7.4 Freshwater fish seed resources in Cameroon

Randall E. Brummett
WorldFish Center
BP 2008 Yaoundé
Cameroon
R.Brummett@cgiar.org

Brummett, R.E. 2007. Freshwater fish seed resources in Cameroon, pp. 171–183. In: M.G. Bondad-Reantaso (ed.). Assessment of freshwater fish seed resources for sustainable aquaculture. *FAO Fisheries Technical Paper.* No. 501. Rome, FAO. 2007. 628p.

ABSTRACT

The climate, land and water resources of Cameroon, combined with the high demand for fisheries products, makes this Central African country a high potential area for aquaculture. Fingerling availability and quality have been identified as key constraints which hold the sector back from rapid expansion. Nile tilapia (*Oreochromis niloticus*) and sharptooth catfish (*Clarias gariepinus*) are the two most widely cultured species and are often grown in polyculture. Some 32 government hatcheries have been built, but few are functional and none operates at full capacity. Most producers rely on 14 small-scale, private sector hatcheries for their seeds, but supply is irregular and quality remains a serious problem. New policy and research initiatives undertaken by a coalition of government, private sector and international research agencies are underway to address these inadequacies.

INTRODUCTION

Cameroon is located in the crux between West and Central Africa, the tropical rainforest and the Sahel. The wide range of ethnic groups and ecosystems has lead many to refer to Cameroon as "Africa in Miniature". Within this microcosm, are 35 000 km^2 of aquatic habitats, representing many of the key aquatic ecosystems that prevail over the continent (Figure 7.4.1): large natural lakes (Lake Chad), reservoirs on dammed rivers (Lagdo, Mape, Bamindjing), crater lakes (Barombi Mbo, Nyos), large rivers (Benue, Sanaga, Cross, Mungo, Wouri, Dibamba), rainforest rivers (Nyong, Ntem, Kienke, Ndian, Lobe, Lokoundji) and thousands of km of first and second order streams (representing 86 percent of total freshwater resources). Overall, including coastal fisheries in the Gulf of Guinea, Cameroon currently produces some 120 000 tonnes of fish per year, 55 percent from inland and 45 percent from coastal waters, according to the Government of Cameroon.

Within this vast array of aquatic resources reside at least 600 species of freshwater fish, a number of which are suitable for aquaculture, a smaller number of which have actually been produced commercially (Table 7.4.1). Most of these are alien to the basins in which they are cultured, having been introduced by various aquaculture projects.

TABLE 7.4.1
Most commonly cultured fish species in Cameroon

Species	Native range in Cameroon	Introduced to/cultured in
Tilapia, *Oreochromis niloticus*	Benue River, Lake Chad	Sanaga River Basin, All Reservoirs, Lake Nyos, Mt. Cameroon watershed
Catfish, *Clarias gariepinus*	Benue River, Lake Chad,	Sanaga River Basin
Kanga, *Heterotis niloticus*	Benue River, Lake Chad	Nyong River Basin
Carp, *Cyprinus carpio*	none	Northwest, West & Central Provinces
Snakehead, *Parachanna obscura*	nearly ubiquitous	unknown
Banded jewelfish, *Hemichromis elongatus*	nearly ubiquitous	unknown

PLATE 7.4.1
Most commonly cultured fish species in Cameroon

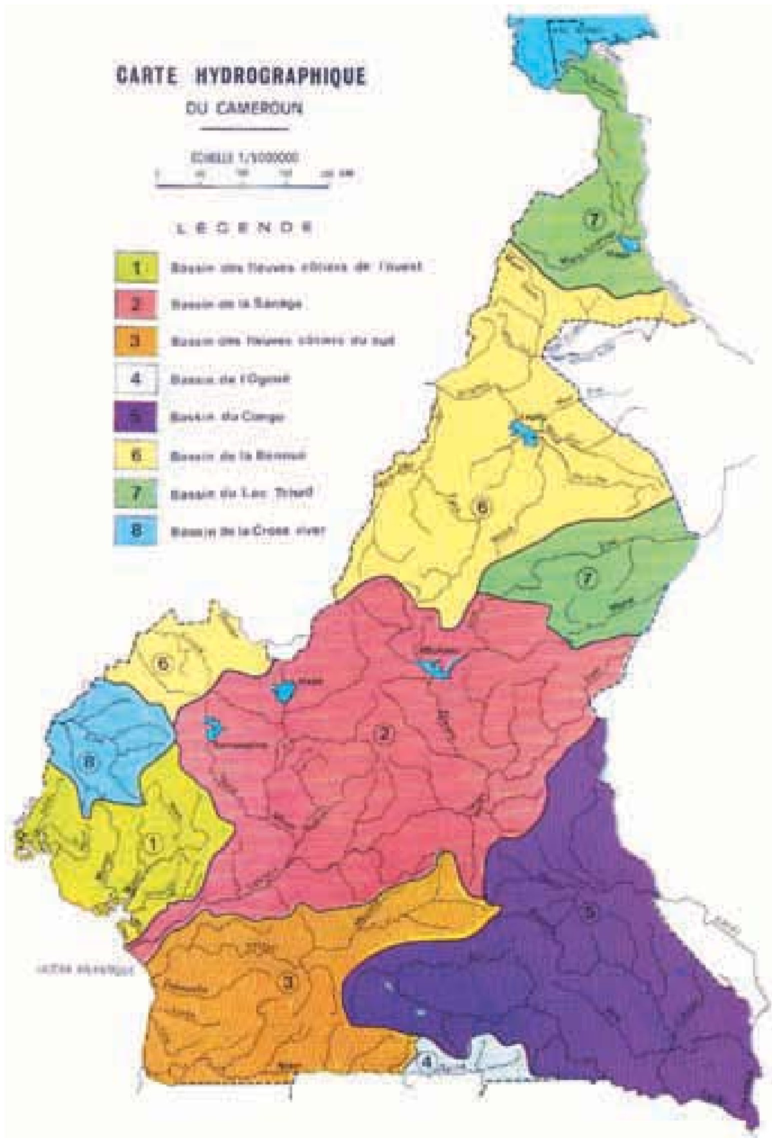
Tilapia (*Oreochromis niloticus*)

Banded jewelfish (*Hemichromis elongates*)

Catfish (*Clarias gariepinus*)

Kanga (*Heterotis niloticus*)

FIGURE 7.4.1
Hydrographic map of Cameroon



Source: Vivien (1991)

Fish farming started in Cameroon in 1948. Its subsequent development can be chronologically summarized as follows:

- 1954: under the French colonial administration, 22 public stations are built to strengthen the action of extension agents; more than 10 000 private earthen ponds around the country.
- 1960: the country is independent. Coffee and cocoa receive most of the government's attention, and support to aquaculture collapses. Competition with fish captured in newly constructed hydroelectric dams reduces economic viability of aquaculture and by 1963 most ponds are abandoned.

- 1968-1976: A United Nations Development Programme/Food and Agriculture Organization of the United Nations (UNDP/FAO) regional project increases the number of extension stations to 32. Foumban station trains more than 150 extension agents. However, financial problems and weak national institutions hindered growth.
- 1980-1990: A number of short-term projects support fish farming: United States Agency for International Aid (USAID, 1980-1984); International Development Research Centre (IDRC, 1986-1990); General Administration for Development Cooperation (AGCD, Belgium); Haskonig (Netherlands), Mission française de coopération et d'action culturelle (MCAC, France). Peace Corps volunteers remain the main manpower for aquaculture extension until 1998 and the remnants of these projects are still visible today.
- In 1994, the government devalued the Central African Franc (CFA) by 50 percent. Availability of fish decreased (from 50 000 tonnes in 1993 to 45 000 tonnes in 1995) while prices rose by an average of 40 percent. The shortage had the most immediate effect on rural fish supplies and created a strong incentive to produce fish locally.
- By 1997, some 5 000 ponds belonging to 3 000 farmers were functioning with a total output of over 300 tonnes of fish, mostly tilapia. The average production was about 1 200 kg/ha/yr. In some projects, production has been temporarily increased by four to six fold.
- leading to the belief that aquaculture might be profitable. The President and a number of other high government officials construct fish ponds.
- In 2000-2005, the WorldFish Center (WFC), the International Institute for Tropical Agriculture (IITA) and the United Kingdom Department for International Development (DFID) implemented a participatory research project in partnership with the Government of Cameroon and a number of local non-governmental organizations (NGOs). By linking small-scale producers to markets, this project managed to increase cash income to rural producers, thus creating a much larger interest in intensified production systems than previously (WorldFish Center, 2005).

In 2005, nearly 49 percent of animal protein consumed in Cameroon, 17 kg/person/yr, consisted of fish. Demand is high and continues to rise with imports passing 53 000 tonnes in 1997, 63 000 tonnes in 1998 and 78 000 tonnes in 1999. In 2002, Cameroon imported 182 000 tonnes of fish, representing 52 percent of domestic supplies, at a total cost of nearly US$90 000 000 (FAOSTAT, 2004). Fish prices remain stubbornly high at around US$3.50/kg live weight on the wholesale market. Through a series of recent consultations facilitated by FAO (April 2003, December 2004) and WorldFish (April 2004, November 2004), access to markets, availability of high quality technical backstopping and regular supply of fish fingerlings have been repeatedly identified as key constraints to growth. According to the government, if these can be overcome, Cameroon has the biophysical potential (i.e. land, water and feed materials) to easily produce 20 000 tonnes of fish per annum through aquaculture and increase over current production of nearly two orders of magnitude.

SEED RESOURCES AND SUPPLY

Of the 32 national fish stations, most of which were designed with the primary objective of producing fingerlings to support the growth of aquaculture, only the Yaoundé Fish Station (supported under the WFC project) and the Institute for Agricultural Research for Development (IRAD) Foumban Research Center continue to produce fingerlings, albeit irregularly and at high prices and variable quality (Figure 7.4.2).

Although these stations listed below are largely dysfunctional, some of the most important of them possess considerable infrastructure and potential for contributing to aquaculture development if either properly managed or transferred to the private sector:

- Ku Bome (26), 35 ponds, 5.9 ha
- Bamessing (29), 13 ponds, 1.5 ha
- Bambui-N'kwen (24), 22 ponds, 1.7 ha
- Foumban (28), 53 ponds, 3.5 ha
- Yaoundé (5), 14 ponds, 2.0 ha
- Ngaoundere (19), 24 ponds, 4 ha
- Bertoua (13), 42 ponds, 12 ha
- Garoua Boulai (15), 9 ponds, 4.2 ha

As these government stations have failed to alleviate any of the main constraints to aquaculture, fish farmers have increasingly turned to other suppliers for information and fingerlings. Since the revision of the laws covering the formation of farmers groups was lifted in 1990, over 90 NGOs and Common Initiative Groups dealing with agriculture and rural development including aquaculture, have sprung up. Many of these offer technical advice on aquaculture and a few have attempted to operate small hatcheries to supply their members with seed. Unfortunately, the level of technology used by these groups is minimal and none of the efforts to overcome the seed shortage have so far produced sustainable outcomes.

FIGURE 7.4.2
Government aquaculture stations in Cameroon (2005)

As a result of the failure of hatcheries to meet demand for fingerlings, most farmers buy or trade amongst themselves, or buy from fishers. Juvenile tilapia, catfish and carp seeds can account for large percentages of total harvest in poorly managed farm ponds. Feral kanga (*Heterotis niloticus*) fingerlings are normally purchased from fishers working in the Nyong River at Akonolinga.

The poor seed supply situation is exacerbated by the lack of critical mass among growers. Without sufficient numbers of growers to buy fingerlings over the course of the year, hatcheries cannot be profitable. On the other hand, without suitable fingerlings, available when needed, producers cannot produce. Since 2002, the WFC project, in conjunction with the Government of Cameroon and a local NGO, *Service d'Etudes et d'Appui aux Populations a la Base* (SEAPB) have focused attention on the linkage between markets, producers and hatcheries with the objective of developing practical, private-sector hatchery, grow-out and marketing strategies that can allow small-scale producers to participate and possibly lead, the growth of fish farming in and around the urban markets of central and western provinces. At present, five private hatcheries (three catfish, two tilapia) engaged in this project are the main suppliers of high-quality fingerlings in the country (Table 7.4.2).

The total number of fingerlings traded is unknown and government production statistics are unreliable as most fish are consumed in villages and do not reach urban markets where they might be counted. According to WFC project datasets, approximately 15 tonnes of fresh catfish were traded on the urban market of Yaoundé in 2004. To produce this amount of fish, 185 000 catfish fingerlings were stocked. Tilapia are stocked at 1.5 fish/m^2, suffer about 20 percent mortality and are marketed at an average of about 80 g. If these values are extrapolated to the government estimates (2002) of 210 tonnes of tilapia and 114 tonnes of catfish, the total number of fingerlings stocked was on the order of 1 400 000 catfish and 3 300 000 tilapia.

TABLE 7.4.2
Private fish hatcheries known to be operating in Cameroon as of November 2005

Farmer	Location	Species	Facilities	Status
Nkoua, Bruno	Nkoabang, Central Province	catfish	hatchery building + seven ponds, 9 000 m^2	active
Etaba, Desiré	Nkolzoa, Central Province	tilapia	11 ponds, 1 430 m^2	active
Diogne, Michel	Batié, West Province	catfish	hatchery building + six ponds, 2 400 m^2	active
Noupimbong, Maurice	Bapi, West Province	catfish, tilapia	six ponds, 700m^2	active
Ndoumou, Antoine	Nkolmesseng, Central Province	catfish	one pond + eight tanks, 2 500 m^2	active
Wouanji, Jean	Bandjoun, West Province	catfish	three ponds, 900 m^2	startup
Youdom, Bernard	Batié-Nsoh, West Province	catfish	ten ponds, 5 000 m^2	startup
Tamo, David	Bafoussam, West Province	catfish	six ponds, 1 200 m^2	startup
Awoa, Lucien	Yemssoa, Central Province	catfish	hatchery building + five ponds, 3 200 m^2	startup
Tabi, Abodo	Mbankomo, Central Province	tilapia, catfish	hatchery building + 19 ponds, 9 500 m^2	dormant
Yene, Joseph	Nkoabang (Lada), Central Province	catfish	12 ponds, 360 m^2	periodic
Yong-Sulem, Steve	Mbankolo, Central Province	catfish	23 ponds, 2 100 m^2	periodic
Oben, Benedicta	Buea, SW Province	catfish	hatchery building + five concrete tanks	periodic
Ebanda, Jeanne	Mbandoum, Central Province	tilapia	17 ponds, 7 000 m^2	dormant

SEED PRODUCTION FACILITIES, TECHOLOGY AND ECONOMICS

Tilapia

Tilapia fingerlings are produced in open ponds of 50-150 m^2 (Figure 7.4.3). The system used at the Nkolzoa Fingerling Centre near Sa'a in Central Provice is typical: broodfish are randomly stocked at a rate of 40 males (average of 210 g) and 40 females (average of 110 g) into 130 m^2 earthen ponds to reproduce. Fingerlings are captured with a fine-mesh seine net beginning 51 days after broodfish stocking and is repeated every 21 days until capture begins to decline (normally after about three months). Harvested fingerlings average about ten grams, are held for two days to recover from the harvest operation and sold at 25 Cameroon Franc (CFA) per piece (US$1 = CFA500).

FIGURE 7.4.3
Nkolzoa Tilapia Fingerling Centre, Sa'a, Cameroon

Catfish

Basic catfish reproduction technology has been well-established over the last 20 years as described by de Graaf and Janssen (1996). In a typical reproduction in Cameroon, 35 female *C. gariepinus* averaging 550 g are injected with 4 000 IU/kg of human chorionic gonadotropine (HCG) to induce final gonadal maturation and stripped after approximately 12 hrs. Eggs of all females are pooled and then dry fertilized with mixed milt from nine sacrificed males. Fertilized eggs are poured onto 70 x 50 cm wooden framed nylon-mesh screens where they adhere and are submerged to 40 cm depth in 1 m^3 hapas installed under the water inlet pipe (to ensure adequate exchange of fresh water) in 150 m^2 earthen ponds (Figure 7.4.4a), or in indoor cement tanks (Figure 7.4.4b). Eggs hatch within 30-35 hrs and are subsequently held in their hapas for two days prior to stocking, by which time they have reached an average individual weight of 2.3 mg. Hatching and survival rate to two days average 95 percent. Production costs for these two-day old larvae are shown in Table 7.4.3. Including a profit-margin, these larvae are sold on the pond bank at five CFA each.

Few farmers, however, want such small seed, 7-10 g being the minimum size to insure decent survival rates. As catfish fry are susceptible to a wide range of predators (Figure 7.4.6) including cannibals, the greatest problems encountered by catfish hatchery operators in the West and Central Provinces concern larval survival.

FIGURE 7.4.4a
Hapa-based, in-pond catfish incubators

FIGURE 7.4.4b
Gravity-fed hatchery tanks

TABLE 7.4.3
Costs for artificial reproduction of Clarias gariepinus (US$ 1 = CFA 500)

Cost Item	Unit Price	Units	Total Cost
Sacrificed ♂ broodfish	2 000	9	18 000
Depreciation on ♀ broodfish (2 yrs)	2 000	35	35 000
HCG	4 500	2	9 000
Disposable equipment (syringes, hapas, etc.)	5 000	1	5 000
Labor	250 (per person-hour)	40	10 000
Depreciation on ponds (10 yrs)	100 000	8	80 000
Total			**157 000**
Total larvae (24 hrs post hatch)			68 700
Cost per larvae			**2.3**

Three basic nursing systems are used:

1. **Low intensity:** Ponds are prepared by drying, cleaning and installing compost cribs comprised of wooden stakes driven into the mud at approximately 10 cm intervals to enclose 10 percent of the pond surface area. Ponds are then surrounded by a 1 m high fence fabricated of locally produced nylon mesh bags or aluminum roofing material to in an effort to exclude frogs, one of the most important larval predators. The compost cribs are filled with 7 kg/are total dry weight (approximately 20 kg wet material) of cut grasses mixed with 0.2 kg/are of wood ash. Ponds are then filled and stocked within three days (to avoid infestation by insects) with two-day old *C. gariepinus* larvae at a rate of 7.5 per m². Once per week, the compost is churned using a stick and another dose of grass and wood ash added.
2. **Medium intensity:** Ponds are prepared as in System 1, but instead of compost, ponds are limed with 2.5 kg/are of quicklime (CaO), fertilized with 20 kg/are (dry weight) of chicken manure and fed a daily supplement of wheat bran at a rate of 1 kg/are. Stocking rate is 15 two-day old larvae/m².
3. **High intensity:** Ponds are prepared as in System 2, but from Day 11 onwards, are fed twice per day with a 1:1 mixture of wheat bran and palm nut cake at a rate of 1.0 kg/are (2.0 kg/are/day total). Two-day-old larvae are stocked at 30/m². As in treatments 1 and 2, a frog fence and last-minute filling are the only anti-predator strategies employed.

Production cost factors are shown in Table 7.4.4 while average results are shown in Table 7.4.5. Survival among systems using only a frog fence and last-minute filling as predation control was about 37 percent, typical for this type of system.

FIGURE 7.4.5
Small-scale private catfish hatchery at Bapi, Western Province, Cameroon

FIGURE 7.4.6
Main predators of catfish larvae

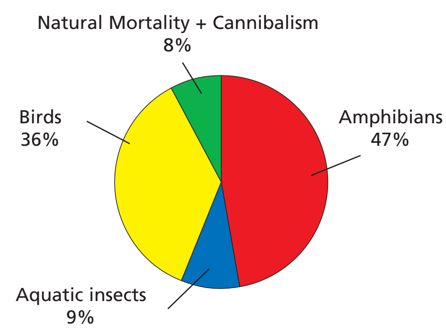


TABLE 7.4.4
Average costs per square meter of pond surface area, for nursing Clarias gariepinus in periurban Yaounde, Cameroon (US$ 1 = CFA 500)

System	Larvae	Pond inputs	Labor	Depreciation on predator fence	Depreciation on ponds & equipment	Total cost Per m²
1	37.5	7.8	233.3	12.5	15.2	306.2
2	75.0	50.4	373.6	10.3	13.9	523.3
3	150.0	95.1	577.1	12.8	15.3	850.3

TABLE 7.4.5
Fingerling survival, final average weight, number harvested and profitability data per m² for *Clarias gariepinus* nursing systems (over 35 days) in periurban Yaoundé, Cameroon. Price of fingerlings is dependant upon size of fingerlings: >5 g = CFA 100, 2-5 g = CFA 75, < 2 g = CFA 50 (USD 1 = 500 CFA)

System	Survival (%)	Final average weight (g)	Number harvested per m²	Gross revenue per m²	Net profit Per m²
1	48.5 ± 26.31	5.9 ± 2.23	3.6 ± 1.97	322.0 ± 163.23	15.8 ± 183.71 a
2	46.8 ± 43.35	5.5 ± 3.23	7.0 ± 6.50	527.4 ± 485.67	4.13 ± 488.83 a
3	28.4 ± 6.12	4.2 + 0.31	8.5 ± 1.84	723.75 ± 268.33	-126.6 ± 275.87 a

SEED MANAGEMENT AND QUALITY

Where small-scale hatcheries have managed to generate significant incomes for the operators and numbers of fingerlings for other farmers, deterioration of the genetic quality of cultured populations was another problem encountered that dilutes impact. The species most commonly produced in Cameroon, catfish (*Clarias gariepinus*) and tilapia (*Oreochromis niloticus*) each presents the hatchery operator with opportunities to mismanage broodstock.

For the highly fecund catfish, there is always the temptation to use the fewest number of broodfish possible to get a certain number of eggs. In addition, male catfish are usually sacrificed and so are used to fertilize as many females as possible (Figure 7.4.7). From these offspring of minimal numbers of parents will be selected the next generation of brooders and after several generations of such mating, bottlenecks lead to inbreeding which can reach levels sufficient to lower growth, decrease fecundity, reduce fitness and generate deformities.

Tilapias present a somewhat different challenge, but the outcome is the same. The typical practice at harvest among small-scale farmers is to sell or eat all fish of a certain minimum size, leaving smaller individuals to be either sold as fingerlings to other farmers or continue growing in the pond.

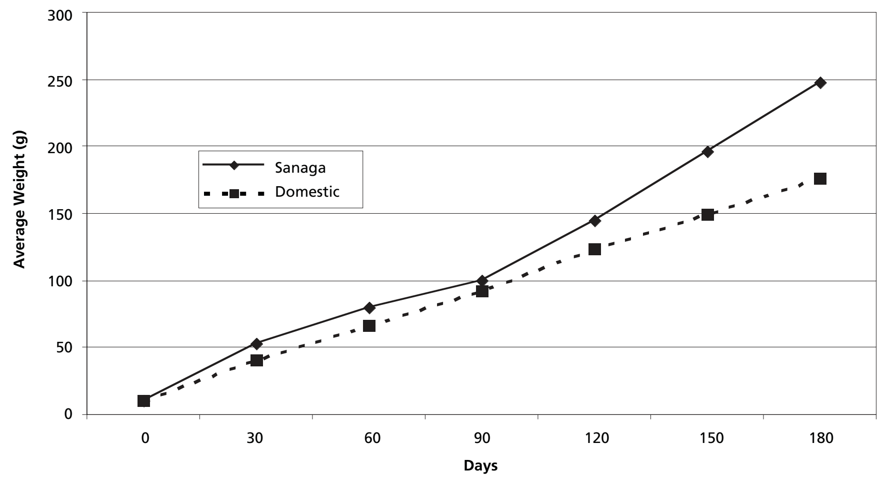
In the case of tilapia, only a part of these small fish are actually fingerlings; many being small are sexually mature adults (Figure 7.4.8). Such selection for smaller adults amounts to inadvertent selection for slow growth and/or early sexual maturation.

Often the numbers of broodfish used are far inferior to the numbers needed to maintain adequate

FIGURE 7.4.7
Sacrificing male catfish to obtain milt

FIGURE 7.4.8
Precocious juvenile (sexually mature at ten cm and < three mos of age) of *Oreochromis niloticus* harvested from a typical small-scale fishpond

FIGURE 7.4.9
Comparison of growth among feral and captive populations of *Oreochromis niloticus* in Cameroon



genetic variability in the population. Also, as male tilapia are highly territorial and competitive for mates, a relatively small percentage of males (the most aggressive and not necessarily the fastest growing) dominate the fertilization of the females. Without some method of ensuring that most males are represented, effective breeding number (N_e) will be less than anticipated and the population can become inbred, reducing growth and viability while increasing phenotypic variation.

Genetic drift, especially the founder effect, is another mechanism that can lead to loss of genetic diversity and the potential for inbreeding. Small founder populations are more common than not in Cameroonian aquaculture and, indeed, aquaculture in general. Being expensive, difficult and often illegal, individuals who seek to acquire exotic broodfish, often resort to minimal numbers, thus building low genetic diversity into their production systems from the outset.

Cumulatively, these various broodstock management mistakes have reduced the growth of tilapia populations held on small-scale hatcheries by about 40 percent (Figure 7.4.9). Although, it was not carefully documented, the replacement of male *Clarias* with feral broodfish at the Yaoundé Aquaculture Station produced offspring exhibiting signs of heterosis (substantially increased growth rate over the parental populations) indicating that the same is probably true for the catfish.

In response to these problems and *in lieu* of a practical broodstock management strategy for small-scale hatcheries, new broodfish populations have recently been acquired through agreements with local fishers to capture and hold both catfish and tilapia. Under the auspices of the WFC office in Yaoundé, these fish are being distributed at cost to local hatcheries. Farmers, having become aware of the growth differences between their existing and the wild fish are not insisting on new bloodline ("*les nouveaux souches*") when they place their orders.

INSTITUTIONAL AND POLICY FRAMEWORKS

The Ministry of Animal Industries and Fisheries (MINEPIA) is charged with the promotion of aquaculture for food security and rural economic development (RDC, 2003). However, current regulations in Cameroon barely mention aquaculture and make no specific reference to fingerling supply or quality. Nevertheless, the government is actively advocating the expansion of aquaculture and there is a long-standing policy of providing some basic support through the operation of the government stations mentioned above (RDC, 1997). Although there are no specifics provided and no funding mechanism identified, the Rural Development Strategy Paper (RDC, 2002) noted several prospective roles for government in the promotion of aquaculture, such as:

- extension of appropriate techniques for aquaculture;
- training of extension agents and farmers;
- development of a functional technical and economic framework;
- advising banks on the viability of aquaculture and opening lines of credit for investors;
- promoting private sector fingerling production;
- involving women and youth in aquaculture;
- organization of restocking programmes.

Although not part of the legal code, the newest policy document that deals with aquaculture is the Poverty Reduction Strategy Paper (RDC, 2003). This document emphasizes "the lifting of constraints to the production of fingerlings and transferring technical solutions to peasant farmers" as main areas of government engagement. Although MINEPIA extension staff are more or less committed to lifting constraints to aquaculture, there currently exists no structure formally charged with the assurance of fingerling or broodstock quality, or any quantitative criteria against which such assurance could be given.

In light of the vague nature of the current regulations, the FAO has recently commissioned a review of the fisheries and aquaculture laws (Kamga, 2005). Although the ways and means are not mentioned, the proposed new regulations charge MINEPIA with stimulating the expansion of aquaculture by providing support to:

- aquaculture investment;
- production and quality assurance of fingerlings;
- production and quality assurance of fish feeds;
- regulating the introduction and movement of aquatic organisms;
- research and extension.

This review of the regulatory environment is a first step in the implementation of a Strategic Framework for Aquaculture in Cameroon developed in 2003 by a consultative group comprised of the Cameroonian Fisheries Department of MINEPIA, the Institute of Agricultural Research for Development (IRAD) of the Ministry of Scientific Research and Innovation (MINRESI), the WFC and the FAO. In this document, the relative roles of government, investors and farmers are elucidated:

Governments:

- provides regular information on sources and prices of good quality seed to producers;
- provides guidelines in producing/ensuring good quality seed through such measures as seed certification;
- maintains broodstock of selected culture organisms corresponding to the identified production systems; and
- encourages commercial farmers and hatcheries to facilitate access to quality seed for the entire sub-sector.

Direct investors (seed producers):

- produce and distribute quality seed;
- sell products at a fair price;
- find mechanisms to facilitate access to high quality seed throughout the sub-sector;
- as appropriate, assist outreach program in promoting good management practices favouring improved yields; and
- monitor results.

Producer organizations:
- serve as a forum for information sharing among stakeholders;
- lobby for collective bargaining and appropriate public sector intervention; and
- link with research organisations.

KEY STAKEHOLDERS

As aquaculture does not play a dominant role in government planning or budgeting, relatively few resources, both human and financial, are available. Most of the key contacts in fingerling production come from the private sector (Table 7.4.2). In terms of institutional support, the main stakeholders are:

Fisheries Department, MINEPIA. (Dr Baba, Malloum Osman, Director; Mr Jean Kouam, Chef de Service for Aquaculture). As mentioned above, MINEPIA is charged with the development and implementation of aquaculture policy. Main activities include the operation of the above-mentioned government fish stations (most of which are defunct) and the payment of extension agent salaries. The MINEPIA Aquaculture Training Centre at Foumban (Figure 7.4.10) produces the majority of extension agents.

National Agricultural Research and Extension Program (PNVRA). This organ was created under a World Bank (WB)/International Fund for Agricultural Development (IFAD) project to provide Training and Visit extension services. Although the structure still exists, the PNVRA has been generally quiet since the end of the project in 2003.

Institute for Agricultural Research for Development (MINRESI). (Dr Vincent Tanya, Scientific Coordinator, Animal Production and Fisheries; Dr.Victor Pouomogne, Senior Aquaculture Scientist; Dr David Nguenga, Fish Reproduction Specialist; Mr Steve Sulem, Aquaculture Research Scientist). IRAD is a semi-autonomous agency with salaries paid by the government, but operating expenses generated through contracts. Although chronically under-funded, IRAD maintains an active program of research and training, based at their aquaculture research station in Foumban. In 2005, IRAD initiated a program of work funded by the Highly Indebted Poor Countries Initiative, focussing directly on training farmers and hatchery operators in catfish fingerling production. A part of this, they are also putting in place a system for the provision of quality broodstock to private hatcheries.

FIGURE 7.4.10
The MINEPIA Aquaculture Training Center, Foumban

Faculty of Agronomy and Agricultural Sciences (FASA), University of Dschang. (Dr J. Tchoumboué, Head, Department of Animal Production; Dr Minette Tabi, Assistant Professor of Aquaculture). The main agricultural university has long had a small Bachelor of Science (B.Sc.) degree program in aquaculture with usually fewer than ten students per year. In 2005, the program was expanded to include Master of Science (M.Sc.) and Doctor of Philisophy (Ph.D.) degrees.

FUTURE PROSPECTS

Cameroon has the potential to become an important aquaculture producer. The climate and water are good (although soils and topography are less so), markets are excellent, human technical capacity is modest, but adequate and basic infrastructure exists in the form of an active research program and a functioning training centre. In addition, the policy environment, although currently vague, is generally supportive. Three international agencies (WFC, the French Centre de coopération internationale en recherche agronomique pour le développement and FAO) are currently active in Cameroonian aquaculture and are working closely with the government and each other to ensure that past mistakes are not repeated and best practices are put in place to ensure that future growth of the sector is sustainable.

Despite the general lack of money, the Government of Cameroon has repeatedly expressed its commitment to the development of aquaculture within the country and the supply of high-quality fingerlings has been identified and clearly enunciated as the key constraint. The new IRAD catfish fingerling and broodstock quality assurance program is a step in the right direction and, linked through the Strategic Framework for Aquaculture Development to private sector initiatives, Cameroon is heading towards a resolution of the fingerling supply problem and the creation of a robust aquaculture sector.

REFERENCES

de Graaf, G. & Janssen, H. 1996. Artificial reproduction and pond rearing of the African catfish, *Clarias gariepinus*, in sub-Saharan Africa. *FAO Fisheries Technical Paper No. 362.* Rome, FAO. 1996. 73 pp.

FAOSTAT. 2004. Online fish production statistics. Food & Agriculture Organization of the United Nations (available at. http://faostat.fao.org/)

Kamga, M.K. 2005. Avant-projet de loi portent régime de la pêche et de l'aquaculture. TCP/CMR/2907(A). Food and Agriculture Organization of the United Nations, Rome, FAO. 2005. 32 pp.

RDC (République du Cameroun). 1997. Politique nationale de vulgarisation agricole. Government of Cameroon, Yaoundé. 14 pp.

RDC (République du Cameroun). 2002. Document de stratégie de développement du secteur rural. Government of Cameroon, Yaoundé. 133 pp.

RDC (République du Cameroun). 2003. Document de stratégie de réduction de la pauvreté. Government of Cameroon, Yaoundé. 167 pp.

Vivien, J. 1991. Faune du Cameroun: guide des mammifères et poisons. Le Groupement Interprofessionnel du Cameroun (GICAM), Yaoundé. 271 pp.

WorldFish Center. 2005. Final technical report: development of integrated agriculture-aquaculture systems for small-scale farmers in the forest margins of Cameroon. NRE9800 605/522/003, UK Department for International Development, London. 34 pp.