ICLARM and South-South Technology Transfer: Philippine Aquaculture Technology and Indonesia

Part II

BARRY A. COSTA-PIERCE
MARY ANN BIMBAO
ICLARM

SUTANDAR ZAINAL
Environmental Group
Indonesian State Electric Company (PLN)
Jl. PHH Mustafa 55
Bandung, Indonesia

PEPEN EFFENDI
West Java Provincial Fisheries Agency
Technical Management Unit - Saguling and Cirata
Jl. Wastukencana 17
Bandung, Indonesia

In Part I we described the benefits that Java tilapia *(Oreochromis mossambicus)* brought to Indonesia in the 1940s and 1950s, and its subsequent loss of popularity; and how the introduction of Nile tilapia *(O. niloticus)* has not led to a thriving industry as in the Philippines.

The Philippines has much experience developing low-cost tilapia aquaculture technology that could be directly implemented in Indonesia. Filipino experiences in development and management of small-scale tilapia hatcheries could provide a profitable alternative crop to small farmers, and assist in supplying seed fish to the rapidly-growing lake and reservoir cage culture industry in Indonesia.

Low-Cost Aquaculture Technology

To complement Indonesia's existing knowledge of tilapia aquaculture, a study tour for Indonesian scientists cooperating with ICLARM in the "Indonesian Reservoir Project" (See Naga, Jan. 1987, p.9) was organized. Staffers of the aquaculture program organized and arranged the tour of ICLARM from 2 to 11 December 1987.

The group visited eight widely differing operations surrounding and floating in the Philippines' largest freshwater lake, the 90,000-ha Laguna de Bay. They also attended a workshop at Central Luzon State University on "Reservoir Fisheries Development and Management."

Two distinct types of tilapia hatcheries are present in the Philippines: the *hapa*, or "floating" hatcheries, and "backyard pond" hatcheries. Although much has been published about these systems, especially by ICLARM[a], the opportunity to see the systems first hand, and to converse informally and directly with farmers in the format of an "international picnic" was invaluable.

Government Tilapia Hatcheries

Under the Laguna Lake Development Authority, ADB-OPEC funded the Laguna de Bay Fishpen Development

Roger S.V. Pullin

The Laguna de Bay Fishpen Development Project (LBFDP) uses a system of breeder *hapas* (floating hatcheries).

[a]e.g., Smith, I.R., E.B. Torres and E.O. Tan, Editors. 1985. Philippine tilapia economics. ICLARM Conference Proceedings 12, 261 p.

Jose Noel Morales

Fish farmers of Bay, Laguna stock 1,000 breeder fish and, in 45 days, harvest about 30,000 fingerlings from each pond.

Project (LBFDP) to improve the socioeconomic conditions of small-scale fishfarmers by developing and demonstrating to them appropriate technologies in fish pen and fish cage operations. LBFDP, which has a 32-ha hatchery/nursery complex for Nile tilapia, milkfish, common carp and bighead carp in Bangyas, Calauan, Laguna, also aims to provide enough fry and fingerlings for growout and, in effect, ensure a continuous fish supply for consumption in the region.

At the LBFDP complex, 308 outer *hapas* of 3 x 5 x 1.5 m are suspended in a 1-ha pond. LBFDP uses a system of 2 x 5 x 1.5 m breeder *hapas* contained as "inserts" in each outer *hapa*. The inner *hapas* or breeder cages are of mesh size 8, while the outer *hapas* are of fine mesh. These units are suspended 30-50 cm off the bottom of a 1-m deep pond. Each breeder *hapa* is coupled to an adjacent 3 x 5 x 1.5 m nursery *hapa*.

During the field visit in December 1987, the practice was to scoop 15-day-old fingerlings directly from the breeder *hapas* into the adjacent nursery *hapas*. Each breeder *hapa* was equipped with a metal frame to hold the net bottom rigid so that female tilapia could easily pick up eggs fertilized on the net bottom for mouth incubation. During a follow-up visit in September 1988, instead of scooping out the fingerlings, the breeder or inner *hapas* were taken out and transferred to adjacent *hapas* of 3 x 5 x 1.5 m. Here, the breeders were allowed to spawn again for 15 days and the procedure repeated. The remaining 15-day-old fingerlings were reared for another 15-30 days until they were sold to private buyers.

The inner *hapas* are stocked with 51 breeder fish which weigh an average of 100-200 g in a 2 female : 1 male ratio. Fry appear 2-5 weeks after breeders are stocked and can get refuge from aggressive males in the outer *hapas*. Broodstock are fed 3% while fingerlings are fed 10% of their body weight/day of a formulated feed composed of copra meal, fish meal and rice bran mix.

Barry A. Costa-Pierce

Each breeder *hapa* was equipped with a metal frame to hold the net bottom rigid so that female tilapia could easily pick up eggs fertilized on the net bottom for mouth incubation. Here a *hapa* is lifted to show the metal frame.

Each breeder/nursery *hapa* combination produced an average of 4,500 fingerlings every 45 days. With 110 breeder nets in a 1-ha pond, average production is 495,000 fry every 45 days.

The income of LBFDP comes from the sale of tilapia fingerlings, breeders, table-size fish and fish feed. For fingerlings, price/fish is ₱0.10 for size 22, ₱0.15 for size 17 and P0.20 for size 14 (US$1 = ₱21). Production cost/fish is ₱0.05, ₱0.08 and ₱0.10, respectively. A profit of ₱1 is realized in each sale of a 60-80g breeder sold at ₱2. Table-size tilapia averaging 110 g sell at ₱20/kg with a production cost of P13.53/kg. The feedmill plant of LBFDP has a capacity of producing 2.5 t of feed per hour. Pelleted feed for breeders sells at ₱5.35/kg, ₱4.80/kg and ₱4.00/kg. Production costs/kg are ₱4.47, ₱4.50 and ₱3.35, respectively. Supply and maintenance of good quality broodstock are the major problems, according to production manager Angel Garcia.

The Freshwater Demonstration Fish Farm (FDFF), located at Sto. Domingo, Bay, Laguna, is a hatchery/growout farm for Nile tilapia, *O. aureus* and some species of carp. It was established in 1966 under the Philippine Department of Agriculture. Orlando Comia, the officer-in-charge of the station, said that their Community Improvement Development Program is supporting 260 families, or 98% of the farmers in the village who are breeding tilapia. The activities of FDFF have helped uplift the economic conditions of the residents. In 1976, people were barely able to provide three meals/day; but now, with tilapia-growing, some families can send their children to college. Moreover, a marked improvement is seen for the tilapia hatchery cooperators in the village such as remodelling of bamboo homes to adobe and the purchase of refrigerators, television sets, stereos and other appliances.

At the station, 680-m^2 ponds are stocked with four breeders per m^2 using a 3 female : 1 male ratio. The ideal water level when stocking breeders is 45-60 cm. The ponds are fertilized with a basal application of 1,000-3,000 kg chicken manure/ha with 100-200 kg urea/ha. Preparing the pond involves applying chicken manure and, after a week, urea. Chicken manure is applied by broadcast method; while urea is placed in a sack suspended in the water. This procedure of fertilization ensures that urea is efficiently used for plankton growth and not just lost in the water. After 4 months, about 150,000 fingerlings are harvested using a beach seine.

The station targets a yearly production of 7.5 million fingerlings, half of which are dispersed in Laguna de Bay for sustenance farmers. The rest are sold or are given to the heads of the towns and provinces who distribute the fish to small-scale fish farmers in their areas.

For fish farmer cooperators, 200-m^2 tilapia breeding ponds are particularly popular. Farmers stock 1,000 breeder fish (200 males and 800 females) and harvest about 30,000 fingerlings in 45 days from each pond. Capital costs for pond construction and nets range from ₱900 to ₱1,000, while operating costs range from ₱200 to ₱300 per year. Fish farmers at Sto. Domingo, Bay, earn ₱2,000 to ₱3,000 in 45 days.

Private Tilapia Hatcheries

Aquatic Biosystems is a 2.7-ha private Nile tilapia hatchery farm at Bay, Laguna, managed by Luzviminda and Rafael Guerrero. Established in 1979, the farm has perfected the sex-reversal technique for tilapia and improved breeding methods using *hapas*. Breeder fish are stocked at 4 per m^2 at a 3 female : 1 male ratio and fry are collected from the perimeter of the pond each morning. Fry are graded by using a series of hand nets of different mesh sizes, and the smallest fish, from 8 to 11 mm, are kept for sex reversal. Larger fry are put in separate *hapas* for growout since these fish are usually males. The fry kept for sex reversal are stocked at 100 per m^2 in 1 x 3 x 1 m "treatment" *hapas*.

Rafael D. Guerrero

To segregate the smallest fish for sex reversal, fry are graded using hand nets of different mesh sizes.

Barry A. Costa-Pierce

At a pond hatchery in Pillilia, Rizal, a farmer walks around the pond with a fine mesh scoop to harvest fry schooling at the pond edges.

Sex reversal is conducted in 200-300 m^2 ponds over a 21-day period. Three days after grading, fry are fed hormone-laced (methyl testosterone) feed at a concentration of 30 µg/g feed at 20-30% of their stocked body weight/day. After 21 days of treatment, the fry are sold. Sex reversal is 95-100% successful.

Breeder ponds are treated with a 5:1 mixture of lime: 21-0-0 ammonium sulfate at a low water level (10 cm water level) for 24 hours to poison competitors before breeders are stocked. Ponds are then filled to 50 cm and breeders stocked. Chicken manure is added every 2 weeks at a rate of 1,000 kg/ha. If a heavy plankton bloom appears that could compete with the hormone-laced feed, breeders are moved to another pond or feeding rates are increased.

Monthly sales of treated fingerlings range between 40,000 and 200,000 at ₱0.25/fish. Untreated fish sell for ₱0.15 each. Hormone-enriched feed is sold at ₱75/kg including a complete package of "how-to-do-it" technology. A 10-g bottle of methyl testosterone was said to be adequate for reversing the sex of three million tilapia fry. The hormone is mixed in ethanol before being applied to 20 kg batches of feed (30-35% protein). The feed is then air dried for 10-12 hours.

Fish farmers report that sex-reversed fingerlings reach a marketable size after only 4 months rather than 6 months which is the average for tilapia in Laguna de Bay and other fishponds in the region.

Jo-Anne's Farm is a small-scale and progressive tilapia pond hatchery in Pillilia, Rizal. Joe Capistrano, who has been in the business for 8 years, started with only two ponds of 400 m^2, but now has developed 0.2 ha out of his 0.5 ha to meet the increased demand for fingerlings. The farm has 5 breeding ponds of 400 m^2 and 2 nursery ponds of 40 m^2.

The hatchery ponds are stocked with 1,000 breeders (said to be hand-sized), 200 male and 800 female *Oreochromis niloticus*. Breeders are fed 2 kg of rice bran a day in two equal feedings. Six times each day, the farmer walks around the pond with a fine mesh scoop to harvest fy schooling at the pond edges.

Fry are stocked into a four-stage series of "nursery *hapas*" staked in 1-m deep, 400-m^2 ponds. Nursery *hapas* are out of the following sizes: stage 1, 1 x 2 x 1 m; stages 2 and 3, 1 x 3 x 1 m; stage 4, 1 x 5 x 1 m. In one pond, the farmer has staked nine nursery *hapas*. New fry spend 3 days each in stage 1 and 2 *hapas*, two weeks in stage 3 *hapas*, and 1 week in stage 4 *hapas*. Fingerlings coming out of stage 4 *hapas* are approximately 1 month old. Production ranges from 1,000 to 5,000/day of 3-day-old fry from each of the five breeder ponds.

Two 20-kg sacks of chicken manure are added to each pond at the time of stocking breeders and whenever the water color "turns brown." Fry and fingerlings are sold at the following ages and prices: stage 1, 1-3 days old, ₱0.08/fish; stage 2, 6 days old, ₱0.09/fish; stage 3, 2 weeks old, ₱0.10/fish; and stage 4, 1 month old, ₱0.15/fish.

Epilogue

Armed with this information, the study group returned to Indonesia and began experiments in Saguling Reservoir, near Bandung. They are using *hapa* hatcheries and holding broodstock and growout fingerlings in floating cages. The technology is showing great potential for reaching poor farmers who have little land or capital but adequate water and, in many cases, access to irrigation. ●

Macrobrachium rosenbergii from a trial pond.

A local species of *Macrobrachium*.

PRAWN CULTURE IN GHANA

A *Macrobrachium rosenbergii* Trial*

CHRIS GORDON
Research Fellow
Volta Basin Research Project
University of Ghana
Legon, Accra, Ghana

The world annual production of prawns and shrimps is currently about 1.8 million t, of which 120,000 t are contributed by aquaculture. Projections indicate that over 2 million t will be required to satisfy the world market by the year 1990. Prawn production from capture fisheries is close to its maximum sustainable yield, and as such, the projected shortfall of over 200,000 t will have to be made up for by culture. This implies that the aquaculture production must increase threefold in the near future.

The high demand for prawns and shrimps makes their culture a lucrative business. It is thus not surprising that interest in aquaculture has been growing in Ghana. Ghana has been increasing its shrimp exports each year since 1984, when it entered the export market (Fig. 1). The entire production comes from capture fisheries along the coast and in the streams and rivers of southern Ghana.

In the marine environment, two shrimp species are most commonly caught, *Penaeus notialis* and *Parapenaeopsis atlantica*. In freshwaters the fishery is based on a number of prawn species, *Macrobrachium felicinum, M. raridens, M. macrobrachium* and *M. vollenhovenni*.

It is on this last species, *M. vollenhovenni* that most local research on prawn culture has concentrated. *M. vollenhovenni* is considered to have the greatest potential for cultivation among local pond adapted species, based on the large size obtainable (up to 16.7 cm) and the number of eggs per female (7,000 to 38,000). Another advantage this species offers is that it can complete its life cycle in purely freshwater habitats.

At present, prawns are grown in a few ponds and dams around Accra without any true attempt at management. Difficulties in transport, feeding and harvest stem from a lack of knowledge on the biology of the species. Research on the species is being conducted by staff of the Volta Basin Research Project and the Institute of Aquatic Biology, Council for Scientific and Industrial Research. The pace of work is slow due to lack of funds and resources.

Research on *Macrobrachium rosenbergii* has progressed rapidly and sufficient data have been collected for its use as a culture organism on a commercial scale. In 1983, a Swedish firm, Aquamat, entered into pilot projects on *M. rosenbergii*. The firm wanted fish farmers to try out the species under local conditions and supplied juveniles to encourage participation.

The following account reports the results of a 3.5-month grow-out trial on *M. rosenbergii* in a farm pond with water at temperatures of 30-33°C. The pond had an area of 15 m^2, mean water depth of 0.8 m and maximum depth of 1.3 m. It was fenced with 1.3 cm mesh wire fencing.

The pond was stocked with 250 postlarval juveniles flown in from Sweden and seeded in the pond. As the pond had been filled and manured some weeks before stocking, no food was supplied to the prawns for the first two weeks. After this, the prawns were fed corn waste and wheat bran. No animal protein was added to the diet.

Growth was monitored by netting, but this proved futile. At the end of the trial period, the pond was harvested by pumping it dry and hand-picking the prawns from the pond bottom. The results of the trial are presented in Fig. 2. The graph shows that 70% of the prawns had achieved lengths of over 13 cm (rostrum to telson) and wet weight of over 35 g. This compares favorably with the growth rates achieved in other parts of the world. It can be seen that culture of *M. rosenbergii* is viable in Ghana.

The problem that prevents further development of this species is that fish farmers lack foreign exchange to purchase juveniles. A possible solution is to find start-up capital and repay the initial investment from export of prawns. The other alternative to prawn farming, i.e., starting an intensive study of local species, is also hampered by lack of hard currency for basic equipment. We are trying to reduce this problem by using local materials as much as possible.

Thus, prawn culture in Ghana follows two approaches: the immediate culture of exotic species on one hand, and on the other, the study of the biology of local species for the long term. ●

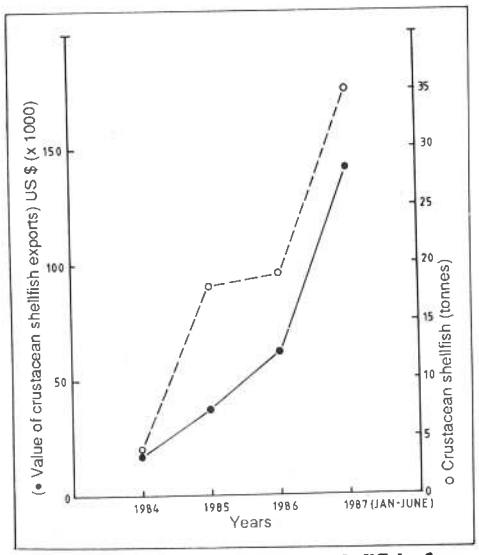

Fig. 1. **Exports of crustacean shellfish from Ghana.**

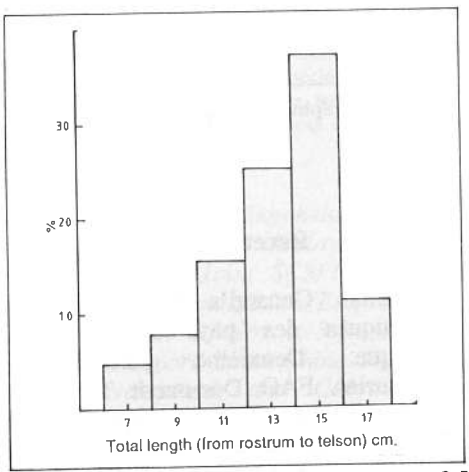

Fig. 2. **Size of *Macrobrachium rosenbergii*, 3-5 months after stocking as postlarvae.**

*This paper was prepared in honor of the late Dr. S.K. Prah of the Institute of Aquatic Biology, Council for Scientific and Industrial Research.