Since the manure load used was 100 kg fresh manure/ha/day or 10 g/m²/day in a period of three months (fish culture period duration), the total manure load is 45 kg/50 m² pond (average size of pond). It was difficult to measure the manure output of ducks. However, the data from Woynarovich (1979) was adopted wherein an output of 6 kg manure/duck was observed over a seven-week period of study, which was equivalent to 11.7% of LW of ducks.

The optimum size based on the 100 kg/ha/day manure load is two pigs per 400 m² or 53 heads per hectare which is comparable to the integrated pig-fish system by the Central Luzon State University in Muñoz, Nueva Ecija, Philippines of 50 heads per hectare. Furthermore, the optimum size of two pigs per 400 m² should be supplemented with 10 ducks based on the total manure output of pigs and ducks.

Reference

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Improvement of Traditional Shrimp Culture in the Mekong Delta

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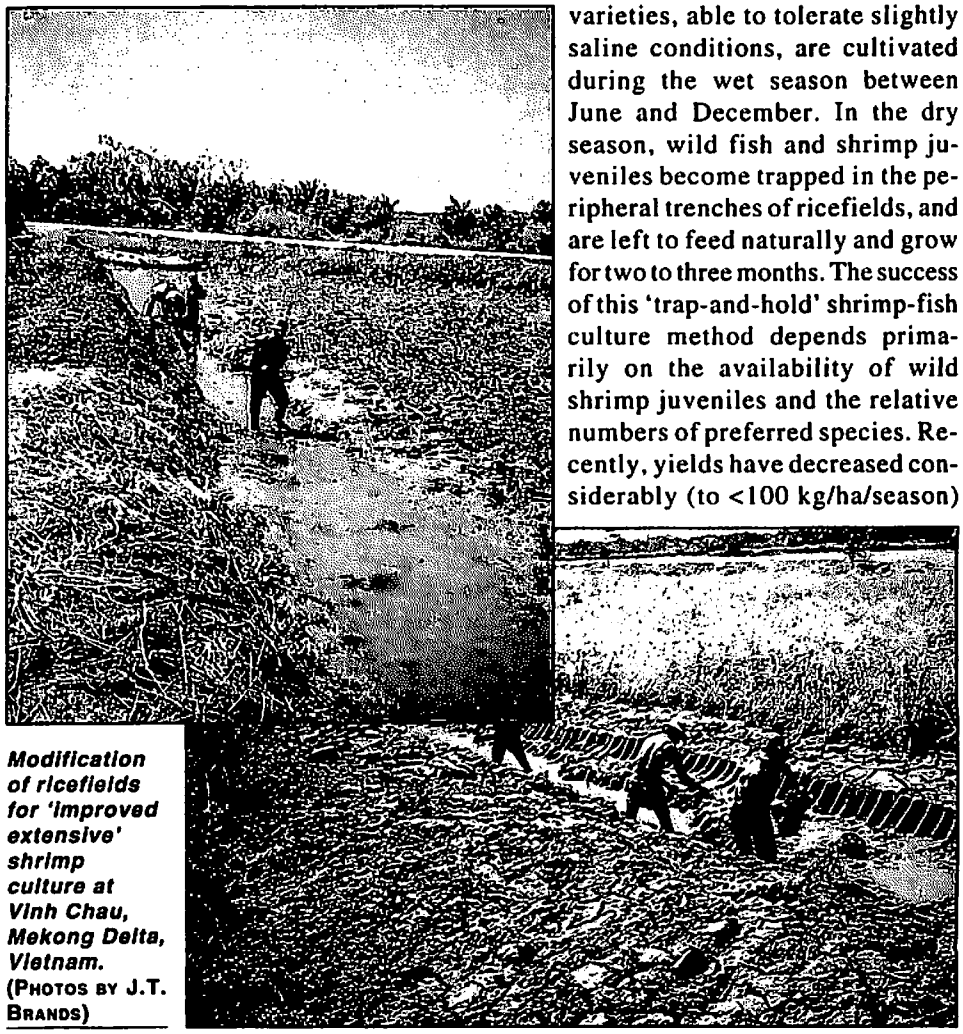
Introduction

In Vietnam, most shrimp farms are 'extensive' and are run by resident small-scale farmers. Yields are about 100-150 kg/ha/crop. Shrimp culture provides employment and income, contributes to improved living conditions for the coastal population and generates foreign exchange - very important for the national economy. The environmental conditions in the Mekong Delta are good for shrimp farming. Most production takes place in two agroecological zones: permanently saline coastal marshland, mangroves and salt works; and seasonally brackishwater areas. Promotion of shrimp farming in the permanent saline area has accelerated mangrove clearance, with expected negative effects on other forms of coastal aquaculture and on capture fisheries. This short paper discusses improvements to traditional brackishwater shrimp culture.

Traditional Shrimp Farming

Traditional shrimp farming in seasonal brackishwaters is based on rotation of rice and shrimp.* Local rice varieties, able to tolerate slightly saline conditions, are cultivated during the wet season between June and December. In the dry season, wild fish and shrimp juveniles become trapped in the peripheral trenches of ricefields, and are left to feed naturally and grow for two to three months. The success of this 'trap-and-hold' shrimp-fish culture method depends primarily on the availability of wild shrimp juveniles and the relative numbers of preferred species. Recently, yields have decreased considerably (to <100 kg/ha/season)



Modification of ricefields for 'improved extensive' shrimp culture at Vinh Chau, Mekong Delta, Vietnam. (PHOTOS BY J.T. BRANDS)

*(See also Naga 15(2):24-29; 16(4):18-21. *Ed.*)

due to a strong decline in the presence of wild seed. Furthermore, market prices for small-sized shrimp have fallen to less than 14,000 VD/kg (US$1 = 10,600 Vietnamese Dong, July 1993). As a result, the income for many rural households has decreased. Alternative sources are virtually nonexistent.

Towards Improvements

To attempt to change this situation, a technical support program has been implemented based on a so-called 'improved extensive' shrimp culture method, as previously developed and tested by the Artemia and Shrimp Research and Development Center (ASRDC). The program focuses on: 1) the use of hatchery-produced postlarvae (of *Penaeus monodon* and *P. merguiensis*), nursed for three to four weeks; and 2) the application of low-cost pond management practices, including predator control, supplementary feeding and frequent water renewal. 'Improved extensive' shrimp culture requires capital to modify the ricefields and to purchase inputs such as shrimp juveniles, feeds, materials for gates, etc. Therefore a credit program, managed as a revolving fund was made available. The program was implemented in the district of Vinh Chau, in Soc Trang province. The farming community in this area is characterized by a high percentage of ethnic minorities, mostly Khmer. The average annual income of a household is estimated at US$400-600.

In the first year, 21 farmers participated, with total area for shrimp production of 34.5 ha; enlarged during the second year to 90 farmers with 106.5 ha. Farmers were selected taking into account their available land and its characteristics (especially soil type and access to suitable water), skills and experience, motivation and means. They were organized into groups. Group representatives took the responsibility to collect elementary data, and were visited fortnightly by two ASRDC extensionists. A dialogue among participating farmers was encouraged through the organization of group meetings before and after each production cycle.

Farming Practices

The farmers excavate peripheral trenches to provide shelter for the shrimp at periods of low water levels and high temperatures. The removed soil is used to heighten the dikes. Fields are usually in the order of 1.0-1.5 ha, with trenches 3-5 m wide and 0.8-1.0 m deep. Water inlets and outlets are screened with bamboo and mosquito netting. Before stocking, the field is treated with Derris root to eliminate predatory fish. Shrimp juveniles are stocked at 1.0-1.5/m^2. Application of fertilizers is hardly necessary because of the high fertility of the incoming water. Supplementary feeds consist of finely chopped trash fish, rice bran, sweet potato and coconut. Water is renewed at spring tides. Throughout the culture period predators are controlled by using traps (for crabs) and Derris root. The shrimp are harvested after three to five months, depending on the growth and the salinity decrease at the onset of the rainy season.

Results

Taking into consideration the novelty of the introduced farming practices, the results obtained, especially with the culture of *P. monodon*, are very promising. Using nursed juveniles, more than 60% survival should be obtainable, resulting in net production of over 300 kg/ha/crop.

Continuing extension efforts combined with the accumulation of farmers' experiences will certainly enable many to reach that goal within one or two years. Already in the second year of operation, most farmers have been able to double (some to even triple) their annual net income. Data (Table 1) indicate that the net production obtained is still close to the range achieved using the traditional system. However, the presence of more commercially acceptable shrimp species and sizes has generated high profits.

So far, the outcome of 'improved extensive' culture of *P. merguiensis* has not been very promising. Slow growth has meant small-size shrimp at harvest, and consequently low net production. Moreover, for most farmers, the relationships between investment, pond management and profit have not been clear. Farmers have tended to stick to their traditional culture methods but with higher operating costs. Farmers growing *P. monodon* have been more receptive to the *new* culture methods because of their unfamiliarity with this species (relatively scarce in the Mekong Delta). The profitability of the new culture method has been illustrated by the high recovery rate of the credit program: over 80% after two seasons.

Impact

The most important result of the program so far has been the proven feasibility of 'improved extensive' shrimp culture (using *P. monodon*), in rotation with rice. As a result, bank loans are now available for small-scale farmers in the district where these trials have taken place. Previously, farmers had to borrow from private money lenders who charge up to six times the interest rates of the agriculture development banks.

Environmental effects, as compared to other types of shrimp culture, are so far insignificant, and the wider application of the demonstrated 'improved extensive'

Table 1. Summary data (averages) on 'improved extensive' shrimp culture at Vinh Chau, Soc Trang province, Mekong Delta, Vietnam.

	Penaeus monodon		*Penaeus merguiensis*	
	1992	1993	1992	1993
No. of data sets	15	14	6	24
Culture period (days)	150	121	97	78
Stocking density (pieces/m^2)	1.2	1.4	1.3	1.0
Mean harvest weight (g)	35	37	14	10
Survival (%)	37	45	44	55
Growth (g/day)	0.23	0.31	0.14	0.13
Net production (kg/ha/crop)	148	220	66	50
Total costs (US$/ha/crop)	441	601	227	66
Net benefit (US$/ha/crop)	380	970	8	30
Return on investment (%)[1]	86	161	4	45

[1]Net benefit/ha in per cent of total costs/ha.

shrimp culture could contribute to sustainable development in the Mekong Delta, specifically aiming at the smallholder. However, caution will be needed. The 'improved extensive' system has a production limit of about 300 kg/ha/crop. Uncontrolled expansion would have environmental consequences. For example, if many ponds were to be constructed in freshwater areas, their impacts on soils and freshwater aquifers could hamper other uses of land and water.

To secure the future of the 'improved extensive' shrimp/rice farming system and to avoid negative impacts, regulation and planning of coastal aquaculture development as components of an Integrated Coastal Area Management plan are urgently needed.

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Aquaculture of a High-Value Freshwater Fish in [Malaysia]: the Marble or Sand Goby (*Oxyeleotris marmoratus*, Bleeker)

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Introduction

The marble goby *(Oxyeleotris marmoratus*, Bleeker) which is also known as the sand goby, is found in Cambodia, Fiji, Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam. It is cultured in ponds and former mining pools either in monoculture or in polyculture with tilapias. Cage culture in lakes and rivers has also been successful. Production statistics for the various countries are difficult to obtain but this excellent food fish commands a retail price of at least US$14/kg in some countries, such as in Malaysia and Singapore.

Breeding

Immature fish are difficult to sex but in the mature female, the urogenital papilla is barrel-shaped, tapers slightly towards the posterior end and extends almost to the anal fin; whereas in the male, the papilla is flattened, triangular in shape and tapers towards the posterior end. In gravid females, the papilla is reddish especially at the tip (Tan and Lam 1973).

The early development of the marble goby was described by Tan and Lam (1973). It was initially bred in Singapore (Tay et al. 1974). Mass seed production techniques have yet to be established and standardized. Natural breeding has been observed in fishponds but little has been published except for reports of Phinal (1980), and Tavarutmaneegul and Lin (1988). It spawns year-round with an annual average of 3.3-4.4 nests per female. The eggs are embedded in circular, jelly-like translucent masses with an average area of 250-350 cm^2 and average number of 24,000 eggs/nest (Tavarutmaneegul and Lin 1988).

In a spawning trial in Thailand, Tavarutmaneegul and Lin (1988) reported that 250-300 pairs of sexually mature males and females (300-500 g) were stocked in each of two 1,600-m^2 earthen ponds. The fish were fed daily with chopped raw fish. Twenty triangular egg collectors were placed at the bottom of each pond close to its edges. The egg collector was made by joining three pieces of asbestos tiles measuring 30 cm x 30 cm at the edges to form a triangle. The amount of eggs deposited ranged from 2,000 to 30,000 and the egg deposition density was about 80-90 eggs/cm^2 (Tavarutmaneegul and Lin 1988). Thirty cm lengths of 15-20 cm diameter sections of polyvinyl chloride (PVC) pipes cut into two can also be used as egg collectors. After about two weeks, the eggs are deposited on the inner surface of the egg collectors and occasionally on the outside of the pipes.

The first reported success at induced spawning of *O. marmoratus* in Malaysia was in 1989 (Lam et al. 1990; Cheah et al. 1991). In the first trial, twelve pairs of fish individually weighing approximately 250 g were divided into three groups and a double injection protocol was adopted. The females in groups A, B and C were