Aquaculture in Jamaica

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Abstract

Jamaica, with its overfished marine resources, has become a major tilapia producer in Latin America led by a small number of large farms practicing tilapia culture with considerable commercial success. Across the country, however, aquaculture is typically practiced by a large number of small-scale fish farmers who own less than 1.0 ha of land. Production is constrained by lack of credit, finite land space and suitable soil type, but larger existing aquaculturists are expanding further for overseas markets. Inspired by pioneering tilapia fish culture demonstration projects funded by the USAID and the government of Jamaica, fish culture production rose from a few hundred kg of *Oreochromis niloticus* in 1977, to about 5 000 t of processed fish mainly red hybrid tilapia, in 2000. Most of this quantity was exported to Europe and North America.

Development of Aquaculture

Jamaica, located in the north central Caribbean Sea, is the third largest island in the Greater Antilles chain. The first aquaculture species to be introduced into Jamaica was the *Oreochromis mossambicus* in 1949 from St. Lucia to supply rural communities with subsistence protein. Subsequently, tilapia was forgotten until 1976 when *O. niloticus* was introduced by the USAID/ Government of Jamaica project from Auburn University in Alabama. This species met with some success with farmers who generally preferred the smaller, darker, more prolific-spawning *O. mossambicus*. Production increase between 1976 and 1980 was mainly from O. *niloticus*. The project was rated as very successful and culture prospects were then quite attractive (Popma et al. 1984; Hanley 1991a, 1991b).

Subsequent to the introduction of *O. niloticus*, a number of other species have been introduced for aquaculture (Table 1).

The new species introduced met with varying success with farmers. Tilapia culture in Jamaica has gradually become widespread since the 1980s, and there was steady growth in the number of fish farmers showing interest in commercial production.

Annual production

Annual production of food fish from aquaculture has risen from a low of 0.1 t in 1976 to just over 5 000 t in 2 000 (Fig. 2). Much of the post-1985 production is based on red hybrids of tilapia. There was some reduction in production between 1991 and 1996, due to a slowing of national economic growth and natural disasters involving flooding (Hanley 2000).

The largest producer is Aquaculture Jamaica Ltd. comprising some 20 ha surface area in western Jamaica and a sister farm of 22 ha in the central part of the island. Details of the semi-intensive and intensive

Table 1. Species introduced into Jamaica for aquaculture.

Species (date of introduction)	Common name in Jamaica	Source/suppliers	Importance
Oreochromis mossambicus (1949)	African perch	St. Lucia, West Indies	Unpopular, relegated to rivers and smaller ponds
O. niloticus (1976)	Silver tilapia	Auburn Univ., USA	Limited success,still used by some farmers
Ctenopharyngodon idellus (1978)	Grass carp	Auburn Univ.	Rejected by public, used for aquatic weed control
Aristichthys nobilis (1978)	Bighead carp	Auburn Univ.	Rejected by farmers
Hypophthalmichthys molitrix (1978)	Silver carp	Auburn Univ.	Rejected by farmers
Colossoma macropomus (1978)	Tambaqui	South America	Rejected by farmers
O. mossambicus x *O. hornorum* albino (1984)	Florida red	Florida	Used for broodstock
O. mosssambicus x *O. aureus*? (species uncertain) (1984)	Red hybrid tilapia (Israeli strain)	Israel	Used for broodstock
O. aureus (red strain) (1985)	Cherry tilapia	Florida	Used for broodstock
Multiple crosses of Tilapia (variously *O. mossambicus* x *O. hornorum* and *O. aureus* x *O. mossambicus* and others) (beyond1986)	Red hybrid tilapia	Various (includes Florida,Auburn University, Taiwan, Israel)	Very successful, now widely cultured
Cherax quadricarinatus	Redclaw cray fish	Australia	Interest of farmers low

Fig. 1. O.* niloticus *harvested from a pond in Jamaica.

commercial tilapia culture are provided by Carberry and Hanley (1997). Of the 10 000 km^2 total land area, only approximately 14% is suitable for aquaculture due mainly to the dominance of porous limestone and a relatively limited water supply. Most tilapia farms are located on the south-central plains where clay soils and an extensive system of irrigation canals installed by the sugar cane industry provide the water supply infrastructure (Hanley 2000). The total aquaculture area is estimated at 526 ha in 2001. Of this, some 90% is under tilapia farming. Of the total production of 5 000 t, 4 500 t is tilapia, approximately 150 t of Chinese carp and 150 t of *Colossoma macropomus.* It also includes 120 t of penaeid shrimp, 25 t of freshwater prawn (*Macrobrachium rosenbergii*) and a small quantity of mangrove oyster and ornamental fishes. Most of the ornamental fishes are for export to the United States. Of the other products, all except tilapia are almost exclusively for local markets.

Levels of aquaculture

Aquaculture operations in Jamaica can be classified into: a) small-scale; b) medium-scale and c) large commercial operations. Small-scale aquaculture dominates with an estimated 300 farmers at the end of 2001 culturing mainly red tilapia hybrids. A few farmers also culture Chinese carps or *C. macropomus* in polyculture with tilapia. Only one farm cultures freshwater prawn (*M. rosenbergii*) at a significant level. Small-scale farmers have not been successful with marine shrimp farming. The expansion of small-scale fish farming is constrained by land ownership. Small-scale farms have an area of 1-4 ha (75% of farms) usually with ownership of the land. Fishponds are often not the only source of income for the family. Stocking rates are lower than practiced by medium-size producers, while food conversion efficiencies, survival and final average weight of the fish are similar (Hanley 2000). Yields are reported to be lower than achieved by medium-size farms in large part due to the lower stocking densities and the absence of aeration and contribute less than 10% of aquaculture production.

Medium-size farms range from 5

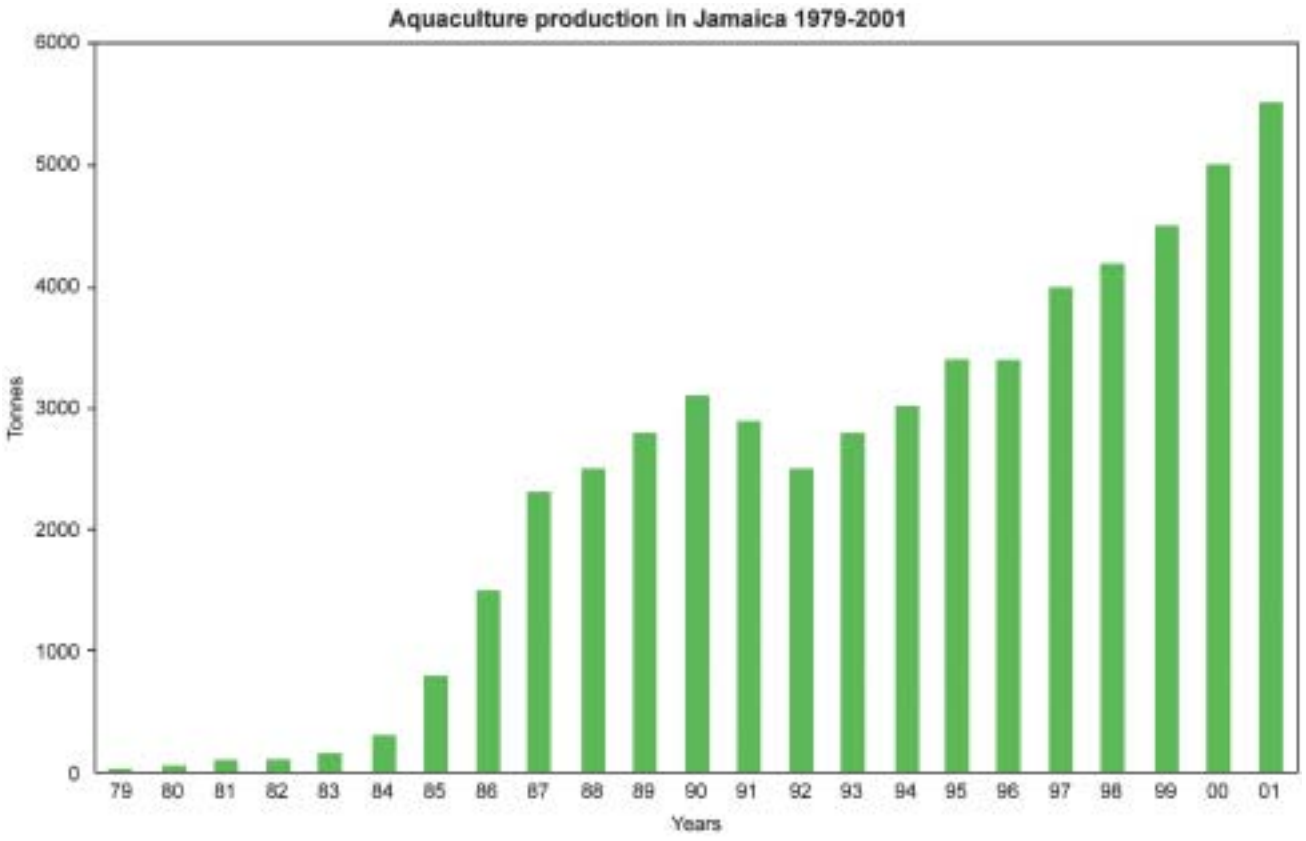

Fig. 2. Aquaculture production in Jamaica, 1979-200. (compiled from various sources).

to 20 ha (19% of farms) and may be owned or leased by the farmers. Harvests may be sold at farm site or to distributors or are under a contract-farming system (sold to large-scale operators who have processing facilities). Most medium-scale farmers have other agricultural income, e.g. from dairy or sugar cane plantations (Hanley 2000).

Large farms or industrial scale farms range from 21 to 45 ha (6% of farms) and are owned either in partnership or are part of a large firm engaged in other business. Thus, they often have other commercial interests whose profits can sustain longer-term investment in aquaculture.

Tilapia culture

On larger commercial farms, ponds are usually rectangular with a mean depth of 1.0-1.5 m. Most are equipped with concrete monks for draining. Most of the larger farms maintain their own broodstock of red tilapia hybrids (Fig. 3). Various phenotypes with differing pigmentation patterns are observed on the farms including red/gold-scalloped, zebra-mottled, white and speckled varieties.

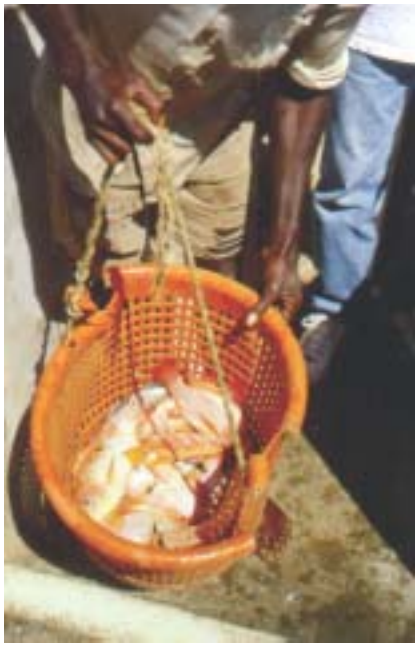

Fig. 3. Red hybrid tilapia cultured in Jamaica.

Monosex male tilapia culture is the main practice and 17á - methyltestosterone is the preferred androgen for treating fry to produce "all-males". Success rates approaching 97% males are reported. Tilapia fingerlings are cultured in a single phase system. The nursery ponds on larger farms are about 0.8 ha each with phytoplankton blooms maintained and with nightly aeration from paddlewheels (Fig. 4). Ponds are stocked with hatchery-produced fry at 36 000-50 000/ha and fed 35% protein feed. After 100 days, fry attain 70 g.

Grow-out pond sizes vary but 0.20 ha ponds are common. The grow-out may be in a single phase stocked directly from the nursery or a two-phase system. The first phase grow-out is in aerated green-water ponds producing 200 g fish. Second phase production ponds raise fish of 200 to 600 g and these are harvested for processing. Fish in grow-out ponds are fed with 28-32% protein feeds, containing 10% fishmeal. The most productive ponds are aerated flow-through ponds producing 45 t/ha/yr (Hanley 2000). Grow-out is for 150 days to produce 0.5 kg fish and 350 days to produce 1.0 kg fish. The harvest is transported for processing in aerated tractor-drawn carts. Strict sanitary practices and careful handling at all stages are in force at the processing facilities and the continued success of the operations is perhaps testimony to that ethos. This is the usual procedure followed at larger culture facilities. Small-scale farmers carry out similar exercises on their farms.

Table 2 shows production parameters for the three categories of tilapia producers.

Generally, farm-raised tilapia larger than 200 g are well received by consumers and much of the small-scale production is sold at pondside by the farmer, or fresh on ice through a network of vendors operating from small roadside locations and from vehicles.

Fig. 4. Typical grow-out ponds with aerators.

Other aquaculture fish species

Ornamental fish: The prospects for ornamental fish farming in the late 1990s seemed to be relatively bright. However, the interest has diminished to a few species cultured on approximately 60 ha (Hanley 2000). Production figures for these species are not available.

Australian redclaw crayfish: *C. quadricarinatus* was introduced in 1997 and was being investigated by a few aquaculturists for its culture potential. Since the increases in freshwater prawn production occurred at about the same time, interest in this crustacean has waned considerably. It may now be of local biodiversity concern, as it has accidentally escaped into streams near farms and may be displacing native crustacean species.

Giant freshwater prawn culture: *M. rosenbergii* is cultured by only a few farms, always in polyculture with tilapia, the latter always as the major crop. Adults are harvested at approximately 100 g. The species has proven quite popular and is tending towards replacing marine shrimp in many hotels and restaurants.

Oyster culture: Oyster culture began in 1977 with studies to assess feasibility. Initial culture efforts

Table 2. Production parameters for small, medium and large tilapia producers. Data based on interviews with selected farmers. Figures are rounded averages (adapted from Hanley 2000).

Parameter	Small farm (1-4 ha)	Medium farm (5-20 ha)	Large farm (21-45 ha)
Phases of production[a]	1	2	3-4
No. of crops/year	2.0	2.0	1.4
Aeration (Hp/ha)[b]	0	5	20
Water exchange (%/d)[b]	0	0-10	150
Stocking density (Fish/ha)[b]	16 000	25 000	120 000
Survival (%)[b]	90	90	92
Market size (g)[b]	315	360	585
FCR	1.5-1.6	1.6-1.7	2.0-2.1
Yield (kg/ha/yr)[c]	9 000	16 000	45 000

[a] Post-hatchery;
[b] Data from final grow-out phase;
[c] Average over total area of farm.

centered on Bowden, St. Thomas in eastern Jamaica in an area that had high density of mangrove oyster, *Crassostrea rhizophorae*. There was previously a small, well-established traditional market for raw oysters in Kingston, the capital. The plan was to better service this market and to provide a new employment option. The initial technology was adapted from Cuban techniques (Wade et al. 1981). Naturally produced spat settle on the artificial rubber tyre cultch during the spawning season, and grown for eight weeks. Afterwards they are transferred to deeper water for a grow-out phase of 4-5 months on either racks or rafts. Culture was attempted at several coastal sites, but the most successful location has been on the east coast. There were few parasites and growth rates were relatively good. The industry has suffered from pollution and theft. A review of the methods, production and problems is provided by Richards (1992).

Marine shrimp culture. Haughton and King (1992) reviewed mariculture potential and reported it useful to investigate a range of marine fish and crustacean species including groupers (Serranidae), snappers (Lutjanidae) as well as penaeid shrimps and queen conch (*Strombus gigas*). In 1996, a small-scale project which investigated the spawning, larval culture and growth rate of marine shrimp (*Penaeus vannamei*) started with the financial assistance initially from the University of the West Indies, and later, from South Korea. Small hatchery facilities are at the Port Royal marine laboratory, near Kingston, and grow-out ponds are 30 km west of Kingston. Results have been unclear, but seem to hold some promise. Limitations locally, however, include a very small tidal fluctuation (20 cm) and high water pumping costs.

Diseases, parasites and predation

Jamaica is fortunate that parasites and diseases are rare. In 1984, the gill fluke *Gyrodactylus* was reported from an experimental fish farm in the central south coast. This species entered the country with Israeli tilapia broodstock. There has been no recurrence since. There are short-term outbreaks of *Trichodina* and *Ichthiopthirius* and 'cold snaps' between December and February sometimes causing mortalities when fish are stressed. Small gastropod snails such as *Thiara granifera* are rated as nuisance species and they are presently free from parasites. During marine cage culture of red hybrid tilapia, these could be infected with a parasitic flatworm, *Neobenedenia melleni* (Monogenea: Capsalidae) as reported by Robinson et al. (1992). A variety of avian predators, mainly egrets and herons, affect culture systems. Bird numbers on larger farms may be high, forcing farmers to use bird-snagging wires.

Economic Aspects

Historically, various economic aspects of fish culture are given by Street (1978), and Ross (1983). Some government departments have produced analyses (e.g. Agro-21 1983a, 1983b), while economic issues concerning integrated fish farming were reported by Wright (1995). Table 3 shows the comparative costs of inputs for tilapia culture for 1984, 1991 and 1998.

With the costs varying in 1984 and 1998, it is a challenge for Jamaican fish farmers to stay in business. However, when the US$ is adjusted for inflation for those years (by a point factor of 1.564), it shows that despite increases of 16% and 8% respectively, in the costs of feed and fingerlings and increases of 29% for transport, 33.8% for labor and a decline of 30% in the cost of diesel fuel, the cost of producing a kilogram of fish declined by 8.5% (Hanley 2000). This suggests improved efficiencies in operation, which have been assisted by an increase in the selling price of fish of 21% in the same period. The increase in the selling price has been greater than the increases in the major cost factors (Table 3).

Prices are presently high on the international market, especially for value added products. Not surprisingly, major tilapia producers are already into the market for fillets and frozen whole fish in Europe. The principal constraints for development include lack of credit, limited land space, inadequate water supply and water quality, and distribution and marketing ability. The tight quality controls have, in the opinion of the authors, greatly benefited the efficiency of fish farms.

Table 3. Costs of selected inputs, costs of production and selling price of tilapia, 1984-1998 in US$/kg. (% increase from 1984; adapted from Hanley 2000).

Parameter	1984	1991	1998
Feed (US$/kg)	0.328	0.359 (9.4%)	0.380 (15.8%)
Fingerlings(US$/1,000 @ 20 g)	3.988	3.731 (-6.4%)	4.310 (8.1%)
Labor (US$/hr)	1.564	6.159 (293.8%)	6.850(337.9%)
Transport (US$/kg)	0.031	0.024 (-22.6%)	0.040 (29.0%)
Diesel fuel (US$/l)	0.485	N/A	0.340 (-29.9%)
Cost of production(US$/kg)[d]	1.736	1.770 (1.9%)	1.620 (-8.5%)
Selling price(US$/kg)[e]	2.190	3.133 (43%)	2.650 (21.0%)

[a] Data from Popma et al.., (1984), Hanley (1991) and interviews with farmers;
[b] 1US$=J$: 1984 = 3.15; 1991 = 8.00; 1998 = 36.50.
[c] All values in "equivalent 1998 dollars" adjusted for inflation by the factors: 1984 = US$1.564; 1991 = US$1.196; 1998 = US$1.00 (Source Department of Economics, University of the West Indies).
[d] Medium-size farm.
[e] Selling price at pondside; N/A = Data not available.

Investment environment

A major disincentive to investment in aquaculture for private investors is the high interest rates, varying 60-35% annually in 1995-2000. These rates by international standards are punitive. Therefore, it is not surprising that there have not been a lot of overseas or local entities investing in Jamaican aquaculture. The major culturists are, in fact, major feed and poultry producer/suppliers. Aquaculture therefore, represented for them, logical expansions, as feed supplies were neither problematic nor requiring of additional capital outlay.

Education and Research

The University of the West Indies, Mona campus (UWI) has offered a final year 6-week course in aquaculture from 1984. The course is now combined with fisheries as Fisheries and Aquaculture Technologies since the 1996/97 academic year (see also Aiken and Steele 1986). The private sector has also allowed useful interactions with the practical component of the course. Applied research led by the Life Sciences Department, Mona has centered on the acclimatization of red tilapia hybrids to seawater in cages (Hall 1991; Grant 1995), stocking density variation and effects on growth rates (Morris 1995; Barrett 2001) and protein digestion (Hanley 1986). Some success has been achieved with cage mariculture, although growth rates are slower than those obtained in ponds. Feeding and stocking rate trials in dug-out ponds revealed that red hybrids responded rapidly to improvements in feed type and protein content. Aquaculture Jamaica Ltd. has an active program of research and development with a focus on improving feed conversion and growth, water quality consistency, genetics and market appearance. A useful handbook for fish farmers and potential investors was prepared by Hanley (1990). There is great potential for increases in research linkages between the UWI and private aquaculturists, which could contribute to improved production.

Future Prospects

Much valuable experience in aquaculture has been gained since 1977. Culture technologies have been tested, a trained cadre of technical expertise exists and the economics well understood. High interest rates, limited land and water supply are hindering growth of the industry. If the internal investment environment becomes less hostile and external markets remain strong, the future of Jamaican aquaculture could be quite good.

Acknowledgement

The authors thank John Carberry of Aquaculture Jamaica Ltd. for comments on this draft.

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