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EVALUATION AND IMPROVEMENT OF TILAPIA FINGERLING PRODUCTION AND AVAILABILITY IN HONDURAS

Eleventh Work Plan, Seedstock Development and Availability Research 2 (11SDAR2)
Final Report

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ABSTRACT

One important factor limiting tilapia culture development in Honduras as well as in the rest of the Central America is the lack of supply of fingerlings in sufficient quantity and quality. To assess the situation, we endeavored to obtain information and purchase fingerlings from every seed producer in Honduras. Sixteen tilapia fingerling producers were visited and interviewed during September 2003 to April 2004. They provided information about their production facilities and techniques, the quality and quantity of fingerlings produced, their socio-economic situation, and their technical needs. Fingerlings were obtained from 12 farms, and then transported to the Zamorano campus for grow-out and comparison. Most samples (70%) contained more than 10% females. Only three of the 10 samples of sex-reversed tilapia fingerlings had less than 3% females. There was a high degree of variability in the sizes of the fingerlings in each sample. Two of the 16 fingerling producers do not use MT sex-reversal. Seven fingerling farms are family-owned, four are private companies, one is a cooperative, and the remaining four are operated by non-profit organizations (NGOs), universities, and government agencies). In aggregate, they produce approximately 15.3 million fingerlings a year. Most (75%) of the fingerling producers interviewed also raise tilapia, produce other aquaculture species, and have other farm enterprise.

INTRODUCTION

With the fall in the price of coffee in international markets, many Central American land-owners are viewing fish culture as an alternative enterprise for food security and cash income. Securing seed stock (or fingerlings) is sometimes uncertain as a first step to growing a crop of tilapia. Small and medium-scale tilapia farmers often encounter difficulties obtaining fingerlings. Several studies and stakeholder meetings have identified the main constraints to the efficient production of tilapia. Inadequate availability and poor quality of tilapia seed were identified as major constraints to fish culture development in Honduras (Aceituno et al., 1997; Triminio, 2001; Lutz, 2001; Aquaculture CRSP, 2002). Limited access to pertinent information and insufficient training opportunities also have been identified as limiting farmer capabilities to culture tilapia more efficiently and profitably (Triminio, 2001; Lutz, 2001). Baseline information about the location, practices, and needs of fingerling producers was not heretofore available.

The objectives of the study were to:

1) Describe techniques utilized in managing brood stock and in production of tilapia fingerlings;
2) Compare the prices and quality (uniformity of size, color, and sex-ratio) of tilapia fingerlings for sale in Honduras; and
3) Develop extension principles and activities that can be used to increase the number and improve the performance of fingerling producers throughout Central America.

METHODS AND MATERIALS

We obtained information and purchased fingerlings

from every seed producer in Honduras. Through previous records, informal interviews, referrals, and others sources, we identified 16 farmers that actually produce and distribute tilapia fingerlings. Tilapia farms that produce and distribute (through sales or donations) fingerlings were visited during the period August 2003 to July 2004. The purpose of the visits was to evaluate the physical facilities (ponds, tanks) used for tilapia reproduction and fingerling production. Of 20 identified farms, 16 were active producers of fingerlings; the others had stopped producing fingerlings for various reasons. Semi-structured interviews, telephone conversations, field visits, as well as contacts during training courses and technical meetings were used to obtain information concerning physical installations, management protocols, and techniques for fingerling production and distribution. Information about their socioeconomic status, needs, and problems also was obtained in the process.

At each farm a minimum of 1,000 fingerlings was purchased (in some cases donated by the farmer) and transported to the Zamorano aquaculture station for evaluation (purchase price, individually counted, uniformity of size, and color). A sub-sample of 250 fingerlings from each vendor was grown to adult size or to the point of ready sex determination. From the 250 fingerlings, 100 were weighed, measured, and color evaluated.

RESULTS

Table 1 summarizes the scale and intensity of production systems used in Honduras. Unlike industrialized operations, small and medium-scale farms tend to combine fish culture with row crops, cattle, coffee, as well as off-farm employment, primarily as wage labor for other farmers.

Producer Characteristics

The 16 tilapia fingerling producers in the study are located throughout the country (Figure 1). Some concentration of seed production occurs in valley areas of Olancho in the eastern part of the country, in the Comayagua Valley in the center of the country, and in the Sula Valley in the north. The map indicates areas where fingerling producers are present in Honduras.

Table 2 summarizes the experience of tilapia producers with respect to the production and distribution of fingerlings. Of the 16 respondents, 10 have been producing fingerlings for less than 5 years, three between 5 and 10 years, and three for more than 10 years. All but one of them began by growing tilapia, later deciding to produce fingerlings. In one case, a nongovernmental organization (NGO) produced fingerlings to distribute to its farmer-beneficiaries.

The physical facilities utilized for fingerling production on Honduras farms are of three types: earthen ponds, concrete tanks and the combination of both. The number of ponds is very variable between farms; ponds often are used interchangeably for grow-out of tilapia.

Facilities and Practices

Table 3 summarizes the number and the size of the ponds and cement tanks utilized by seed producers. Three of the farmers use cement tanks to produce fingerlings. Nile tilapia (*Oreochromis niloticus*) is grown on 13 farms, red tilapia on 15 farms, and white tilapia (pearl tilapia) on two farms. The predominant species are the Nile and the red tilapia. Even though the growth and reproduction of red tilapia present some additional problems, the demand from restaurants for red fish motivates many farmers to grow this variety.

The strains of tilapia maintained by the farms are lines brought into the country at least 10 years ago, with exception of the white tilapia that came about three years ago. The farmers have obtained brood fish from the El Carao National Station and the Pan-American Agriculture School, as well as commercial sources outside the country. Respondents felt their brood stock had too much inbreeding, leading to reduced reproduction efficiency. Many (75%) farmers practice genetic selection of their brooders. They select brood fish to reflect the demand and preferences of their clients. They look for adult fish that present the most typical and original characteristics of the species, such as color, with no lesions, and robust body shapes.

The sex-ratio for reproduction is 2 to 6 females per male fish. The adult fish are stocked at a density of 0.66 to 7 brooders per 1 m^2 of tank space. The size of the brood fish is highly variable between farms. Brooders are rested between cycles by 12 of the farmers; the other four keep them in continuous reproduction.

Fingerling sex reversal with hormone-treated feed is practiced by 14 of the 16 farmers. Alpha methyltestosterone (MT) is the hormone used for sex reversal typically applied at a dose of 60 mg MT/kg of feed. The fry are offered feed containing MT for a period of 23 to 30 days. The MT feed commonly is provided to fingerlings in feeding trays made from 10 cm diameter PVC pipe cut in half lengthwise.

Fry are fed *ad libitum*. Producers report fry survival rates between 30 and 90%. Final average weight of the fingerlings varies between 0.05 to 2.00 g each.

Fingerling Characteristics

Table 4 summarizes characteristics of tilapia fingerlings collected from 12 farms. Only three farms provided

uniformly-sized fingerlings. The color evaluation shows that only 2 of the 12 samples were 100% homogeneous Nile tilapia and 2 samples were 100% homogeneous red tilapia. The remaining eight samples included a combination of fingerlings that were spotted with red and black colors.

The evaluation of the sex composition of each group revealed that only 5 farms are selling mostly (≥ 90%) male fingerlings. The remaining farms had percentages of males below 90% and one sample contained only 43% male fish.

Table 5 presents a summary of the economic activities of tilapia fingerling producers. Twelve of the farmers not only produce fingerlings but also grow-out tilapia. Four of them focus solely on fingerlings. Thirteen others culture fresh water aquaculture species like guapote (*Cichlasoma managuense*), common carp (*Cyprinnus carpio*), apple snails (*Pomocea* sp.), and channel catfish (*Ictalurus punctatus*). One of the fingerling producers polycultures tilapia and marine shrimp for a group of farmers on the south coast of the country. In many cases, aquaculture has been a secondary economic activity that the farmers have tried as a way of diversifying their farm production.

Tilapia fingerling production in Honduras is seasonal (Table 6) due to cycles in rainfall and ambient temperatures. The data about production and distribution of fingerlings is presented in the Table 7. Total production of tilapia fingerlings in Honduras from these 16 producers is estimated in 15.3 million. Of this total, 65% were sold to 2,316 tilapia farmers for grow-out. The remaining fish are used for on-farm production.

In the opinion of the farmers, there is always an unsatisfied demand for fingerlings in Honduras. If they could produce more fingerlings, they would be able to sell them easily. The demand is strongest during the months when cold temperatures tend to inhibit fish reproduction. Farmers stock their ponds in November to have fish available for Easter Week (April–May), when due to religious tradition, fish consumption increases in Honduras.

Most of the interviewed fingerling producers do not advertise in any way. Several farmers have roadside signs. Our interpretation is that each farmer acquires a local reputation based on the quality of their fingerlings. Sales of fingerling are promoted largely via word of mouth, though Internet contacts and knowledgeable individuals in universities and public agencies also connect growers to fingerling vendors.

Fingerling Sales Methods

Table 8 show that the average deviation from the number of fish ordered across the 12 samples was 95.6 fingerlings. Five of the 12 samples evaluated had less than the amount ordered. Two of the samples contained fewer than 850 fish when 1000 were requested. The remaining samples had more than the requested number of fingerlings. One sample contained 32% additional fish.

Fingerling survival in transit to Zamorano varied from 74.0 to 99.0% upon their arrival, averaging 94.5%. Eight of the fingerling samples transported to Zamorano had survival rates above 96%. After counting 1,000 fingerlings, many seed producers add from 1 to 10% more to compensate for losses in transport or otherwise. In one case, higher mortality was due to the farmer not having pure oxygen; instead the plastic transport bag was inflated with a bicycle pump. Considering counting errors and survival rates, 7 samples produced a proportion of net available fingerlings less than 100% of what was ordered. (Table 8).

The majority of farms do not manage any type of accounting records. Thus it is difficult to determine the real cost of their fingerlings. Farmers who have some idea of their costs report that the expense of producing a fingerling is between USD $0.005 to 0.020. The most important component of that total cost is the fish feed. The sales price for fingerlings varies from farm to farm, with prices ranging from USD $0.02 to 0.03 for sizes ranging from 0.05 to 3.00 g. Some farms have pricing systems based on species, red fish having a higher sales price than the grey Nile fish. Prices also vary according to fingerling size and number purchased.

Problems and Needs

Respondents were concerned about the lack of training opportunities. Fourteen of the 16 fingerling producers expressed the need to learn more about production techniques. They also think that there is an urgent need for new genetic material for tilapia in Honduras.

Another important problem for the tilapia farmers in general is the acquisition of some important inputs. Although there is availability of prepared feed in local markets, the prices are high, often fluctuating suddenly without apparent reason. They feel that the companies that produce and distribute fish feed control charge high prices. The farmers observe that the big commercial fish farms receive a better price because they buy higher amounts of feed each month.

Four of the farmers report having problems with the acquisition of the MT hormone. As an imported product, it is not generally available in Honduras. Many do not have a secure provider of MT; most obtain MT from another farmer or from the fish feed distributor who is willing to sell hormone. Also, they report that a lack of local distributors of equipment and materials for fish culture hinders their progress.

Losses from bird predation are a very important problem. It is not known exactly how much damage that birds cause, but the respondents perceive the losses as significant. Several farms hired a watchman to deter predators. Many farms also experience loss of fish due to human action. Neighbors and people from other communities steal fish, sometimes draining ponds, and otherwise causing damage.

Lack of record keeping, accounting problems, and technical questions were reported by several respondents. Without proper records, they do not have information to calculate the costs of production and learn from their experience. They have asked for assistance to establish a record keeping system.

DISCUSSION

Successful fingerling farms tend to be located in valley areas where the climate is favorable for tilapia culture and where grow-out producers find good marketing possibilities to urban centers. Compared to mountainous areas, these small and medium-scale tilapia producers have experienced rapid growth. Despite less favorable conditions in mountainous areas, tilapia culture has expanded there as well. This is particularly true at the subsistence level, due to the need for protein sources. The latter producers are encouraged by NGOs and other organizations that support food security programs. It is here where there is a special need for fingerling supplies accessible by subsistence-level tilapia farmers.

The success of the farmers in producing fingerlings is based on knowledge and experience gained by growing tilapia before producing fingerlings. The fact that they first learned to manage the grow-out of tilapia means they have a deeper grasp of the habits and needs of the organism. Understanding the dynamics of water quality, fish reproductive behavior, and temperature fluctuations is foundational for producing fingerlings. In most cases, the decision to produce fingerlings was one of necessity; farmers were reacting to unreliable supplies for their own production needs. They later discovered that fingerling production is a good business with steady demand, reliable margins, and technical challenge.

Most of the farmers have received some type of training on tilapia production, but few have received training in fingerling production techniques. Production facilities are generally under-utilized on most farms. Producers often do not know the holding capacity of their ponds and often have a weak understanding of the optimum densities for fish growth and reproduction. In many cases, respondents did not know the surface area of their production ponds.

Honduran fingerling producers use commercial feed with high cost. It is essential for the economic sustainability of the activity that the farmers have a good understanding on how to provide the feed to the brood fish as well as the fry. For example, in the case of the brood fish, most reported supplying the same amount of feed all the time. Yet, it is known that the female tilapia will consume less feed when they are carrying the eggs in their mouth. Most farmers know how to culture tilapia and why certain things work, but in most cases they do not understand why the fish respond or how the reproductive process in tilapia can be managed.

Given the overall assessment, we found that the tilapia fingerlings sold in Honduras are generally of low quality. There is a general lack of uniformity in the amount and condition of fingerlings sold. Fingerling vendors seem to lack knowledge of how to handle different lines of tilapia and there was wide variability in the kind and intensity of management practices used to maintain brood stock.

CONCLUSIONS

The poor quality of the fingerlings produced in Honduras is an important factor that constrains the efficient development of the domestic industry. This important component of tilapia culture development has had a negative effect on the prospects of small and medium scale farmers throughout the country. Creative and innovative responses are needed to improve the number and effectiveness of local fingerling producers. The introduction of new and improved genetic lines of tilapia is an important consideration for government hatcheries; some medium-scale producers report purchasing brood stock from outside the country.

The use of hormones for the sex reversal process is an issue that has a number of consumer perception and drug regulation problems. As a practical matter, the substance is difficult to acquire in Honduras. There are also environmental and possible consumer acceptance questions concerning its future use with tilapia. Researchers must begin now to identify alternatives that are accessible to farmers, acceptable to consumers, and environmentally safe. In the case of backyard or self-consumption farmers, the manual identification of each fingerling's sex is a feasible alternative that avoids the use of hormone. It is also a business opportunity for technically adept entrepreneurs.

Fingerling production and sales in Honduras can be a lucrative activity. There still exists an unsatisfied demand for tilapia fingerlings in many parts of Honduras. This could be considered as an alternative enterprise for any farmer that has access to the appropriate resources (water) and adequate knowledge of the required techniques and management protocols. Better estimates of the production costs for fingerlings and training in

record keeping could help farmers be more efficient in the use of their resources and to learn from their own experiences.

Training is the central means for improving the efficiency and productivity of fingerling producers. Improving the ability to understand why things have to be done in a certain way will enable their ability to make better and wiser decisions. Most farmers mentioned that they already do on-farm trials to determine the best way to manage their fish. This expands their perspective on culturing fish. Their confidence grows with their knowledge and understanding of tilapia culture. They then may be better able to share what they learn with other farmers.

ANTICIPATED BENEFITS

The results of the evaluation of the fingerlings samples are in the process of being delivered to each farmer with recommendations on how to improve production protocol and fingerling handling methods. Eleven fingerling producers, including two NGO extension agents and seven farmers, participated in a four-day course of tilapia reproduction and fingerling production in December of 2003.

Twenty-four people from Guatemala (7), El Salvador (3), Chile (1), and Honduras (13) participated in a four-day course for new fingerling producers held in July of 2004. The group included several NGOs extension agents, fish farmers and one professor from a university in Chile. We estimate that more than 2,300 fish farmers in Honduras, Guatemala, and El Salvador will benefit from the improved quality and better supply of tilapia fingerlings locally. Four formal presentations of the results of this program were made at international symposia to disseminate results that may benefit technicians working in other countries. Written Spanish materials on fingerling production techniques are being developed. Courses with similar content also will be offered for tilapia producers in other countries of Central America and the Caribbean.

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Table 1. Three types of tilapia farms in Honduras, 2003.

Farm Type	Market Type	Estimated Farms (Number)
Industrial-Scale (Export Market)	Sale of fillets	4
Medium-Scale (> 1000 M^2 Water Surface)	Sale of whole fish	1,000
Small-Scale (< 1000 M^2 Water Surface)	Home consumption, some sales	1,500

Table 2. Experience in tilapia culture and fingerling production, Honduras 2003.

Activity	< 5 Years	5 to 10 Years	> 10 Years
Culturing Tilapia	6	4	5
Producing Fingerlings	10	3	3

Table 3. Characteristics of tilapia fingerling production facilities, Honduras 2003.

Values	Ponds [a] (number)	Size (m^2)	Water Surface (m^2)	Cement Tanks (number)	Size (m^2)	Water Surface (m^2)
Minimum	4	150	1,500	1	9	40
Maximum	27	2900	123,000	47	3000	72,000
Average	13	N/A	16,637	11	228	5,438

[a] Three producers have no earthen ponds, but all have at least a cement tank
N/A= Not Available

Table 4. Results of the evaluation on size, color, and sex of fingerling samples, Honduras 2003.

Sample	Average Size (cm)	Coefficient of Variation [a] (%)	Grey (%)	Grey-red (%)	Red (%)	White (%)	Female (%)	Male (%)
1	2.16	14	100				4	96
2	3.22	26	7	31	62		2	98
3	3.91	21	88			12	2	98
4	1.86	13	100				6	94
5	6.31	16	69	24	7		22	78
6	2.83	23	7	25	68		13	87
7	2.45	13	69	20	21		13	87
8	2.38	13	92	5	3		36	64
9	3.26	26	69	24	7		57	43
10	1.84	16			100		10	90
11	3.46	33			50	50	15	85
12	1.87	27			100		12	88

[a] Standard deviation as a percent of the mean.

Table 5. Economic activities of fingerling producers, Honduras 2003.

Activities	Yes	No	Response
Grow-Out Tilapia	12	4	No = solely fingerling production
Culture Others Species	13	3	Yes= Guapote, carp, shrimp, apple snails, catfish
Other Production Activities	13	3	Yes=Agriculture, teaching, cattle, business

Table 6. Seasonality of tilapia fingerling production in Honduras.

Stage of Cycle	Period
Production Peak	March to July
Normal Growth	August to October
Reduced Production	November to February

Table 7. Tilapia fingerling production and distribution for 16 Honduras farmers, 2003.

Characteristic	Amount
Total Fingerling Production	15,313,000
Total Distribution	10,025,000
Distributed (%)	65
Transactions (number)	2,316

Table 8. Fingerlings purchased, counted, and survived after transport, Honduras 2003.

Sample	Fingerlings Purchased (number)	Fingerlings Counted (number)	Count Error (%)	Survival After Transit (%)	Net Available for Grow-out [a] (%)
1	1000	1093	9.3	99.0	108.3
2	1000	1085	8.5	94.0	102.5
3	1000	1016	1.6	74.0	75.6
4	1000	828	-17.2	96.5	79.3
5	1000	1026	2.6	98.4	101.0
6	1000	1015	1.5	98.2	99.7
7	1000	990	-1.0	97.3	96.3
8	1500	1351	-9.9	88.7	78.8
9	1000	1018	1.8	98.8	100.6
10	1000	824	-17.6	97.0	79.4
11	1000	1320	32.0	94.0	126.0
12	1000	932	-6.8	98.0	91.2

[a] [(Number Lost to Mortality + Count Error)/ Number Purchased]

Figure 1. Location of fingerling producers, Honduras 2003.

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