Production of Uniform-Age Male *Tilapia nilotica* Fingerlings in Nursery Ponds

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ABSTRACT

Ten nursery ponds (0.12 to 0.28 ha) at the government-owned facilities at Mitchell Town and Twickenham Park in Jamaica were used for experimental rearing of *Tilapia nilotica* fingerlings. These fish were subsequently hand-sexed for stocking in privately-owned monosex food-fish production ponds. When mixed-sex fry weighing 1 g each were stocked at a rate of 150,000 to 190,000 per hectare and fed a locally produced fish feed, an average of 37,100 males per ha per 9-week cycle were produced. Assuming that the female fingerlings had no economic value, production cost for the male fingerlings, with an average weight of 24 g, was US $2.66 per kg or $0.06 per individual.

Fry to stock the nursery ponds were taken from three brood ponds with a combined area of 0.7 ha that had been stocked at a density of 7,500 to 10,000/ha (3 females: 1 male). Weekly partial harvesting of the brood ponds began after 6 weeks with a 0.6-mm square-mesh seine. A total of 1.6 million fry, with an average weight of 0.8 g, were taken from the brood ponds during an average harvest period of 17 weeks.

During 1981 the demand for male tilapia fingerlings had been consistently greater than available supplies at government facilities. Continued growth in freshwater food-fish production would be dependent upon the ability of private commercial food-fish producers to provide their own male fingerlings. However, based on the policy of encouraging only those fish farming practices which had been technically and economically proven, private sector production of male fingerlings was not emphasized for commercial fish farmers until actual production and cost-return data could be provided.

Research by the Inland Fisheries Project in Jamaica to develop efficient methods of fingerling production has yielded the following data, and these preliminary results form the basis for implementing the policy that fingerling nursery ponds be included in the management system of commercial silver perch producers who have more than 1 acre in food-fish production.

MATERIALS AND METHODS

Brood Ponds

Three earthen brood ponds, 0.1 to 0.3 ha each, were used to produce fry for subsequent stocking in nursery ponds. Ponds that could not be completely drained were poisoned with rotenone at a rate of 6 mg/*l*. After filling and chemical fertilization (300 to 400 kg/ha), the ponds were stocked with 50- to 150-g brood fish at a density of 7,500 to 10,000/ha with a sex ratio of three females per male.

A locally produced fish feed was offered at the rate of 22 kg/ha 4 to 5 days per week during the first 5 weeks and thereafter at a daily rate of 33 kg/ha. Approximately 5 to 6 weeks after stocking, partial cropping of fry was started on a weekly basis, using a 0.6-mm mesh seine. Fry were graded through a 12-mm nylon holding box into a cage covered with 6-mm mesh screen to obtain uniform size fry.

Nursery Ponds

Ten nursery ponds, 0.1- to 0.3-ha each, were used in the nursery trials. After poisoning puddles with rotenone, ponds were refilled with water and chemically

fertilized at a rate of 200 to 300 kg/ha. Fry weighing approximately 1-g each, were transferred from a brood pond to a nursery pond so that stocking densities ranged from 150,000 to 190,000/ha. Feed schedules were based on assumed growth rates, beginning with daily rations equivalent to 6% of estimated total body weight and gradually reducing to the 3% level by the end of the rearing period. The total amount of feed administered was approximately 2,000 kg/ha during the rearing period, with maximum daily feed inputs near 80 kg/ha. A daily ration was divided into two meals and was offered 5 to 6 days per week.

Ponds were usually sampled after 5 weeks to determine if most fish had attained the minimum acceptable weight of approximately 20 g. Fingerlings were harvested by seining and subsequent draining of the pond. The harvesting operation ranged from 4 days to 2 weeks, the latter being the most common. During the early part of the harvest period, the catch was usually passed through a metal grader (19 x 25 mm rectangular mesh) which permitted fish smaller than 18 g to return to the pond for an additional period of growth. Once harvested, fingerlings were sexed the same or following day by visual examination of the genital papilla. Production figures include only those fish alive after harvesting and sexing.

Table 1. Brood pond fry production of *T. nilotica* with frequent partial harvests with 6 mm square mesh seine

Pond size (ha)	Harvest period (wks)	$\bar{x}$ size fry (g)	No. fry/ha/week: During harvest period only	No. fry/ha/week: Period between stocking and first partial harvest
0.10	9	1.0	273,777	137,420
0.36	25	0.7	84,550	68,184
0.24	17	0.8	157,931	119,516
$\bar{x}$	17	0.8	157,753	108,374

Ponds were initially stocked with brood fish weighing 50-150 grams each at a density of 7,500 to 10,000 per ha. Feed was administered at a rate of 22 kg/ha/4-5 days per week during the first 5 weeks and thereafter at a daily rate od 33 kg/ha 4-5 days per week. The harvest period began 5-6 weeks after initial stocking of brood fish. Ponds were partially harvested thereafter at least once per week by seining a full pond with a 6 mm-mesh drag-seine.

RESULTS AND DISCUSSION

Brood Ponds

The three brood ponds had a combined surface area of 0.7 ha. Weekly harvesting of fry began 5 to 6 weeks after stocking of brood fish and continued for an average harvest time of 17 weeks. A total of 1.6 million fry with average weight of 0.8 g each were obtained. Total weight of harvested fry was 1,280 kg during that average cycle time of 23 weeks. Approximately 2,200 kg of feed was offered; feed conversion was 1.7 kg of feed per kg of fry or 727 fry per kg of feed. Growth rate of brood fish was not recorded.

Table 2. Economic analysis of production of male *T. nilotica* fingerlings in a 0.2 - hectare (0.5 - acre) nursery pond in Jamaica

Initial Costs	$ US
Pond construction	875.14
Equipment	200.00
	1,075.14
Annual Fixed Costs	
Initial costs amortized at 9% for 5 years	271.75
Pond maintenance	14.28
Depreciation	84.00
	370.03
Variable Costs (per 10-wk production cycle)	
Fry 35,000 @ $1.71/m fry*	60.00
Irrigation water, prorated	2.86
Fertilizer (40 kg @ $0.326/kg)	13.04
Feed (425 kg @ $0.36/kg)	153.00
Transportation (prorated)	11.43
Labor (30 h @ $1.14/hour)	34.28
Harvest and sexing (7,700 males @ $0.014 each)†	107.80
Sub Total	382.41
Interest on Capital (12% for 10 wk)	8.82
	391.23
Total Costs per Crop	
Fixed costs (annual 5.2 crop per yr)	71.16
Variable costs	391.23
Total Production Costs for 7,400 fingerlings	462.39
Unit Costs	
Per fingerling ($462.39 - 7,400)	0.06
Per kg of fingerlings ($462.39 - 174)	2.66

*Cost of production at the government facility.
†Harvest charge of $0.126 per kg of fish plus a sexing charge of $0.57 per hundred unsexed fingerlings.

During the harvest period the rate of fry production exceeded 150,000/ha/week. If the time between stocking of brood fish and the beginning of fry harvest is included, the rate of fry production was slightly more than 100,000 fry/ha/week (Table 1).

When the partial harvesting of fry was not carried out frequently (generally at least once per week) the rate of fry production greatly decreased and the average fry size increased. As observed in Table 1, the rate of fry production was inversely re-

lated to the length of the harvest period. In both cases, the decline in fry production was probably caused by the predatory action of larger fingerlings that accumulated in the brood pond.

Because of the need for frequent partial harvesting of brood ponds, the management system is not appropriate for small fish farming operations that do not have a near constant demand for fry. It has proved satisfactory, however, at the government hatchery facility with both brood and numerous nursery ponds. It should also be adequate for larger private operations or smaller farms that supply fry to other facilities.

Based on the results of these brood-pond trials, 1 ha of brood ponds will produce sufficient 1-g fry to supply 3.5 ha of nursery ponds stocked at a rate of 190,000 fry/ha every 10 weeks.

At the government facility, feed costs were US $0.50 per thousand fry. It was impossible to keep an accurate record of labor requirements, but it is estimated at approximately US $1.00 per thousand fry.

Nursery Ponds

When nursery ponds were stocked with 1-g fry at densities of 150,000 to 190,000/ha, the average duration of the rearing period was 9 weeks. The combined area of the 10 nursery ponds was 1.6 ha, producing a total of approximately 42,000 male tilapia fingerlings with an average weight of 24 g.

These are the principal results of the nursery pond trials. Feed conversion was 1.22 kg of feed per kg of fish (both male and female); 2.45 kg of feed was given for each kg of male fingerlings recovered. Approximately 50% of the fry initially stocked were recovered alive during harvest, and 45% of the recovered fish were classified as males.

If 2 weeks are allowed for "turnaround" time between crops in small nursery ponds, the annual production level is 175,000 male fingerlings per hectare. In Jamaica the average food-fish pond has an annual fingerling requirement of approximately 50,000 males/ha (15,000 males/ha with a 15 to 17-week production cycle). Therefore, on a large scale 1 ha of nursery ponds would supply the male fingerlings required to stock 3.5 ha of food-fish production ponds.

For a small-scale operator the 10 to 11-week nursery pond production cycle does not syncronize well with the 15 to 17-week production cycle for food-fish ponds. Additional research is currently being conducted on lowering the initial stocking density in nursery ponds in order to reduce the duration of the production cycle to one-half that of food-fish ponds. If that is possible, a small-scale producer could have one nursery pond to supply fingerlings for two food-fish ponds. Until this information is available, the results of this study suggest that small-scale fish farmers should construct a nursery pond approximately 40 to 50% as large as their production pond.

In a 0.2-ha (0.5-acre) nursery pond the total cost to produce an average of 7,400 male fingerlings was US $462.39 (Table 2). This is equivalent to $6.25 per hundred males or $2.66 per kg of male fingerlings. Labor costs incurred in pond maintenance, feeding, harvesting, and sexing operations amount to 40% of this cost; and amortization of the initial costs during the first 5 years represents 11% of the total cost.

SUMMARY AND CONCLUSIONS

In Jamaica small brood ponds (0.1 to 0.3 ha) for rearing 1-g fry of *Tilapia nilotica* produced with supplemental feeding an average of 150,000 fry/ha/week during a 4-month harvest period. The weekly partial harvesting with a 0.6 mm square-

mesh seine began 4 to 6 weeks after stocking brood fish at a density of 7,500 to 10,000/ha (3 females: 1 male).

The rate of fry production was reduced when frequent (usually weekly) partial harvests were not continued. Fry production also declined significantly after 3 to 4 months. After this period a brood pond should be drained and a new production cycle begun.

When small nursery ponds (0.1 to 0.3 ha) were stocked with 1-g fry at a density of approximately 170,000 male fingerlings/ha and offered supplemental feed, 35,000 to 40,000 male fingerlings/ha, with average weight of 20 to 25 g each, were produced during a 7 to 11-week production cycle.

In Jamaica, food-fish production ponds are currently stocked at a density of 15,000 male fingerlings/ha, and have a production cycle of 15 to 17 weeks. Under these conditions, on a large scale 10 ha of food-fish production ponds would require support from approximately 3 ha of nursery ponds and 1 ha of brood ponds.

For small-scale producers the average 9-week rearing period for nursery ponds does not syncronize with a 15 to 17 week cycle for food-fish ponds. Additional research is being conducted on lower stocking densities in an attempt to reduce the duration of the nursery pond production cycle to one-half that of food-fish ponds, thus making it possible for one nursery pond to support two food-fish ponds.

Under the conditions of this study, the cost to produce the male fingerlings in small nursery ponds was approximately US $6.24 per hundred fingerlings. At this level fingerling production costs would usually be one-third of the total cost incurred in the production of 200-g fish in food-fish ponds.

As aquaculture continues to develop in Jamaica, other techniques, such as hormonal sex-reversal and hybridization, may provide greater efficiency to the system. The present production levels in nursery ponds could be almost doubled if all-male fry could be stocked in the nursery ponds instead of mixed-sex fry. Also, the labor costs involved in sexing the fingerlings is currently substantial (19% of total cost of nursery ponds). A hybridization program that produced all-male or nearly all-male offspring could eliminate or reduce this cost by one-half.

The advantages of the hybridization technique, however, are at least partially offset by the additional facilities and technical sophistication required to maintain pure lines in numbers needed for a large-scale operation. Sex-reversal is another potentially useful technique to produce nearly all-male tilapia fingerlings. Research is currently being conducted in Jamaica on large-scale sex-reversal, but high mortalities are very common. Until these techniques can be developed, proven and incorporated into the system, the present method can continue to produce male fingerlings in numbers and at a cost that provided economic impetus to continued growth of fish culture in Jamaica.