

With this second issue of 1994, ICLARM is pleased to announce that the first Directory of the NTAS has been printed and distributed to members. Please let us know if your copy has not arrived and please send us feedback - complimentary or otherwise. This issue has a diversity of aquaculture articles ranging from production of tilapia fry in Thailand to integrated pond aquaculture in the Philippines and improvement of traditional shrimp culture

in Vietnam, plus a minireview of sand goby aquaculture research and development in Malaysia. We still lack substantial input from members in the form of letters, news items and photographs - particularly items that tell a story or demonstrate a technique. However, the flow of papers for publication is increasing. Let's make *Aquabyte* more of a vehicle for the exchange of ideas and methods as the year proceeds.
R.S.V. Pullin

Commercial Production and Marketing of Nile Tilapia (*Oreochromis niloticus*) Fry in Chonburi and Chachoengsao Provinces, Thailand

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Background

The country-wide adoption of tilapia culture in Thailand has been paralleled by an associated increase in fry production which, in contrast, has been concentrated in one small area. Tilapia fry production in Thailand has been studied at the Asian Institute of Technology (e.g., Juntana 1990; Sikawa 1993). Originally tilapia fry were produced and disseminated through the Department of Fisheries' provincial fishery stations but, for the last decade, most fry have been produced by the commercial sector. Large quantities are produced by former rice farmers, in three subdistricts of Chonburi and Chachoengsao provinces to the southeast of Bangkok connected, via a network of middlemen, to growers all over the country.

Nile tilapia (*Oreochromis niloticus*) is very easy to breed, but poor synchrony of spawning precludes predictable mass production of uniform size fry. The concentration of small producers in one area, linked together as 'production' groups, reduces that problem. There are at least 12 groups of 12-30 farmers, linked with middlemen in the area. Each group produces at least 150-300 million fry/year. These figures indicate the true scale of the tilapia industry in Thailand; even

if 30% of this number were to survive to be harvested at a weight of 100 g, 4,500 t of fish would result from the output of a single production group, and 54,000 t from the whole area.

Historical Background

The original area of tilapia production in Panthong district, Chonburi province was around 150 ha and is owned by Roman

Catholic missionaries, who first established themselves there in 1880. Population increases in the area have led to a gradual occupancy of the land by farming communities and recently, the church began collecting rent as a proportion of the rice crop. In 1976, Nile tilapia was introduced by an individual farmer who had travelled with six others to obtain fry from another farmer in Bangkok. Within a few years, this group had formed a nucleus producing both market-size fish and fry. The activity



Graded tilapia at the Sapan Bla central fish market, Bangkok. Typically at least 50 t of tilapia from ponds in Central Thailand are traded daily before distribution on ice to major provincial cities all over Thailand. (PHOTO BY D.C. LITTLE)

was promoted by both local government agencies and the church, which loaned money to stimulate other farmers to construct ponds and adopt the practice. A few years later, government programs to purchase fry to stock natural waters stimulated the demand for fry and producers began to concentrate on fry production.

Ten years after the fish had been introduced into the area, hatchery operators from other areas, acting as wholesalers, began to purchase tilapia fry and distribute the fish still further afield. As the demand grew, the wholesalers began to compete to purchase the limited numbers of fry available at that time and this caused the original group to fragment, as different members began to supply different middlemen. This stimulated rapid spread of the practice, as these individuals persuaded groups of rice farmers to begin tilapia fry production and new groups formed to supply the ever-expanding demand. Farmers were attracted by the returns, which are very favorable compared to rice production, and the relatively easy nature of work. Undoubtedly, the group structure and support facilitated the adoption of the activity since inputs were readily available and the product is readily marketable. Growout of both tilapia and hybrid walking catfish (*Clarias gariepinus* x *Clarias macrocephalus*) remains popular in the area, particularly in Panthong and Panat Nikhom districts, Chonburi province. Currently around 90% of the land owned by fry-producing farmers is used for aquaculture.

Group Organization

Fry producers are organized in semi-formal groups of 12-30 members, who market their fry through a local middleman (also a producer) to outsiders - typically large hatcheries also selling carps and catfish, and dealers - who distribute them throughout the country. The group members' ponds are harvested in rotation, with the ponds of at least one member harvested each day. This allows a continual supply of fry for sale and gives an average

harvest interval of 10 to 15 days. The mean land holding of fry producers is 3.3 ha of which 80% comprises about 18 small fishponds (mean size 1,240 m²; Table 1). These shallow ponds are simply adapted from ricefields. Water depths are typically maintained at 40-60 cm.

Most farmers invested using commercial loans (<US\$1,500/farmer) from the government's agricultural bank (Bank of Agriculture and Agricultural Cooperatives); only a minority used their own savings or borrowed from family or friends. This production of fry by natural spawning is labor-intensive. Most of the operators rely on both family and hired labor (60%), males and females, and labor exchange among group members is a common, although a declining practice. Most labor is required for the intermittent harvesting of fry. An average of seven people is required to seine the shallow ponds. Fry are produced year-round, but the peak in production and demand is at the end of the dry season (April-May) through to the early-mid wet season (June-August). During the dry season months, farmers downstream within the irrigation

system often experience water shortages that limit production.

Production Methodology

Fry production ponds predominate but older, deeper ponds are often converted into tilapia or catfish growout ponds. There appears to be much exchange of broodfish between and within producer groups: tilapia broodfish (150-g fish of between 7 to 12 months of age) are normally obtained locally from other producers cheaply at US\$0.40/kg. Many farmers look for characteristics of 'pure' Nile tilapia such as well-defined vertical stripes on the body and tail. Broodfish are used for between six months and one year before replacement; old fish are often stocked in catfish ponds for fattening prior to sale as food fish (Table 2).

Most farmers have a good understanding of the environmental requirements for high fry production. Water quality is maintained through frequent fertilization and water exchange/input. Water transparency tends to be higher in breeding ponds than in growout ponds, reflecting the different

Table 1. Physical details of land holdings, rental and construction costs of tilapia (*Oreochromis* spp.) fry production units among six producer groups in Chonburi/Chachoengsao provinces in eastern Thailand.

	Fry producer group						Mean
	1	2	3	4	5	6	
Land area (ha per household)	3.2	4.8	3.3	3.2	2.6	2.9	3.3
Rental (US\$/ha/year)	95	75	806	1,250	260	315	467
Mean pond size (m ²)	1,300	1,600	1,260	800	880	1,600	1,240
Number of ponds per household	15.5	20	15.5	18	22	18	18
Construction cost (US\$/ha)	450	325	688	500	875	688	588

Table 2. Stocking and management data for tilapia (*Oreochromis* spp.) fry production among six producer groups in Chonburi/Chachoengsao provinces, eastern Thailand.

	Fry producer group					
	1	2	3	4	5	6
Source	middleman	group member	middleman	own	own	group member
Age of broodstock at stocking (months)	6	-	12	6	7-12	6
Size of broodstock at stocking (g)	150	300	330	100	250	150
Duration of broodstock use (months)	7-12	>12	>12	6	6	6
Cost of broodfish (US\$/kg)	0.34	0.32	0.4	-	-	-
Stocking rate (fish/m ²)						
Male	0.08	0.05	0.05	0.13	0.03	0.05
Female	0.31	0.14	0.22	0.25	0.09	0.20
Sex ratio (female:male)	4	3	5	2	3	4

types and quantities of inputs. Ponds are re-excavated at least once annually, to remove the bottom mud. This maintains a firm pond substrate which, farmers believe, improves production. Many farmers can describe both the oral incubation habit, and the mating and courtship behavior of tilapia breeders.

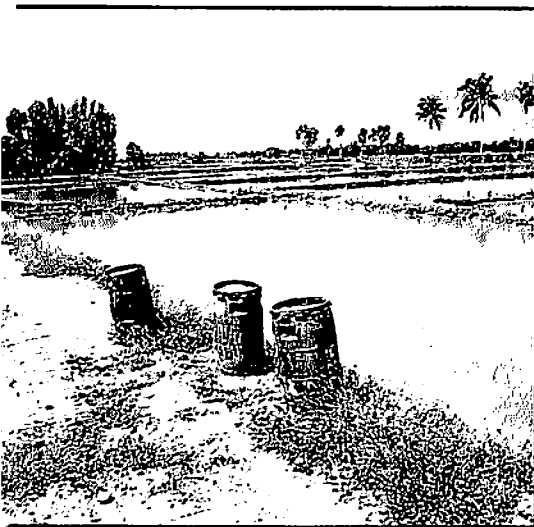
The systems are semi-intensive and use organic fertilizers (particularly pig manure) and fine rice bran as a supplementary feed (Table 3). Pig manure, a mixture of solids and urine, is cheap and is delivered to the pond side in large plastic containers. The area has a good deal of pig and poultry production. Chicken manure is used in growout ponds rather than in breeding ponds. *Ami ami*, a nitrogen-rich by-product of the monosodium glutamate manufacturing process (4% N on a dry matter basis) is also commonly used when available.

Stocking densities of broodfish are low (1 fish/4 m²) and sex ratios varied between 2-5:1 (female:male). The first fry harvest occurs around 45 days after initial stocking but thereafter the harvest interval is from 10 to 15 days. Fry are removed by careful, close seining by a large number of family members and hired hands. This ensures a relatively high harvest efficiency which is crucial to the system's sustained productivity. The adults are replaced immediately back into the pond



Broodfish are removed from the seine with shallow dip nets and returned to the pond for further breeding. (PHOTO BY D.C. LITTLE)

and the fry removed for grading and conditioning. The number of 'recruits' is kept very low and the smallest size class of fry, at 60% to 70% of the harvest, predominates (Table 4). Fry are graded through mesh of different sizes and are held in hapas before holding in similar-sized groups for three to six days, depending on demand. During this period, the fry are held at a very high density and fed with fine rice bran. Most of the fry (>90%) are sold in this way, via the local middleman, who arranges buyers and negotiates the price. Typically his margin is around US\$0.80/1,000 fry, whereas



Large-scale, modern pig production is common in the area and fresh pig manure is delivered to the pond side in black plastic containers. (PHOTO BY D.C. LITTLE)



The by-product of monosodium glutamate production, *ami ami* is rich in soluble nitrogen compounds and is widely used as an input for horticulture and aquaculture in Thailand. It is delivered by tanker and stored temporarily in simple concrete ring cisterns at the pond side. Mr. Jingjo, a fry producer and local middleman, is pictured with a sample. (PHOTO BY D.C. LITTLE)

Table 3. Frequency of pond management activities and level of inputs for tilapia (*Oreochromis* spp.) fry production among six producer groups in Chonburi/Chachoengsao provinces, eastern Thailand.

	Fry producer group					
	1	2	3	4	5	6
Pond management (frequency/year)						
Draining	1	<1	1	2	2	1
Remove mud	1	<1	1	2	2	1
Quicklime applied	0	<1	0	2	2	1
Inputs (wet wt. in kg/ha/week)						
Pig manure	648	688	766	500	-	250
<i>Ami ami</i>	-	-	375	1563	438	125
Fine rice bran	175	<i>ad libitum</i>	219	350	250	175
Catfish pellets	-	-	<i>ad libitum</i>	-	-	-
Bread (left overs)	-	-	-	-	-	<i>ad libitum</i>

returns to the producer range from US\$1.20 to US\$4.40/1,000 fry. Variability in size class among producer groups is relatively small. A study of maturation time and growth also revealed high homogeneity in fry quality.

In a study of six groups producing fry, it was found that output per unit area is relatively high and uniform. The output of fry, at 2.5 to 5.0 m²/day, can vary by a factor of 2. Efficiency of broodfish use is more variable, ranging from 1,000 to 4,000 fry/kg female/month. The groups using most pig manure have relatively lower production. The stocking of young broodfish (six months), maintenance of

Table 4. The category, mean individual size and harvest composition of tilapia (*Oreochromis* spp.) fry produced by producer groups in Chonburi/Chachoengsao provinces, eastern Thailand.

Size/Description	Mean values (\pm standard errors)		Composition of the harvest (%)
	Individual weight (g)	Total length (cm)	
1 Tiny	0.26 (\pm 0.02)	2.66 (\pm 0.06)	60-70
2 Small	0.70 (\pm 0.04)	3.75 (\pm 0.07)	15-20
3 Medium	1.77 (\pm 0.12)	4.90 (\pm 0.11)	10
4 Large	10.49 (\pm 0.70)	8.10 (\pm 0.14)	4-5

low stocking densities and use of *ami ami* as inputs are positive factors.

A Transferable Technology?

The productivity attained in these farmer-managed systems using simple open ponds raises the question of how transferable such technology is to other regions and/or countries. Productivity is highly management dependent. Yields of fry can be reduced significantly by poor water quality and/or a build-up in recruits within the system. The experience and knowledge attained by farmers, and passed on to neighbors and relatives have been enhanced by informal, but highly effective, marketing linkages that drive its expansion. A good road network, the pick-up truck and, more recently, the mobile phone are important elements that make the system work. The growth of the tilapia industry here has been paralleled by a rise in feedlot livestock production in the same area, which provides low-cost inputs. A large demand for tilapia fry from growout farmers is assured, particularly as carnivorous, but valuable, predatory fish such as snakehead (*Channa striata*) persist in the typical large-scale growout ponds. Such carnivorous fish limit the survival of progeny and ensure that 'fry saving' by farmers is limited and that frequent repurchase of tilapia fry is necessary.

Future Trends

The main center of fry fish production has been shifting away from its origin, Panthong district towards Panat Nikhom district, Chonburi and Ban Po district, Chachoengsao province. Market-size fish are now raised almost exclusively in Panthong district, Chonburi. Very little rice is now grown here as pest and water level management became problematic after a large proportion of land (>50%) was converted to ponds. Tilapia fry producers in subdistrict Takham, Panat Nikhom have recently shifted to intensive shrimp (*Penaeus monodon*) culture, perhaps spurred by the decline in

the real price of tilapia fry. Another important factor has been the renting of land to outsiders who had previously raised shrimp on the coast but had been forced to give up shrimp culture because of deterioration in water quality. Current yields have been good and the shrimp, except for a period of acclimation, are raised in freshwater. Overall, however, the total area of tilapia fry production continues to expand as farmers, who previously grew rice, still find the returns attractive.

The quality of tilapia fry is believed to have declined recently in some groups, perhaps due to the entry of less experienced farmers and poorer returns. Poor broodfish and the purposeful mixing of the more fecund *Oreochromis mossambicus* to increase fry yields have been reported. Labor exchange at harvest has been superseded by local harvest teams who hire themselves to farmers

as a group for fry harvest, as is common practice in the shrimp industry.

References

- Sikawa, D.C. 1993. An investigation of tilapia (*Oreochromis niloticus*) fry quality produced by small-scale farmers in eastern Thailand. Asian Institute of Technology, Bangkok, Thailand. 97 p. Masters thesis.
- Juntana, J. 1990. Mass incubation of Nile tilapia (*Oreochromis niloticus*) in relation to its proposed introduction into Udon Thani province, Thailand, Asian Institute of Technology, Bangkok, Thailand. 74 p. Masters thesis.

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Field trips to this unique tilapia fry-producing area of Thailand are an integral part of an annual short course "The Nile Tilapia: Techniques for Mass Fry Production and Growout" offered by the Asian Institute of Technology. For further details and an application form, please contact Aquaculture Short Course Unit, AIT, PO Box 2754, Bangkok, Thailand.

Cross-country Fish Fry Supply Linkages

Tilapia fry are sold all over the country; the large-scale production of tilapia, often in polyculture with various local and exotic carps, is centered around Bangkok. A thriving countertrade appears to exist between producers of mainly carp fry in northeast Thailand and the tilapia fry producers described above. High opportunity costs of well-watered land in the drier northeast region have depressed their Nile tilapia fry production: only 50% of the fish hatcheries in one province, Udon Thani, still produce tilapia fry, despite high demand. Large numbers are imported in oxygenated plastic bags. Carp fry producers probably started the practice by looking for a product for the return trip after delivering carp fry to the Bangkok area. A survey conducted of twenty hatcheries in Udon Thani revealed that over five million tilapia fry were imported annually in this one province. Although most carp and catfish were produced in the province, the majority of tilapia (64%) were imported mainly from Chachoengsao province. Eighty-six million fry were traded in Udon Thani province during 1990, most of which were stocked in culture systems; less than 10% were released in open waters. A high proportion (>40%) were exported to other regions of Thailand, 25% to other provinces in the region and nearly 20% to central and eastern Thailand. The demand for tilapia fry during the wet season exceeds supply. Hatchery operators interviewed estimated that the demand is three times the current supply in the area, i.e., 25 million fry/year.



Tilapia fry bagged up ready for transport to northeast Thailand. The pick-up truck distribution system works efficiently but the cost of the smallest size class (tiny) at least doubles from hatchery gate to the northeast. (PHOTO BY D.C. LITTLE)