



MANGROVES OR AQUACULTURE? Why not both?

Eva T. Aldon, Rolando R. Platon and V.T. Sulit

This article briefly summarizes the techniques developed, verified and/or refined during the implementation of the Project on the Promotion of Mangrove-Friendly Shrimp Aquaculture in Southeast Asia, which was implemented by the SEAFDEC Aquaculture Department from 2000 to 2005. Conducted under the ASEAN-SEAFDEC FCG collaborative mechanism, the project which received generous funding from the Government of Japan through its JTF Program, aimed to develop sustainable culture technology packages on shrimp farming that are friendly to mangroves and the environment.

We have always been told to “regulate the cutting of mangroves for aquaculture.” But why cut when mangroves and aquaculture can co-exist? In fact, aquaculture could be done right in mangrove areas, as what the SEAFDEC Aquaculture Department (AQD) has done at its Dumangas Brackishwater Station in Iloilo, Philippines, which has a flourishing crab culture facility within the mangroves (Baliao et al, 1999; Baliao et al, 1999a). The same technology was adopted by the Government of Palau, courtesy of technicians from AQD seconded by the Government of the Philippines to the Government of Palau. The Government of Palau is also promoting the culture of mud crab in mangroves with least impact to the environment and the pilot activity is proving great potentials for future development (FAO SOWA, 2006).

The Project on the Promotion of Mangrove-Friendly Aquaculture in Southeast Asian Countries: Mangrove-

Friendly Shrimp Culture was aimed at developing sustainable culture packages on shrimp farming that are friendly to mangroves and the environment, and disseminating such packages to the region through actual demonstration and training. Conducted by AQD with funding support from the Japanese Trust Fund (JTF) Program of the Fisheries Agency of Japan, verification and pilot demonstration of intensive shrimp culture techniques were implemented in Thailand and the Philippines; verification and pilot demonstration of semi-intensive shrimp culture techniques in Vietnam, Myanmar, Cambodia and Malaysia; research at AQD’s pond facilities on capacity of mangroves to absorb nutrients and on the evaluation of probiotics/waste digesters used in shrimp culture; and research on the economic benefits of mangrove-friendly aquaculture (Fish for the People, Vol. 5 No. 3: 2007).

Training was also a major component of the project where a number of sessions were conducted at AQD and

on-site in Vietnam, Myanmar and Cambodia. Various publications were produced from the results of the project's verification and R&D activities including a manual on Best Management Practices for Mangrove-Friendly Shrimp Farming, originally in English and translated into Bahasa Indonesia (Melayu), Filipino, Thai, Vietnamese and Burmese languages.

The results of a study conducted under the Project focusing on the mangroves' capacity to absorb nutrients, indicated that mangroves exhibited higher growth rates in the presence of aquaculture effluents than those with no adjacent aquaculture activities. Primavera (2004) confirmed that mangroves can indeed remove significant levels of nitrogen and solid wastes from shrimp pond effluents. In another study also under the project, it was concluded that "waste water from shrimp farms observing good management practices has no negative effect on natural mangrove areas" (Sangrungruang, 2004).

What to do?

Primavera (2004) established the following information for the effective co-existence of mangroves and aquaculture:

- Maintain mangroves at an estimated 1.4–1.6 ha to process wastes from one hectare of intensive or semi-intensive shrimp pond. These estimates cover only the waste assimilation function and are therefore minimum levels. Do not use antibiotics and other chemical or biological inputs that may be harmful to mangrove organisms.



Results of the study also showed that Bruguiera gymnorhiza (right) has the highest efficiency on the water treatment. On the other hand, Avicennia alba (left) has the highest efficiency on the treatment of high nutrient waste (Primavera, 2004).

- Hold shrimp pond effluents for 6h or more in the mangrove wetland to reduce levels of nitrogen and solid wastes before discharge into the creek.
- Harvest mangroves partially (as branches of Avicennia, Sonneratia and other non-Rhizophoraceae) or as the whole tree (for Rhizophorea, Ceriops and other Rhizophoraceae) with replanting of the latter. For ponds that border a waterway (creek, river or shore), the mangrove treatment area can also serve as the 20-m to 50-m greenbelt required by law.

Simple Water Recycling Treatments

The Manual on Best Management Practices in Shrimp Farming developed by the Department of Fisheries of Thailand features various good management practices as regards shrimp farming in mangrove areas. One of the most practiced is the use of integrated physical and biological technology as effluent treatment system for treated water, which can be recirculated using a reservoir (Songsangjinda, 2004). The strategy was developed to reduce the water consumption in shrimp ponds by recycling the water and re-using it for succeeding culture operations. The JTF Project corroborated the technique demonstrated through the Manual for the verification study on the effect of shrimp farm effluents on the mangrove ecosystem. The study confirmed that effluent from shrimp ponds, which is usually turbid and enriched with organic nutrients, can be cleaned using the integrated physical and biological treatment system. The treatment, consisting of filter boxes and biological filtration using bivalves, fishes and seaweeds, has proved to be effective and can be used extensively in the process of recycling the water in the shrimp farms.

As discussed by Songsangjinda (2004), the shrimp pond system usually consists of a grow-out pond (35x90 m²) and a treatment pond (30x27 m²). A third pond is required to serve as reservoir for new water during the initial filling and to compensate for losses due to evaporation and seepage. The grow-out pond and the treatment pond are connected in order to allow the water to circulate from one pond to the other. A 0.7-ton capacity filter box is installed in the treatment pond. The filter box is perforated at the sides and bottom, and filled with bags containing sand, shells or pieces of broken corals. The inlet of the water supply pump is set in the middle of the bags containing the filter media. The treated water is pumped through the filter box into the grow-out pond when refilling of the water is required. The treatment pond should be efficient so that sediment reduction and water quality improvement is at least 20-50% better than that of an untreated pond.

The use of biological treatments, such as seaweeds, tilapia and oysters, can reduce luminous bacteria (lum bac) levels from 7.5×10^2 cfu/ml in the water and 1.0×10^1 cfu/g in the sediments, to zero. Lum bac infection is caused by *Vibrio harveyi*, originally reported in cultured shrimp and are now also devastating crab larvae. Lumbac disease outbreaks in the shrimp industry showed that the shift in husbandry and feeding practices led to ecological imbalance in the culture system. The Total N and P concentrations in the culture water can also decrease from 33% to 9%. The technique established by Golez (2004) is to culture oysters at the mouth of shrimp effluent discharge pipes and stocking the settling pond with tilapia and seaweeds to “clean” and maintain good pond water-soil quality. Biological filtration improves the water quality of pond effluents by removing suspended matters especially the particulate organic matters. However, fecal pellets produced by bivalves accumulate and decompose on the pond bottom. Seaweeds are therefore used to absorb the excess nutrients in the water produced by the decomposition. Songsangjinda (2004) also added that integrating filter with the biological filter has the advantage of removing organic wastes and dissolved nutrients in the water. Therefore, the waste water from shrimp ponds that are released to the receiving mangrove ecosystems is free from undesirable elements and hence, has no adverse impact on the ecosystem.

Seawater irrigation system

The Royal Project in Kung Krabaen Bay, Thailand has developed a seawater irrigation system (SIS) with the objective of minimizing some obstacles in shrimp farming, e.g., diseases, environmental impact, etc., as well as in conserving the mangroves while operating shrimp culture farms. In discussing the SIS, Sangrungruang (2004) and Ekamaharaj (Tookwinas) (2002) confirmed that the seawater irrigation system of Thailand is applicable in intensive shrimp farming. The system has been tried in Kung Krabaen Bay shrimp farms but is yet to be tried in other areas in the region. SIS is parallel to the irrigation system in agriculture (i.e., rice irrigation or other crop irrigation system) where one farmer draws water from one source (in the case of shrimp farming from a treated water source) for his farms. The discharge of the water will also be through a common outlet canal, to make sure that the water is treated before it goes back to the mangrove ecosystem or to the sea, as the case may be. The seawater irrigation system of Thailand aims to clean shrimp pond effluents and provide quality water for shrimp culture. The system also includes a rest canal for rearing water released from the shrimp ponds, as the water undergoes treatment before being further released into the sea or in this case

Box 1. Detailed Information on Thailand’s Seawater Irrigation System (SIS)

The SIS consists of:

Seawater Conduit

- The facility has six rows of high pressure high density polyethylene (HDPE) conduits, each having a diameter of 1.0 m, and buried under the sea at a distance of about 350 m offshore. These conduits deliver seawater to the pumping station onshore.

Water pumping station

- This is used to pump seawater from the underground storage located about 11 m deep. This station can store water up to 4650 m³ and can continuously drain water using eight 200-Hp pumps, each having a drainage capacity of 1.25 m³ of water/sec. Water flows in through two 1.0-m diameter HPDE conduits, into a stocking pond, which can hold water up to 3000 m³.

Water inlet canal

- Running a distance of about 8820 m, the water inlet canal delivers seawater to the shrimp culture areas. This concrete canal stores seawater from the stocking pond, before the water is finally released into the shrimp ponds by gravity.

Sub-distributory canal

- About 5 m wide and approximately 580 m long, the sub-distributory canal is used to receive and distribute seawater to farmers in the lower areas.

Secondary canals

- Separated from the main canal, secondary canals are necessary for delivering water to shrimp ponds since the shrimp culture areas are usually large.

The SIS also includes a wastewater system, which is necessary to treat discharged water. This consists of:

- The sludge-pond where suspended solids settle so that clear water flows into the water treatment canal
- The water treatment canals are supplemented with physical and biological treatment systems, with an aeration system consisting of 24 units 5 Hp mechanical aerators along the canals. Oysters are hung in the treatment canals to enhance the efficiency of the wastewater treatment before passing the water to the sedimentation canals.
- Sedimentation canals comprise seven local canals, where both sides of the canals lay along the mangrove forest areas. The canals receive discharged water from the treatment canals.

to Kung Krabaen Bay, Thailand. More information on the SIS is shown in **Box 1**.

Ekamaharaj (2002) emphasized that the SIS ensures good water quality for shrimp farming and responsible release of pond effluents. From the results of the study conducted in Kung Krabaen Bay under the JTF Project, it was confirmed that the effluents from shrimp ponds using SIS do not have adverse effects on the receiving waters especially on the mangroves, and more particularly in this case the mangrove ecosystems of Kung Krabaen Bay.

Cost and benefits of environment-friendly shrimp farming

The low discharge and recirculating shrimp culture technologies, verified in different sites in the ASEAN region (Philippines, Vietnam, Myanmar, Cambodia, Malaysia) under different climatic conditions as part of the activities of the JTF Project, are capable of achieving high productivity and return on investment (ROI). Baliao (2004) has established the ideal stocking density for shrimp farming based on Philippine experience, using the low discharge and recirculating culture technologies. The average net profit/hectare was recorded to be highest with stocking densities around 25 pc/m². The net profit/hectare for 25 pc/m² was 1.8 M while for 15 pc/m² was PhP 1.1 M. In 40 pc/m² stocking density, the average was PhP 0.6 M/ha whereas in 5 pc/m², it was PhP 0.57 M/ha. The high net profit was attributed to the high quality and uniform sized shrimps harvested with average survival rate of 95%. (Note: 1.0 USD = PhP 50.0)

In the low discharge system, a small amount of water is discharged from the grow-out pond and released to the sea after passing through the settling pond. Water is pumped only once, from the head reservoir to the grow-out pond. In the recirculating system, effluents from the grow-out pond are reused after passing through the treatment pond. Water is fully recirculated by pumping twice, first from the head reservoir to the grow-out pond, and second from the treatment pond to the grow-out pond. Discharges from shrimp ponds using environment-friendly farming practices do not affect the quality of the receiving waters or mangrove wetlands, hence requires no cost (Ekmaharaj et. al, 2000). The average annual investment in pollution management of the shrimp farming industry constitutes a significant portion—around 9% of the annual production cost and only 3-4% of environmental benefits that the environment-friendly shrimp farming practices would generate (Samonte-Tan and Cruz, 2006).

Following the concept of environment-friendly shrimp farming which has been promoted by SEAFDEC, intensive shrimp farmers from the region now employ a variety of progressive technologies and practices without necessarily felling mangrove forests. Among the most recent improvements include reduced stocking density, proper pond preparation, crop rotation, feed quality improvement, stocking of good quality fry, use of bioremediators and increased aeration, use of settling ponds, and adoption of biosecurity measures (Samonte-Tan and Cruz, 2007). Such efforts are aimed at reducing the adverse impact of shrimp aquaculture on the environment, and effectively integrating responsible shrimp farming in mangrove conservation.

Samonte-Tan and Cruz (2006) further estimated that the opportunity cost for not utilizing environment-friendly shrimp farming practices in terms of pollution damage to the fisheries could be PhP740,000/ha and PhP44,000 to human health. On the other hand, the environment friendly shrimp farming practices generate net economic benefits to the economy as a whole for they increase the economic value of mangrove habitats in supporting fisheries.

Code of Practice for Sustainable Use of Mangrove Ecosystems for Aquaculture in Southeast Asia

Mangrove ecosystem has always been nature's best gift to the peoples of the ASEAN region. But in the past, peoples have regarded mangroves as wetlands to be converted into more useful and productive areas. Thus, large areas of mangrove forests in the region have been clear-felled and converted into many ways for food, fuel, timber and even for foreign exchange. The mangrove ecosystem has also been exploited for human and industrial settlements, infrastructure development as well as aquaculture as means of livelihood. It can not be denied that mangrove-associated aquaculture specifically shrimp culture, has provided economic benefits to a wide range of stakeholders in the ASEAN region. However, most of such aquaculture ventures have resulted in severe environmental degradation and socio-economic problems due to irresponsible and poor culture management practices and the lax enforcement of environmental regulations. Thus, the JTF Project has campaigned for the adoption of better aquaculture practices that are compatible with mangrove ecosystem conservation and management.

As an outcome of the JTF Project, AQD published in 2005 the "Regional Code of Practice for Sustainable Use of Mangrove Ecosystems for Aquaculture in Southeast Asia" to specifically address **Article 9.1.3.4** of the **Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Aquaculture** which states that "Given the importance of mangroves, States and regional institutions should prepare regional guidelines for the responsible use of mangroves for aquaculture." The Code also aims advance to the ASEAN region the need to "promote good farm management practices that reduce effluent pollution load and comply with relevant effluent standards through appropriate treatment" as specified in **Section B.3** Aquaculture of the **Plan of Action for Sustainable Fisheries for Food Security for the ASEAN Region** adopted in 2001.

Through the Code of Practice, SEAFDEC continues to enjoin the aquaculture sector and all other users of the mangrove ecosystem to be responsible stewards of this gift

of nature as the payback is food security and sustainable livelihoods. After all, mangrove ecosystem is like a “big bank account” containing big capital and earning big interests. As responsible recipients of this gift of nature, countries in the region are encouraged to adhere to the provisions in the Code of Practice by using only the “interest” (new growth of mangroves through reforestation) and leave the “capital” (the original mangrove ecosystem) in tact.

Way Forward

Shrimp aquaculture, which has always been associated with mangrove loss and destruction, has contributed much to the ASEAN region’s economy. Thus, shrimp farmers from the region have been steadily emboldened by the Code of Practice, for them to institute the sustainable use of mangroves including the operation of aquaculture systems integrated in more or less intact mangrove ecosystem in place of newly-felled mangrove forests. Moreover, with technologies already developed, refined and verified, shrimp aquaculture can after all be compatible with mangrove ecosystems provided better farm management practices are adopted.

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About the Authors

Ms. Eva T. Aldon is a Researcher of the SEAFDEC Aquaculture Department in Tigbauan, Iloilo, Philippines.

Dr. Rolando R. Platon, Ph.D. was the former Chief of SEAFDEC Aquaculture Department (1996-2006). After SEAFDEC, Dr. Platon joined the private sector, where he is involved in the development and management of projects in aquaculture and other related areas.

Ms. Virgilia T. Sulit is a Member of the Editorial Team for Fish for the People. She is based at the SEAFDEC Secretariat in Bangkok, Thailand.