Small-scale commercial production of tilapia fry and fingerlings in concrete raceways

SMALL-SCALE COMMERCIAL PRODUCTION OF TILAPIA FRY AND FINGERLINGS IN CONCRETE RACEWAYS

by

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ABSTRACT

This paper discusses the investment prospects in *Tilapia* fry and fingerling production in raceways created from the concrete drainage channel of a raservoir or pond of an existing fish farm. With an initial capital of ₦1,300 and an annual operating cost of ₦310 spent on procurement of fish feed and brood stock for a 10 m^2 raceway per se, a net profit of ₦4,100 and ₦5,090 would be realized from *S. galilaeus* in the first year and subsequent years of production respectively, assuming that the fingerling production rate has been maintained through the production period.

It is concluded that the application of this approach of optimizing the use of available resources in the fish farm for the productive breeding of Tilapia fry and fingerlings will apart from alleviating the problem of scarcity of stocking materials in the country, increase the profit margin accruing to the fish farmer.

INTRODUCTION

The recent upsurge in aquaculture investment in Nigeria is traceable to the slump in the poultry industry coupled with the restriction on the importation of frozen fish and stockfish as a result of the country's meagre foreign exchange earnings. Aquaculture is used in this context to mean "Fish Culture" which Mires (1983) defined as "the commercial raring of fish done in conditions where all the basic means of production can be controlled within their respective limitations and from which producers aim to obtain optimal economical results". Although many fish species are being cultured, the tilapias are regarded (CIFA, 1975) as the main-stay of aquaculture production systems in the African Region. But unfortunately, it is the fish that has not attracted adequate breeding manipulations to enhance its spawning potential. This attitude stems from their established prolific breeding habit and their ubiquitous nature which give a general impression that their juveniles (fry and fingerlings) could be collected in required quantity from the wild for stocking ponds and reservoirs. Experience has however, shown the contrary because of the difficulty encountered in their exploitation in natural waters.

The need for a regular source of fingerling supply in a commercial fish farm cannot be overemphasized as lack of it could reduce such a venture to a monumental waste and consequently discourage further financial investments in fish culture.

Hora and Pillay (1962) stated that fry could be artificially produced but that the consensus of opinion among fishery biologists is that the production from natural spawning is definitely superior to the meagre production of artificial hatching. Hughes & Behrends (1983) pointed out that the most important requirements for the advancement of tilapia culture is the development of systems for mass production of seed which Dadzie (pers. comm.) mentioned as the basis for every successful aquaculture practice. This paper therefore discusses optimal utilization of water in the drainage channel of a pond/ reservoir for small scale commercial production of tilapia fry and fingerlings from the point of view of brood stock management as a modest investment option for small scale fish farmers.

Raceway Design and Cultural Utility

Raceways are open channels or ponds of earthen or concrete conformation with considerably longer dimension than their width. Their maximum width and depth are 6m and 2m, respectively. There are different layout of raceways but the commonest arrangements are series raceway design and parallel raceway design, in which water flow increases in direct proportion to the number of raceways.

Although raceways are usually utilized for rearing growout in hatcheries, they could also be used for fry and fingerling production. The approach here is centred on the partitioning of water drainage channel of earthen reservoir or pond into compartments by means of screened sluice gates to give small-sized series of raceways with surface area range of 10 - 20 m^2 and a width of 1 m each. The drainage channel along which the raceways are constructed consists of concrete floor of 15 cm thick and non-hollowed blocks (cement bricks) of 15 cm.

Since the small-sized raceways are constructed adjacent to one another in a series along the drainage canal of a pond or reservoir, water effluent from the pond or reservoir flows through the raceways such that the outlet of the upper raceway is the inlet of the lower one with the outflow (the fall) of the former providing energy for aerating the immediate inlet vicinity of the latter. By this arrangement, surface water flow will be slow but a fast under water current is created which favours oxygenation of the bottom stratum of the culture system.

Sex Combination Ratio, Size and Replacement Rate of Tilapia Brooders

The most commonly cultured Tilapia species in Nigeria are *Oreochromis* (*Sarotherodon*) *niloticus* and *Sarotherodon galilaeus* in fresh water; *Tilapia guineensis* (*melanopleura*) and *Sarotherodon melanotheron* (*heudolotti*) in brackish water environment. The present report focuses on the spawning potential of *S. galilaeus* based on the data and observations recorded by Sado (1985).

From published information in available literature, there does not seem to be a consensus on the size and standard sex combination ratio for stocking Tilapia brooders in concrete tanks and raceways for fry and fingerling production. However, Guerrero (1983) reported that a 1 : 3 male to female ratio was acceptable for fry production in terms of breeding efficiency and economy in feed and maintenance cost. His result corraborated the observations of Uchida and King (1962) on *O. mossambicus*.

Sado (1985) found a 1 : 2 male to female sex ratio of *S. galilaeus* most suitable in terms of fry production in a 10 m^2 concrete raceway. He obtained an average of 3,000 fry in outdoor concrete raceways with a water depth of 0.41 m in five months (June - October). It is important to note that sex ratio alone cannot be the only yardstick for assessing the fecundity and fertility of broodstocks. The complex interaction between environmental and physiological factors such as physiological disposition of brooders, brood fish nutrition, age and size, species of fish and water quality are factors to be considered for rational deductions to be made. Nevertheless, a sex combination of 1 : 2 (3 brooders m^2) sex ratio of *S. galilaeus* have been recommended as a working sex ratio for broodfish combination of these species in a 10 m^2 raceway with a minimum water depth of 0.45 m.

S. galilaeus breeders weighing between 220.9g and 355g and combined in a 1:2 male to female ratio produced an average of 3,000 fry in five months (Sado, 1985). The breeders were replaced after each spawning season. Guerrero (1983) reported the stocking of *O. niloticus* breeders weighing 50-450g in the breeding ponds of Fresh water Fish Hatchery of the BFAR-USAID in Munoz, Nueva Ecija in the Philippines, while small - scale hatchery operators in Bay Laguna used *O. niloticus* breeders weighing 50 - 100g. Breeders were replaced when they attained 250 - 350 g each.

Feed and Feeding Rates of Tilapia Breeders

Tilapia breeders can be sustained on natural foods in the raceway but supplemental feeding could be adopted if the water is not sufficiently rich in natural foods. Pelleted artificial feed compounded from 10% fish powder (ground whole fish) and 90% mixed flour (3 parts corn bran + 1 part chicken layer concentrate) could be fed to fish at 3% body weight. In the absence of these ingredients, poultry mash or broiler starter could be fed to fish at the same feeding rate twice daily (morning and evening).

Stocking Rate of Tilapia Breeders and Fry Production

At a stocking rate of 3 breeders /m^2 (1:2 male to female ratio), 30 breeders of S. galilaeus would be required to stock a 10m^2 concrete raceway. Going by the fry production rates of *S. galilaeus* documented by Sado (1985) for the species (Table 1), 30,000 fry of *S. galilaeus* would be produced in five months. This author observed that August was the peak fry production period for this species.

Ideally, breeding raceways should be checked for fresh spawns every other day by pulling a 2mm mesh dip net (0.8 x 0.3) through the compartment and lifting at short distances for observation. Fry are collected into plastic bowls containing some quantity of water and counted before being transferred into a nursery where they are reared to fingerlings. Fry collection should be regular to avoid loss due to cannibalism.

Fingerling Production

In farms where fish nurseries do not exist, another raceway could be provided for use as nursery. In situations of poor primary production in the nursery, 25% fish powder and 75% mixed powder could be fed to the fry in pulverized form at 8% of body weight supplied to fish as two meals morning and evening daily until a weight range of 20 - 25 g is attained. Poultry mash could also be used to supplement natural foods.

From projected annual estimates, about 27,000 fingerlings of *S. galilaeus*, less 10% mortality would be produced from a 10 m² raceway. At a stocking rate of 200 fry/m², a nursery of 150 - 300 m² would be required.

Cost Benefit Analysis Of Fingerling Production In Concrete Raceway

The cost benefit analysis of producing fingerlings of *S. galilaeus* in a 10 m² concrete raceway for a five year period is presented in Table 2.

An initial capital of ₦1,300 is required for producing *S. galilaeus* fingerlings. In the subsequent years, operating costs on *S. galilaeus* would be ₦310 representing the re-current expenditure on procurement of broodstock and fish feed. This financial analysis does not take into account other financial inputs such as staff emolument, vehicle maintenance etc. as it is assumed that all these expenditures have been taken care of in the running of an existing fish farm. All the costing here are strictly based on the construction and stocking of a raceway created along an already existing drainage canal in the farm.

Assuming that the fingerling production rate of this Tilapia species has been maintained in five years, a net profit of ₦4,100 would be realized from *S. galilaeus* in the first year of production. Thereafter, the net profits from the species would be ₦5,090, respectively, for the next four years.

CONCLUSION

It seems from available literature that *S. galilaeus* is very fecund and this possibly explains its preponderance in natural waters. There are also indications from recent investigation at the IITA, Ibadan, reservoirs (Ita, pers. comm.) that *S. galilaeus* compares very favourably with *O. niloticus* in terms of growth rate in the presence of suitable natural foods. This observation therefore reinforces the selection of *S. galilaeus* as a culture species.

It is however hoped that with this approach of optimizing the use of available resources in the fish farm for the productive breeding of Tilapia fry and fingerlings, the present short supply of stocking materials in the country will immensely improve while at the same time enhancing the economic returns to the fish farmer.

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Table 1 - Stocking density of breeders of *S. galilaeus* and fry/fingerling production rates in a 10 m^2 concrete raceway

Species	No. of breeders	Male to Female sex ratio per m^2	Fry production rate	Fingerling production (less 10% mortality)
Sarotherodon galilaeus	30	1.2	30,000	27,000

Table 2 - Financial analysis of construction of 10 m² concrete raceway and fry/fingerlings production of *S. galilaeus*

YEAR	1	2	3	4	6
CONSTRUCTION COST					
a) Mass concrete	300.00	-	-	-	-
b) Brickwork (non-hollow cement blocks)	500.00	-	-	-	-
c) One sluice gate	40.00	-	-	-	-
d) Labour (6 man/day)	150.00	-	-	-	-
Sub-Total	990.00	-	-	-	-
ANNUAL OPERATING COST					
i) Broodstock 30 *S. galilaeus* @ ₦2.00 a piece (weight 250 - 350)	60.00	60.00	60.00	60.00	60.00
ii) Feed	250.00	250.00	250.00	250.00	250.00
Total Expenditure	1,300.00	310.00	310.00	310.00	310.00
ECONOMIC RETURNS					
Fingerling sales 27,000 S. galilaeus @ 20k per fingerling	5,400.00	5,400.00	5,400.00	5,400.00	5,400.00
Net Profit	4,100.00	5,090.00	5,090.00	5,090.00	5,090.00