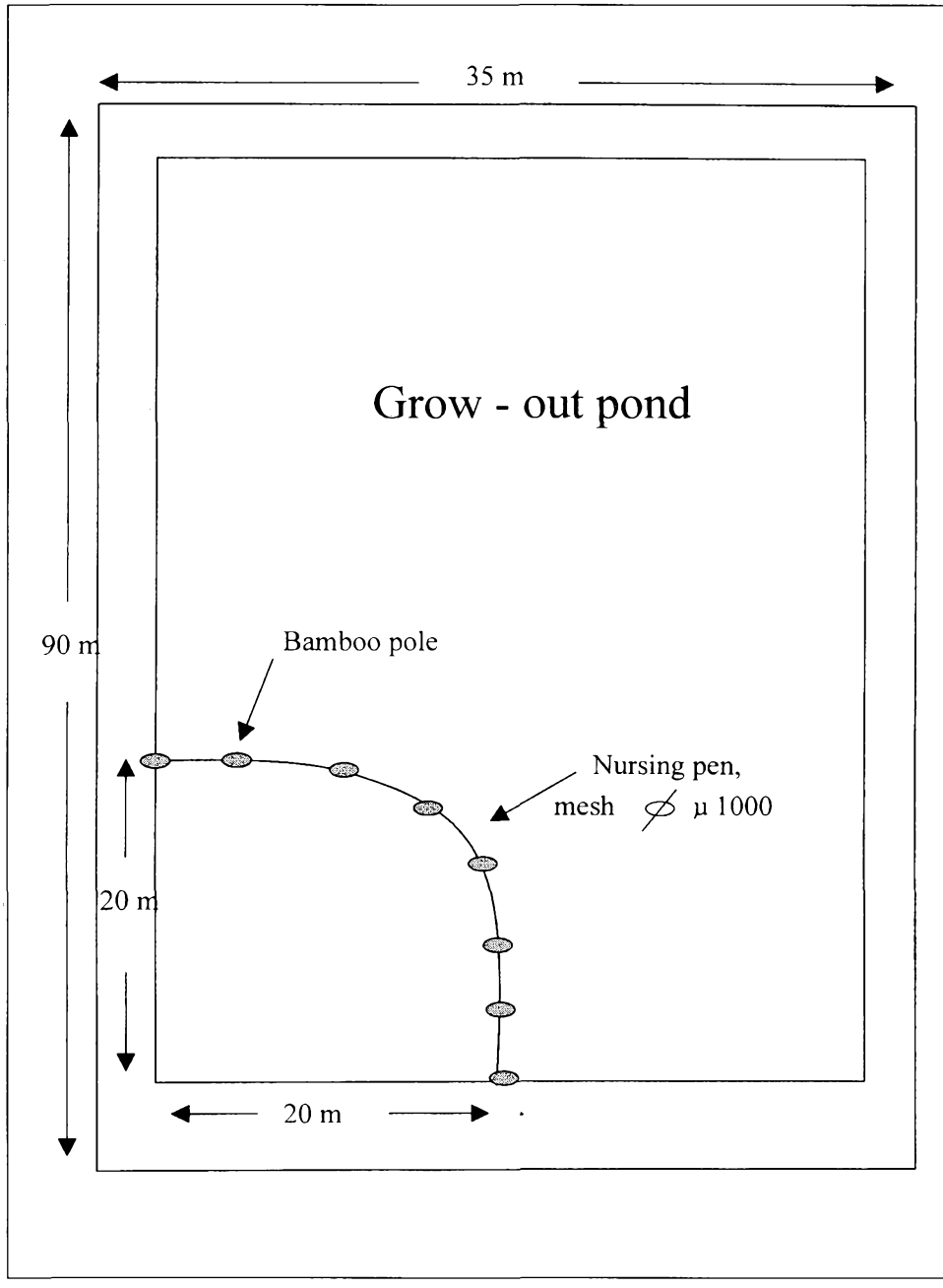

Figure 5. Sketch of nursing pens

Increase the feeding quantity at the rate of 200 g per day after the 2nd month of culture. The amount of feed may be increased and adjusted according to the feed consumed based on feeding tray monitoring.

FREQUENCY OF FEEDING

During the 1st month, feeding should be done 4 times/day at 06.00, 10.00, 14.00, and 18.00 hr.

During 2nd-4th month, feeding should be 5 times/day at 06.00, 10.00, 14.00, 18.00, and 22.00 hr.

FEEDING PRACTICE

Divide the total daily feed quantity into equal portions according to the daily feeding frequency.

During the first 3 weeks the feeds are applied evenly throughout the nursing pens.

After 3 weeks when the fry has been released from the nursing pens distribute the feed evenly throughout the pond except at the center clayey area of the pond.

Install two feeding trays per rai (12 trays per ha) on the 3rd week. Place 10 grams of feed per tray per kg of feed.

Check the feed consumption in the feeding trays after the 1st month.

If the feed in the feeding trays are not consumed within 2 hours, the feed quantity for the next feeding should be decreased.

If totally consumed, the amount of feed given at that particular feeding time in should be increased the following day.

Shrimp culture management

GROWTH MONITORING

Starting on the 2nd month use the feeding trays to obtain shrimp samples for weight and length measurements at weekly intervals.

After the 2nd month, use a cast net to sample the shrimps.

Calculate the average body weight (ABW).

ESTIMATION OF THE NUMBER OF SHRIMPS

Estimate the number of shrimps surviving in the pond each day using their total daily feed consumption and the average percentage of feed consumed per day.

Calculate the weekly average survival using the daily survival estimate.

ESTIMATION OF FCR

Calculate the FCR on a weekly basis using the calculated average number of shrimps in each week, the ABW of shrimp, and the total feed consumption of that week.

The calculated FCR value must be controlled so that it will not exceed 1.5.

DAILY SHRIMP HEALTH EXAMINATION

Monitor the condition of the shrimps daily using the following characteristics to determine shrimp health:

- The shell is hard, smooth, without ulcers, lesions or erosion, and without dirt or debris adhering to the surface of the body.
- The gills look normal without any black discoloration and are clean with no dirt or sediments attached to it.
- The uropod has no sign of lesion or swelling.
- The digestive tract is full of food.
- The pancreas and hepatopancreas are normal in color without a shrunken or swollen appearance.
- The shrimp do not exhibit abnormal behavior, such as aggregation at the pond edge, weak appearance, decreased feeding or not feeding at all, and discoloration.

MANAGEMENT OF ANIMALS AND AQUATIC PLANTS IN THE TREATMENT POND

Algae: Clean the algae by lifting and agitating the algae basket until the sediments fall out. If the quantity of algae is observed to have decreased, new algae must be added.

Fish: Allow the fish to live freely in the treatment pond. If additional fish larvae are available and the concentration of dissolved oxygen in the water is high, more fish can be released into the pond.

Phytoplankton: Allow them to grow freely in the treatment pond.

Water quality management

MONITORING OF ENVIRONMENTAL QUALITY

In the grow-out pond: Water in the grow-out pond at the feeding station is sampled from 2 levels: surface and bottom. The following parameters are monitored regularly at the indicated frequency:

- Transparency, salinity, atmospheric conditions, air temperature and the highest-lowest tidal level which are monitored once daily at 15.00 hr.
- pH and oxygen are monitored twice daily at 06.00 and 15.00 hr.

- Alkalinity, ammonia and nitrite are monitored every Monday, Wednesday and Friday at 15.00 hr. The 24-hour oxygen and temperature fluctuation are monitored once weekly.
- Coliforms, fecal coliforms, heavy metals and insecticides in the grow-out pond and the natural water are monitored once monthly.
- The alkalinity, ammonia, nitrite, nitrate, phosphate, chlorophyll a, suspended solids, oxygen requirement of water, BOD, *Vibrio* spp., and total bacteria of the pre-treated water are measured by sampling at the inlet of the outflowing pump every time the water is drained out.

In the treatment pond: Water samples are taken from the pond surface, pond bottom and at the inflow pump supplying water to the grow-out pond. The following parameters are measured at the indicated times:

- pH, oxygen, temperature, salinity, transparency at 15.00 hr.
- Ammonia and nitrite at 15.00 hr.
- Quality of the treated water is determined by sampling at the inlet of the pump supplying water to the grow-out pond. Alkalinity, ammonia, nitrite, nitrate, phosphate, chlorophyll a, suspended solids, oxygen requirement of water, BOD, *Vibrio* spp. and total bacteria are measured each time the water is filled or exchanged.

WATER CHANGE SCHEDULE

1st Month : 5% change once every 15 days;

2nd Month : 5% change once every 10 days;

3rd Month : 5-10% change once every 7 days

4th Month : 5-10% change once every 5 days

PROCEDURE FOR WATER CHANGE

The process of water exchange starts by pumping water out of the treatment pond through the sand filter into the grow-out pond.

A paddle wheel aerator is operated at the outflow.

Pumping is continued until the water level in the treatment pond is 40 cm or lower.

The same amount of water in the grow-out pond is then pumped back into the treatment pond.

Increasing pond DO level

AERATION SYSTEMS IN THE GROWING PONDS

Surface aeration system: Operate the paddle wheel aerators at locations where there is a need to increase the oxygen and to circulate the water completely throughout the pond.

- Two sets of paddle wheel aerators should be operated during the 1st and 2nd month.
- The number of aerators is increased to 4 sets after the 3rd month.

Pond bottom aeration system: The system consists of an air blower and a parallel grid of perforated PVC pipes laid on the pond bottom with the perforations facing downward.

Mode of operation

- The paddle wheel aerators are operated only 50% of the time when the oxygen concentration in the pond is higher than saturation.
- The paddle wheel aerators are operated 100% when the oxygen concentration in the water is higher than 50% of saturation.
- The bottom aerators and the surface aerators are operated simultaneously when the oxygen concentration in the pond is lower than 50% of saturation.

Aeration within the treatment pond: The aeration system in treatment pond consists of one unit 2 HP paddle wheel aerator.

WATER QUALITY MAINTENANCE

Grow-out pond: Through out the culture project, the water parameters in the grow-out ponds should be maintained at the following levels:

Parameter	Level
Dissolved oxygen	>3.5 ppm
Total ammonia	<1.0 ppm
Nitrite	<0.2 ppm
Transparency	30-40 cm
pH	7.8-8.5
Alkalinity	>80 ppm
Oxygen demand	<0.2 mg O_2/l/hr
Total bacteria and *Vibrio* spp.	10^4 - 10^3 cfu/ml

Treatment pond: Through out the culture period, water parameters in the treatment pond should be controlled, using the following criteria:

Parameter	Level
Dissolved oxygen	>3.5 ppm
pH	7.8-8.5
Alkalinity	>80 ppm
Total suspended solids in the water	<20 ppm
Total bacteria and *Vibrio* spp.	10^4 and 10^3 cfu/ml

Common problems and their management

GROWTH LOWER THAN STANDARD

Improve and control the water quality, such as the pH, oxygen, ammonia and nitrite, to be within the optimum range.

FCR VALUE

If the calculated FCR is higher than 1.5, improve the efficiency and accuracy of the feeding quantity through a more careful monitoring of the feeding trays. The amount of feed increment should be controlled by lowering the rate of increase at 20-100%.

UNEQUAL GROWTH

Feed the shrimps with 2 sizes of feed pellet in the same meal by feeding bigger size pellets at 15-30 minutes prior to feeding of smaller size pellets, in order to increase the feed consumption rate of the smaller shrimps.

DIRTY BODY SURFACE AND ABNORMAL BEHAVIOR OR SYMPTOM

Start by decreasing the rate of feeding and improving the water quality. Water and shrimp samples are examined and diagnosed for possible unfavorable factors. If the shrimps are found to be infected with bacteria, use only approved and registered therapeutants following a recommended dosage and treatment duration. The therapeutants should be added to the feeds before the shrimps stop feeding. Records should be kept each time drugs or chemicals are applied. Antibiotics should not be applied when the shrimps are older than 2.5-3.0 months to prevent the occurrence of antibiotic residue in the body of the shrimps.

DECREASED FEEDING DURING CHANGES IN THE ENVIRONMENT OR AT THE MOLTING PERIOD

Decrease the feeding by 20 to 70% when suitable and add vitamin C or combined vitamins at 2-5 g/kg of feed until the environment returns to normal or becomes favorable.

PROBLEMS IN WATER QUALITY

Low oxygen level

- In case oxygen concentration is lower than 3.5 ppm, the number of paddle wheel aerators or the working duration of the aerators must be immediately increased.
- In case oxygen concentration is lower than 2.8 ppm, decrease the amount of feed during that period by 20-70%.
- In case oxygen concentration is lower than 2.0 ppm, feeding must be stopped until the oxygen concentration is raised to more than 2.8 ppm.

pH and alkalinity

- In case the pH and alkalinity are lower than the optimal level, carbonated lime must be added into the pond at 4 kg/rai (25 kg/ha) daily until the pH is raised to the desired range.
- If the pH and alkalinity in the pond are higher than the optimal level, stop the application of lime and water exchange.

Transparency

- If the transparency is lower than 25 cm, the rate of water exchange should be increased to a level higher than in normal conditions.
- If the transparency is higher than 40 cm and the phosphate level is low, 0-46-0 formulated fertilizer should be added at 1 kg/rai (6.25 kg/ha).

Ammonia and nitrite

- In case ammonia and nitrite concentrations are too high, the farmer must increase the efficiency and accuracy of the feed quantity estimate, increase the oxygen to more than 4 mg/l to accelerate the natural treatment process, and consider a decrease in the feeding quantity by 10 to 40% as needed.

Biological oxygen demand (BOD)

- In case the oxygen concentration is too high, paddle wheel aeration must be increased and try to manage so that the oxygen concentration is not lower than 3.5 ppm.
- In case the oxygen demand is too high, the efficiency and accurateness of the feeding quantity estimation and the aeration must be increased, while the feeding quantity should be considerably decreased at 10-40% as necessary.

Bacteria and *Vibrio* spp.

- In case the total bacteria and *Vibrio* spp. is too high, consider a decrease in the feeding rate and an increase in the water exchange rate, as necessary.
- In case of other related problems, immediate action must be taken and continued until the problem is solved. Chemicals should not be used, especially those with strong action and with long lasting residue. When problems are encountered, one must consider increasing the oxygen and exchange the water as necessary.

Water quality in the treatment pond

- In case oxygen is lower than 3.5 ppm, aeration should be considerably increased through the operation of the aerator.
- In case of low pH or low alkalinity, lime should be added to increase the alkalinity of the water.
- In case the sand bags clogged, these must be changed and cleaned. During the cleaning of the sand bags, recirculate the water into the treatment pond.
- When the efficiency of ammonia removal is decreased, increase the oxygen concentration in the grow-out pond.
- In case total bacteria and *Vibrio* spp. is too high, increase the aeration in the treatment pond and change the sand bags as necessary.
- When the treatment pond is highly loaded and the oxygen concentration is low, increase the aeration.
- If mortality of the fish or seaweeds occurs, increase the water circulation. If the water quality in the grow-out pond is in the optimal range or no problem has been encountered, stop adding water from the treatment pond into the grow-out pond. When the problem is solved, additional fishes or seaweeds should be restocked at the required amount.

Record keeping

TYPES OF DATA TO BE RECORDED

All production cost items such as the cost of shrimp fry, feed, lime, fertilizer, electricity, fuel, and all miscellaneous expenses both during the normal grow-out condition and during the occurrence of problems.

Production and farm management activities such as feeding, monitoring of feed consumption through the feeding trays, growth rate.

Daily monitoring data of the environmental parameters.

Daily shrimp health examination.

All other relevant information during crisis management.

MANNER OF RECORDING

The record must be categorized into items, must be clear and easy to read and understand so that they can be easily referred to when formulating future farm management plans.

All the activities should be recorded immediately after the termination of each action on a daily basis.

Harvesting

DATE OF HARVEST

Investigation should be done on selling price trends before harvesting, to ensure higher profit.

The shrimps must have reached marketable size.

The shrimp should have no antibiotic residue or the last antibiotic application should not have been done in the past 20 days before harvest.

HARVESTING METHOD

Water in the draining sump or in the artificial sluice gate operated at a corner of the pond is pumped into the treatment pond and the draining canal or in an empty grow-out pond.

While the water is being pumped out, a catching net is set at the water outlet of the sluice gate to harvest all the shrimps. This method is found to be very efficient resulting in fast harvest, fresh and clean shrimps without polluting the external environment.

MANAGEMENT OF EFFLUENT WATER AND SLUDGE

Sample of the effluent water is collected for examination at the tip of the effluent pumping pipe of the treatment pond.

If the BOD value is less than 10 ppm and the suspended solids and the chlorophyll ais less than those in the natural water, then the water in the treatment pond can be released into the natural water system.

The sludge at the bottom of the pond can be treated by drying and adjusting the pH and the moisture of the bottom mud to accelerate the complete decomposition of the organic matter.

Research team

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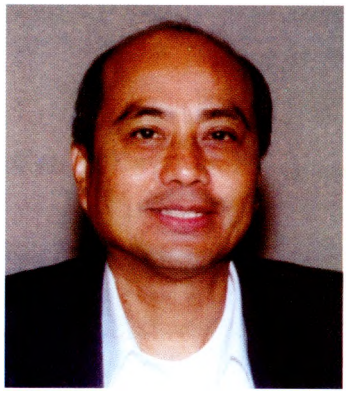

Mr. Siri Tookwinas is currently the Director of the Marine Shrimp Research and Development Institute, Department of Fisheries in Thailand.

He earned his Masters degree in Environmental Science from the University of Alberta, Canada in 1979. He attended the Kasetsart University in Bangkok for his Bachelors degree in Marine Science (1972).

Mr. Tookwinas has published several technical papers in refereed journals on a wide range of aquaculture subjects, including: cockles, shrimp, mudcrab, seabass, grouper and seaweeds, as well as studies on farming systems, water quality and effluents, coastal aquaculture and biotechnology.

Mr. Tookwinas has also attended several international workshops and seminars on various aspects of aquaculture. Among his official duties is to represent his country in several committees regarding fisheries held both locally and abroad.

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.