Sustainable Alternatives of Shrimp Aquaculture

Early Sustainable Aquaculture

Aquaculture traces its roots back thousands of years. Local farmers and fishers have cultured fish, mollusks, and crustaceans for generations, using traditional methods and local ingenuity to improve their living conditions through **low-intensity** aquaculture.
Though these systems produced low yields, production was sufficient to meet the needs of local residents. Such early systems are still practiced by many indigenous coastal peoples. But newer, more intensive systems of aquaculture have recently overshadowed the traditional forms, and actually threaten these earlier systems.

Working Models for Sustainability

We offer sketches of **3 models** for sustainable shrimp production:

- two models from traditional aquaculture
- one model involving intensive technological and capital inputs

These forms of shrimp aquaculture are all currently being practiced in areas of the world today, and they all appear to meet most, if not all of the **criteria for sustainable shrimp culture**:

1. maintain the integrity of affected ecosystems;
2. equitable balance with natural resources and resource-users of affected coastal zone;
3. structured to promote social and economic equity within and between nations; and
4. economically viable.

Traditional Extensive Systems

Some traditional shrimp aquaculture methods have been practiced sustainably on a small-scale for thousands of years. These systems are low-intensity, usually sustainable systems which depend on **diurnal tidal inundations** to supply the larval shrimp and all of their food nutrients to the ponds.
The ponds are usually relatively small, and often placed within the mangrove forests. Since mangroves also serve as natural shrimp nurseries, there are sufficient supplies of shrimp larvae to naturally stock the ponds.
Excavation of shallow ponds among the mangroves allows a containment area for juvenile shrimp to mature and requires little maintenance. Stocking rates are less than 10,000 fry per ha (<1 per m^2). These are usually polyculture ponds, containing finfish, such as milkfish, in combination with shrimp. **Yields are low**, perhaps less than 500 kg per ha per annual harvest, but this provides additional supplemental income and protein source to make such production worthwhile. Traditional pond production mainly satisfies local consumer needs, and very little product is exported (reference).

MODEL 1. Indonesia's traditional "Tambak" System

The tambak system combines rice paddy production with finfish and shrimp aquaculture. The fish and shrimp are reared in the rice paddies after the rice has been harvested.
The constructed dikes, which usually separate and protect the paddy from the incoming tides, are intentionally breached so that sea water can enter at high tide. Larval fish and shrimp are

captured and reared to maturity. After the fish or shrimp are harvested, the paddies are reconverted in preparation for the next rice crop.
This production system traces its roots back many hundreds of years, and may be one of the earliest forms of aquaculture practiced in Asia.

MODEL 2. The Gei Wai System

Another traditional aquaculture system evolved in Hong Kong, perhaps centuries ago. Gei Wais basically utilize the positive attributes of natural mangrove forests as nursery and breeding grounds for fish, crabs, mollusks, and shrimps. Wide channels, around 1-3 m in depth, are excavated around what becomes a small island of healthy mangrove forest.
The channels allow the several hectares or more of each Gei Wai pond to hold sufficient waters at low tides to sustain the captured shrimp and fish. At high tides renewed sources of nutrients enter the ponds through constructed sluice gates to sustain pond life anew. Up to 1900 kg of shrimp can be raised and harvested annually from one Gei Wai.
In the mid-1990's, there was only one remaining area of Hong Kong, called Mai Po, which borders Deep Bay, where gei wais were still found. These few remaining gei wais are protected as a nature reserve by the Hong Kong Government. Mai Po continues to serve as an important site for long-distance migratory birds and wildlife.
The World Wide Fund for Nature Hong Kong has managed this site since 1984, utilizing the sale of its harvested shrimp to help subsidize the expenses involved in site management. One of the greatest recent threats to the Mai Po reserve and its gei wais is the intrusion of mounting water pollution from mainland China. Fish and shrimp varieties and populations have already declined.

Viability of Traditional Systems

Can these traditional systems be viable at the commercial scale of shrimp aquaculture enterprises? Perhaps not. It must be noted, however, that shrimp aquaculture operations themselves are often out of scale with the multiple needs and users of the natural resource base which they depend upon. Some research indicates that the eco-cultural principles which traditional methods are based on can be successfully adapted to larger-scale operations.
MAP is aware of efforts in Thailand, the US, Ecuador, and Brazil to diversify aquaculture production, whereby two or more mutually compatible species are cultivated in a particular pond. Some shrimp ponds are trying to improve their water quality by introducing seaweed and mollusk culture within the drainage canals of the pond complex to remove nutrients and pollutants before the water is discharged.
In Vietnam, prawn farming, which partly serves an export market, also integrates rice production and garden cultivation for local markets. In areas where shrimp production has suffered from widespread disease, the industry has sought to diversify their crops. These are all good first steps, but increased efforts are needed.
MAP believes that given adequate research and testing, the traditional models can offer important principles, like those outlined above, for sustainably farmed shrimp production at the commercial level.

Modern Systems

MODEL 3. Closed-System Shrimp Aquaculture

In the US, Thailand, and other countries where industrial shrimp aquaculture is being competitively pursued, a new alternative method is being lauded as more sustainable. This is the so-called "closed production system" approach. The aquaculture industry has itself been wrestling with those many insurmountable problems inherent in the so-called "open production

systems." This stems from the fact that these present-day methods of shrimp aquaculture still pollute and degrade their surrounding environments, while at the same time depending on a healthy state of natural resources to maintain their own production. This reliance on the health of the external environment, such as the sea and fresh water sources, while at the same time degrading these very vital supporting systems with massive amounts of toxic effluents, classifies these self-degenerative open-cycle production schemes as "throughput systems."

The "closed-system" potentially eliminates many of the obvious failures of the modern "open-production system," by operating in a more environmentally "friendly" fashion. Recirculating production pond waters, which remove toxins from these fouled waters, is one step in the right direction. Recycling of the effluent waters emanating from the production ponds can be done in various ways, ranging from complex and costly water filtration systems to establishment of settlement ponds, or integrated secondary containment ponds.

High technology closed systems are being tested now with some hopes for success. Taking the closed system to its ultimate levels has led some ambitious aquaculturists to set up facilities within a fully contained facility, where all levels of the shrimp production operation take place indoors. Such large enclosed facilities are in operation in Texas, Florida, and Virginia, among other locations.

There is hope that innovative closed-system aquaculture enterprises succeed, where the open-cycle systems have so miserably failed. Water quality is obviously a major concern of any aquaculture facility, and elimination of antibiotics, pesticides, and fertilizers will help alleviate one of the major contributing factors leading to water quality declines during production. Improved feeds and feeding regimes are also important considerations in water quality control, as is regular careful monitoring and assessment of the internal pond environment.

Integrated aquaculture techniques are also proving promising for semi-closed production methods. In some ponds, oysters and other shell fish, fin fish, and seaweeds are being cultivated either together with the shrimp, or in separate but interconnected ponds. The recycling shrimp pond water provides many nutrients for the other cultured species, which in turn can filter out a lot of the particulate matter and pollutants, thus helping to purify the fouled waters. For example, oysters can filter up to 50 gallons of water per day. Thus, they can potentially aid considerably in absorbing the excess organic substances in the ponds.

In addition to the ecological advantages of an organic, closed-system approach, the pond operator can actually stagger harvests and sizes to produce whatever the current market demands on a year round basis. While the initial financial risk is steep, the closed-system eliminates many of the production risks that are beyond the control of most shrimp farm operators, such as pollution and disease from coastal water exchange, natural predators, weather peculiarities, and the side effects or long-term effects of medicinal additives such as synthetic antibiotics. These drawbacks are increasingly unappealing to consumers who want to know how their food is produced.

One great disadvantage at present is the very high startup costs for a fully integrated and enclosed facility. These high-tech and capital intensive systems cannot replace in importance for developing nation coastal communities the more labor intensive and sustainable traditional systems, which have served local consumption needs for generations. Such closed-systems, however, hold great potential to one day fill the current outside market demands of those numerous shrimp importing nations, especially when today's consumption demands far outweigh the current ability of the industrial aquaculturists to produce enough shrimp in environmentally and socially friendly ways.

More information can be found at: http://www.mangroveactionproject.org/issues/shrimp-farming/sustainable-alternatives-of-shrimp-aquaculture