7.7 Freshwater fish seed resources in Cuba[1]

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Coto, M. & Acuña, W. 2007. Freshwater fish seed resources in Cuba, pp. 219–231. 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

Cuban fisheries began in the early 1920s, with the introduction of common carp and black bass which were stocked in small reservoirs and lakes for sport fishing. During the decade of the 1960s, a massive reservoirs and dams construction programme led to the opening of more than 130 000 ha of such commonly owned water bodies. These were stocked with hatchery-reared cyprinids, mostly common carp, and tilapia as food fish for the human settlements around them. The establishment of hatcheries to produce the seed needed, was the start of aquaculture in the country.

There are currently some 400 ha of nursery ponds throughout the country, whose production supports regular restocking of such water bodies, as well as some 1000 ha of fish rearing ponds. Both reservoirs and ponds produced 26.9 thousand tonnes in 2004, 96 percent of which corresponded to carps and tilapia.

Freshwater seed production in Cuba reached approximately 200 million fry by the year 2001, of which carp and tilapia contributed to 82 and 16 percent, respectively, the balance being other species such as *Clarias gariepinuss* and *Ictalurus punctatus*. However, the overall installed capacity amounts to 500 million in the 26 state-owned freshwater hatcheries that operate throughout the country. In general terms, the production of freshwater seed for aquaculture in Cuba amply meets the national demand both for restocking of dams and reservoirs, and for fish ponds and cages.

Breeding techniques vary according to the species. Whilst tilapia and channel catfish are bred employing semi-natural methods in earthen and concrete ponds provided with artificial nests, cyprinids and *Clarias* are hormonally-induced to spawn in more controlled environments. Fry of tilapia and the Asian catfish are reared in green water ponds in monoculture, while carps (common, bighead and grass carp), are reared in polyculture fertilized ponds. Fingerlings of all species are grown until they reach 5-8 g if they are to be stocked in ponds, or between 15 and 18 g, if they are to be stocked in reservoirs. Only in some cases tilapia fry are sex-reversed hormonally employing standard methods, to

[1] The original document was written in Spanish and was translated in English jointly by M.B. Reantaso (FAO), V. Alday-Sanz (Spain) and A. Flores Nava (Mexico) for purposes of this publication.

produce monosex batches. Rearing density of fingerlings vary from 15/m² in the case of channel catfish, up to 250/m² in the case of *Clarias gariepinus*.

There are no national standards set as far as seed quality is concerned. However, recent HACCP-like programmes, provide preventive guidelines to improve quality of the end product, including hatchery processes. Seed certification in the country is limited to pathological aspects, and is required only when seed are to be moved between different regions or when seed or breeders are imported. Zoosanitary inspection is carried out by regional and national fisheries inspection offices.

Fish seed production and distribution are carried out almost exclusively by the government at subsidized or no cost, hence the lack of a market environment does not allow for an objective seed pricing in the country. Distribution is centrally planned o a yearly basis, and is carried out using government transport either directly to open access water bodies, or through aquaculture cooperatives or associations, which in turn redistribute to farmer members.

Support services to the industry include a series of well-established aquaculture training centres, as well as some producer cooperatives and farmers associations which work closely with small farmers and the government, acting as a bridge to trickle down new technology and capacity building. Women play an important role in these processes, since they account for 27 and 43 percent of the total and technical labour force of this sector, respectively.

The lack of indigenous aquaculture fish species makes Cuban aquaculture dependent on exotic species which have long been introduced and for which no genetic selection/improvement programmes are established. More recently, some exotic species, such as the Asian catfish *C. gariepinus*, have been introduced, and regular imports of breeders are common thus posing a threat of introducing alien pathogens into Cuban ecosystems.

INTRODUCTION

Aquaculture in Cuba began during the second decade of the 20th century with the introduction of several freshwater species (e.g. common carp, trout, black bass) with the objective of producing fingerlings for stocking in existing water bodies and to support sport fishing, which was discontinued after a few years.

Freshwater aquaculture production at commercial level began in the 1960s with the introduction of new species, for example tilapias and cyprinids. This was made possible because of the presence of many dams/reservoirs to protect rural population, farms and agriculture from flooding, for irrigation purposes and other socio-economic objectives.

The programme "Voluntad Hidráulica" created an important vehicle for the development of aquaculture with the construction of freshwater dams. At the moment, there are 130 000 ha of freshwater in the country; about 125 freshwater reservoirs grouped according to size, for example, big (if greater than 100 ha) and médium if less than 100 ha.

All these water bodies are utilized to raise fish using extensive and semi-intensive systems. Regular monitoring of these water bodies are undertaken and a programme for integrated management of stocking and capture fishing is being implemented to allow fish utilization in the manner that has been ordered by state, company, cooperative and other relevant authorities. In addition, there exist about 400 ha of fish ponds used for seed/fingerling production, the majority of which are destined for stock enhancement as previously mentioned and about 1 000 ha of earthen ponds and cages for grow-out.

In Cuba, it is not common to differentiate freshwater aquaculture at the industrial or smalll-scale levels since the major part of production is through extensive and semi-intensive systems in dams or reservoirs and in fish ponds which are both

TABLE 7.7.1
Freshwater aquaculture production by species (2003/2004, Bulletin MEP, Ministry of Economy and Planning) and Ministry of Fisheries (MIP)

Species	2003 (million metric tonnes)	2004 (million metric tonnes)
Freshwater species (1)	19.52	24.54
Carpa herbívora	1.69	4.7
Carpa común	0.447	0.470
Carpa plateada	13.133	14. 994
Tilapia	3.342	3.207
Trucha americana	-	0.2
Clarias	0.908	0.969
*Otros fluviales (2)	6.289	8.839
***Aquaculture of other organism (3)**	**8.828**	**9.732**
Total Freshwater (1+2+3)	**28.348**	**34.272**

undertaken at intermediate scale using intensive systems (integrated management of the ecosystem in the case of dams/reservoirs with or without fertilization, and semi-intensive systems in the case of fish ponds with fertilization, feeding and aeration).

The principal species used for freshwater fish seed production belong to the group of tilapias and cyprinids. In addition, there are some work on other species such as *Clarias* sp. which requires artificial spawning and which are destined for 3 stations that are dedicated to breeding, larval rearing and grow-out in earthern ponds. In these stations, the general work involved include maintenance of gene banks and facilities/ laboratorios for breeding, water chemistry and nutrition in addition to tanks for larval rearing, nursing and grow-out. Seed grow well through the application of technical management of water, feeding and aeration.

Total annual aquaculture production was in the order of 10.5 million tonnes between 1981 and 1994 and 20.5 million tonnes between 1995 and 2004 and reaching almost 30 million tonnes in 2003 and 35 million tonnes in 2004.

At present, there are 35 species of fish, crustaceans, reptiles and mollusks cultured in the country. Since 96 percent of fish production comes from cyprinids and tilapias, the information presented in this document refer mainly to these two species.

The commercial value of aquaculture production is not quantified accurately since a certain portion of production is destined for self consumption on the part of producers or distributed to institutional network of consumers. Nevertheless, for purposes of comparison with other countries of the region, Cuba produced, in 2004, 35 000 tonnes valued at US$30 million. It is important to note that cyprinid and tilapia products are exported to the Carribean and command a price of US$1 000/tonne.

Aquaculture production from freshwater fishes is destined almost exclusively to the internal market, with possibility of equitable distribution between urban and rural zones for consumption of labourers and supply to hospitals and other consumers. A small part of the production is sold in specialized fish markets, but in this case it is mainly products of cyprinids that do not enjoy much acceptance in the form of fresh or whole fish. In the past, in Cuba, there was no custom of eating freshwater fish, unlike in Asia for example. Many species, introduced during the last decade, has been processed to make it more attractive to consumers.

The annual consumption of fish produced from freshwater aquaculture is estimated at 3 kg per capita, equivalent to one-third of the fishing products that are consumed in Cuba, including marine fish and imported fish.

SEED RESOURCES/SUPPLY

Annual seed production from freshwater fish is more than 220 million fingerlings. For example, production for 2003 was 223 million fingerlings and 226 million in 2004. Almost all of the seed produced from freshwater species come from companies of the Ministry of Fisheries (MIP). The distribution of freshwater fingerling production stations in Cuba are presented in Figure 7.7.1.

FIGURE 7.7.1
Distribution of freshwater fingerling producing stations in Cuba

In general terms, it is possible to say that seed production from freshwater fish is sufficient to satisfy the national needs. All stations and hatchery facilities does not realize that expected capacity of producing 500 million seed using semi-intensive and extensive systems and the possibility of increasing seed production without the necessity of having new investments.

In the future, new stations should be built or the capacity of the existing ones should be increased if stocking density is higher (intensive culture) or there is an expansion of the family operations and therefore an increase in demand for stocking.

SEED PRODUCTION FACILITIES AND SEED TECHNOLOGY

Seed production stations

Fingerling production in Cuba began in the 1960s with the construction of three small farms, located in western provinces, for seed production for the purpose of stock enhancement. In the 1970s, one major station was constructed in the center of the island. These stations supply seed to the different regions of the country, especially in reservoirs or dams already producing fish. In the 1970s and 1980s, there was an increase in the construction of fingerling production stations, reaching 26 stations with capacity to supply seed throughout the country based on existing technology.

It is estimated that if necessary, the capacity of existing stations in Cuba can produce up to 500 million fingerlings annually.

The main production comes from tilapias and cyprinids and minor quantity produced from *Clarias* since 2001 as can be seen in Table 7.7.2.

Hatching technology

In the case of cyprinids and bagres, artificial and induced breeding are used. For tilapias, natural spawning is used from broodstock maintained by producers. Broodstocks are renewed on a regular basis from fingerlings that are specially produced for replacement of broodstock in the gene banks of Mamposton Station in the western zone, Pavon Station in the central zone and Paso Malo Station in the eastern zone. In addition, importation of fingerlings of cyprinids and tilapias have been made.

Tilapia and catfish fingerlings are raised in monoculture systems while cyprinids are raised in polyculture until they reach the required size depending on their destination. For stocking in dams or resevoirs, the required size are between 8 to 15 g; for stocking in ponds, the required size varies between 5 and 8 g.

SEED MANAGEMENT

Techniques of reproduction and main species

Tilapias (*Oreochromis aureus, O. niloticus, O. mossambicus and O. rendalis*) and catfish or channel catfish and common carp are spawned naturally. Cyprinids such as *Cyprnius*

cabezona, C. plateada and C. herbivora, Clarias gariepinus and Colossoma sp. are spawned artificially. Common carp are spawned naturally and artificially.

For channel catfish, tilapias and common carp, spawning are induced when appropriate conditions exist in the ponds, e.g. for catfish – spawning ground; for carps – good vegetation; for tilapia good water condition and temperature. Correct ratio of male and female of the target species to attain effective spawning and to begin with breeders with good quality are necessary.

TABLE 7.7.2
Fingerling production from 1995 for the main freshwater species (in million tonnes)

Species	Tilapias	Cyprinids	*Clarias*
1995	115.50	76.70	
1996	87.70	37.20	
1997	64.00	51.40	
1998	67.60	97.00	
1999	60.10	97.00	
2000	57.50	154.30	
2001	27.60	121.50	9.90
2002	35.40	166.80	19.90
2003	47.80	165.70	10.20
2004	36.7	192.50	6.60

Source: Bulletin MEP, Ministry of Economy and Planning) and MIP[1]

In the case of tilapias, larvae can be sex-reversed to obtain the required number of males and to obtain faster growth during grow-out. The nursery stage of each species last between 12 and 15 days.

Grow-out stage from larvae to fingerling

Larvae can be stocked directly in the pond or in a nursery for 12-15 days up to fingerling size at a density of 0.5-5 million larvae/ha according to the species. In any case, the pond needs to be fertilized to produce enough natural feed.

Feeding

Urea and superphosphate and other organic material from chicken, pig or cow manure are used as fertilizer. The mixture of animal and vegetal materials, flour and trash fish are also commonly used as feed for tilapia and Clarias fingerlings and have better quality.

Fertilization is done approximately one week before stocking of the larvae and for it to be effective, based on experience, during 1-2 months of culture, 2-3 fertilizations are done on average.

FIGURE 7.7.2
Natural egg laying scheme of channel catfish, tilapia and common carp

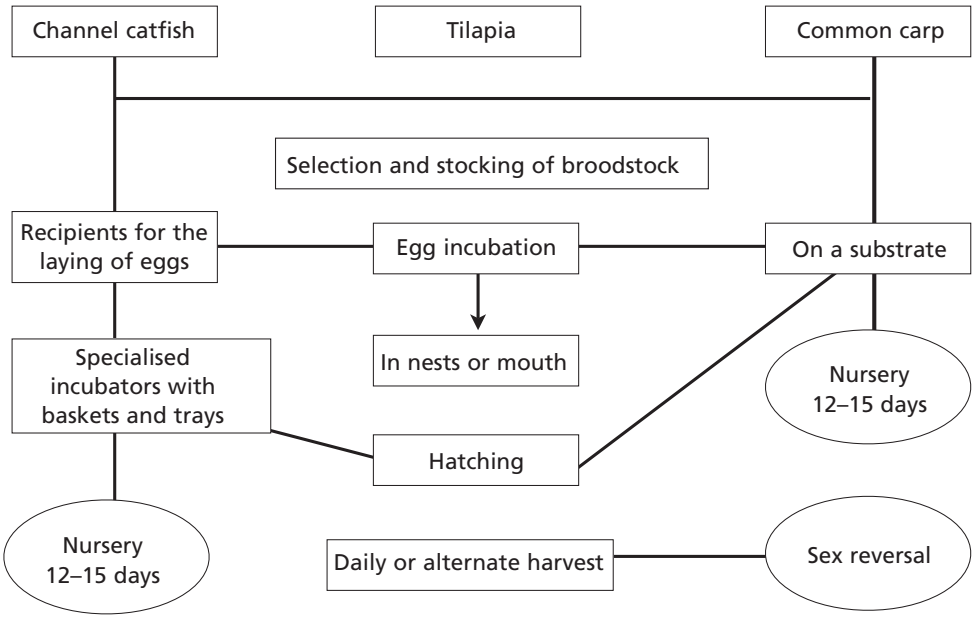


FIGURE 7.7.3
Natural egg-laying scheme of channel catfish, tilapia and common carp

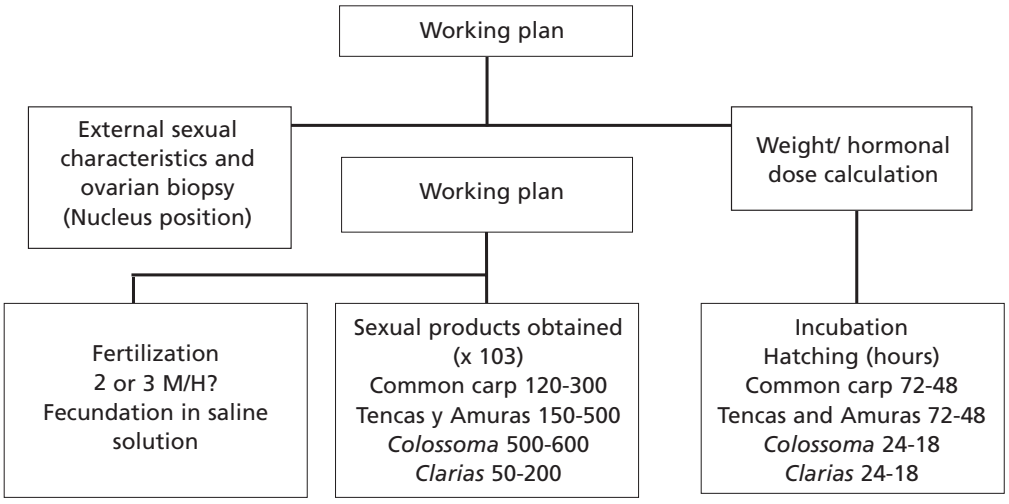


TABLE 7.7.3
Characteristics of fingerling of the main cultured species

Type of culture	***Clarias* sp.**						
Monoculture	***Clarias híbrido***				***Clarias gariepinus***		
density (n. /m²)	100	300	500	800	100	300	500
initial weight (g)				0.005			0.002
final weight (g)	4.34	4.65	3.20	2.85	4.65	4.94	4.88
duration of the culture				42	35	42	46
survival rate	62.0	52.35	44.0	28.2	47.9	55	48

Cyprinids					
Polyculture	**Silver carp**	**Bighead carp**	**Grass carp**	**Common carp**	*Colossoma macropomun* (Monoculture). In polyculture, it replaces common carp
density (210-250 n./ m²)	10.0–15.0 (60 %)	3.0–40 (16 %)	1.5–2.0 (8%)	3.0–4.0 (16%)	
initial weight (g)	0.005				0.004
final weight (g)	6–10				10–20
duration of the culture	45–60				60
survival rate	50				60
Monoculture	**Tilapias**				***Ictalurus punctatus***
density (n. /m²)	60–80				15–25
initial weight (g)	5		10		10–20
duration of the culture	45-50		64		60

Artificial feed is delivered at least twice a day in semi-intensive systems. It is placed in feed trays or spread freely. In intensive culture systems, feeding is done on average 4 times/day.

SEED QUALITY

In general, in Cuba, for each step of the production process, the Hazard Analysis and Critical Control Point (HACCP) is applied.

The quality of the egg-laying is defined by the amount of eggs and the quality of the sperm of the brooders

In 1992, an instrument of MIP called "Development Program for a System of Diagnosis of Disease and Contaminants in Aquatic Organisms" is jointly implemented with the Institute of Hygiene and Epidemiology of the Ministry of Public Health (MINSAP) and CITMA of the Minister of Science, Technology and Environment. The latter two are responsible for the over-all coordination. The program and its control

is made at every phase of the culture process.

There are Standard Operating Procedures for the prevention and control of seed diseases in each of the culture facilities. There is also a communication network in case there is a need for the research centers to intervene.

TABLE 7.7.4
Most common diseases and mortality rates

Species	Disease	% Mortality
Catfish	CCV (virus catfish)	70
Tilapia	Parasites	5–20
Ciprínids	Parasites	5–10
Others	Nutricional	40

There has been some isolated cases of disease in seed as seen in Table 7.7.4.

All the cases of disease outbreak have been isolated and kept under control with no dissemination to other areas.

SEED MARKETING

The marketing takes into account what is supplied by MIP to the national network of commerce that is run by the Company Group INDIPES of MIP. The whole production and comercial cycle is controlled by the same agency while exports is carried out by an export company (CARIBEX).

The export market of seed is scarce and often directed to countries that require help from Cuba such as the program with Haiti for the development of the fisheries sector.

Sales are carried out through the commercial department of the provincial company of the group INDIPES. Seed is sent using a distribution plan annually planned taking into consideration the production needs.

The company trucks carry out distribution. Transport service is offered to other agencies and to the Network of Municipal Council Advisors in the case of "Family Aquaculture". In some ocassions, private transportation is used.

It should be noted that sales are planned the year before for each of the provinces regardless of the type of client.

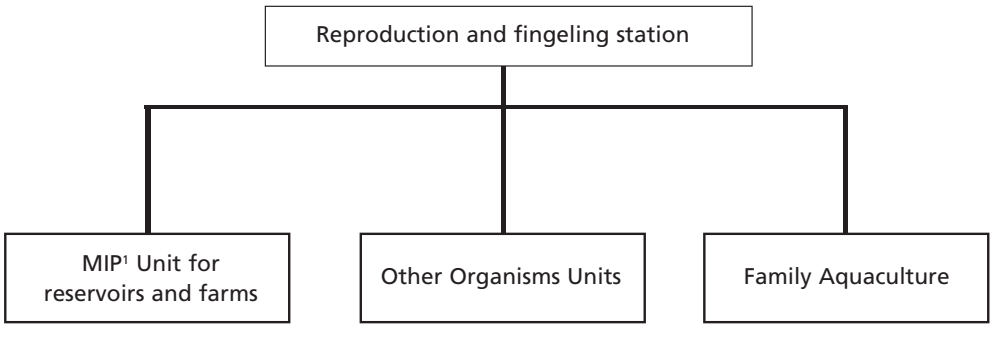
When there is an excess of seed production, it can be sold to private producers that little by little are incorporated into the Family Aquaculture movement.

Seed need to have a health certificate for transportation.

SEED INDUSTRY

Seed are produced in fingerling stations operating all over the country where they are reared to the right size befote stocking in reservoirs, grow-out ponds in the same stations or on their own managed by the fisheries sector. Seed are also distributed to other state entities such as the MINAGRI and the MINAZ and "Family Aquaculture" or "Community Aquaculture".

FIGURE 7.7.4
Flowchart of seed sale



SUPPORT SERVICES

Extension services in the country are efficient in rapidly transferring scientific and technological innovations to the aquaculture production sector. Furthermore, aquaculture research is driven by the needs of producers. It is aimed at sustainable development of the sector, including seed production.

The Aquaculture Training Centre of Mamposton (CEPAM) is a research, development and aquaculture training institution, that offers short, hands-on training courses, as well as post-graduate courses for both technical and management staff involved in the national aquaculture sector. The centre also offers technical assistance to producers and publishes practical aquaculture manuals, handouts and technical papers.

There are a number of training courses dealing with each of the freshwater aquaculture species of the country, which include breeding and seed production.

There is also an institute (Andres Gonzalez Lines Fisheries Institute) that trains aquaculture technicians at the secondary level, with enrolment of students coming from all regions of the country. After completion of their training courses, they are sent back to their communities to support the aquaculture sector. Many of them work in seed production stations.

Both aquaculture farmers and extensión officers are members of the Cuban Association of Animal Production (ACPA), which in turn provides technical assistance and extension services through the Cuban Aquaculture Society. The society disseminates aquaculture technical knowledge, including seed production techniques to farmers and the academia through a variety of means including a technical journal.

There is a managerial protocol for each cultured freshwater species, which describes every step of the production cycle from broodstock selection, through breeding, larviculture and nursery. Such a protocol is printed and distributed among aquaculture farmers and revisions are made according to scientific and technical innovations.

A number of demonstration videos have been developed, which include seed production techniques for species such as channel catfish, cyprinids, *Clarias* and tilapia.

The involvement of women in aquaculture production in the country accounts for 27 percent of the total workforce of the industry, and to 43 percent with respect to the total technical staff of the sector.

SEED QUALITY CERTIFICATION

Seed quality is certified through an official and indispensable certificate provided by the seed supply company, and inspected and signed by the disease group of MIP. Quality is also verified by the producer through routine performance follow-up, and by the provincial and national aquaculture enterprises organizations. This is carried out through routine quality control sampling, backed-up by random samplings by the Provincial and National Fisheries Inspection Services (OPIP).

It is worth noting that the National Aquaculture Enterprises Organization carries out routine inspection throughout every step of the aquaculture production cycle, including seed production. This is realized through the OPIP and the Auditing Directorate of MIP.

The Code of Fishery Products and Practices, Section 16, CX/FFP 004, includes the mandatory use of HACCP protocols for aquaculture seed production. This allows the quality control personnel to focus on food safety, since all other steps of the production process are taken care of through the HACCP programme.

As an example, the breeding process is described in the Aquaculture Management Procedures document. Farmers are expected to follow these procedures for which critical limits (CL) are set so that efficiency and correct application of the procedures are ensured through routine evaluation of aquaculture parameter. If performance parameters exceed critical limits, corrective measures are adopted in a timely manner, to ensure high quality product.

Feeding of breeders, fry and fingerlings is also monitored. Routine inspection of feed manufacturing and raw materials is commonly practiced. Feeding schedules and the overall quality of feed is macroscopically assessed. Also, the Aquaculture Management Procedures document involves seed harvest and transportation procedures, to ensure that the quality of the seed is optimum.

Technical data regarding all monitored parameters are registered in specific logbooks, so that in case of deviations from the established protocols, farmers are adviced, corrective measures introduced, and, if applicable, farmers are fined.

Freshwater fish seed exporters and importers are required to produce a health certificate prior to the movement of organisms. Additionally, in the case of imports, a quarantine period is established by the Institute of Sanitation and Epidemiology of the Ministry of Animal Health (MINSAP). The quarantine protocol is approved only after a preliminary environmental impact assessment (EIA) is submitted and cleared by the CITMA. This latter EIA is required in the case of new infrastructure for seed culture or quarantine.

All these measures have resulted in a drastic reduction in negative externalities caused by aquaculture projects in the country in the recent past.

LEGAL AND POLITICAL FRAMEWORKS

There are a number of legal paths for aquaculture and fisheries development in the country.

1. Act No. 164. "Fisheries Law"

This act is the highest hierarchical legal instrument that regulates the exploitation of fishery resources and the protection of the fisheries environment. It was enacted in September 1996, and includes items regarding seed production such as:

- licensing system for all fishing and aquaculture activities carried out by individuals or companies;
- sanctions applicable to individuals or companies not complying with the law.

2. Complementary regulations

These include norms regarding minimum capture size for juveniles captured from the wild, as well as protected nursery areas.

The national CITMA is an instrument derived from the Environment, Science and Technology National Strategy. Such an instrument also influences aquaculture regulation in the country.

3. Environmental protection strategies established by the Ministry of Science, Technology and the Environment

Act No. 81 relates to the general protection of the environment, and the agency responsible for ensuring compliance to this act is the CITMA. Such a legal instrument is to be observed by all entities of the central state administration. For example, if MIP is to construct new fry production stations, it has to comply with the norms established in the aforementioned Act.

4. Environmental licensing

The same Act No. 81 establishes CITMA as the official agency responsible for analyzing and give authorizations according to the legal framework, concerning any action involving the use of natural resources or modification of the landscape. This includes the construction and operation of breeding and nursery stations.

It is thus compulsory to obtain the environmental license prior to the construction of infrastructure and the operation of aquaculture facilities.

Every step of the culture process, is described in detail in the Aquaculture Management Procedures document (POT), whose application is supervised by nacional state organisms and audited by the ONIP and its provincial offices, as well as by the Auditing Directorate of MIP.

There are also regulations regarding imports and exports of fish seed, as well as the handling and stocking of fry in aquaculture ponds within the Fisheries Law that have to be complied with.

The market for fish seed is regulated through a national annual projection which determines the demand for seed of the different provinces of the country, at a reservoir and even pond level.

Seed distribution both for the public and private sectors, is carried out through government institutions.

ECONOMICS

The seed production stations currently in operation in the country are sufficient to meet the present demand. Furthermore, the overall national installed capacity is 500 million fry, while the current demand is only 223 million fry.

Prices of seed are rather stable and only revised annually to adjust for possible increases in production costs. There is only one national price list for the whole country, given that the transport from the seed production stations to the farms, is an additional cost absorbed by the seed buyers, who seek to buy seed at their nearest seed selling point.

Seed production stations have staff paid by the government. However, these facilities are allowed to sell directly to farmers, which generates additional funds, and in turn, together with their operational budget allocated by the government, constitute the overall running budget of the station.

Moreover, production surpluses are sold and the profit is distributed as an economic incentive to efficient workers. These incentives range from 10 to 15 percentof their monthly wage, and is paid partially in Cuban currency and partially in hard currency.

Farms with grow-out facilities produce their own seed, and sell the surplus production to nearby farmers, in accordance with the production plans stated by the corresponding provincial aquaculture company.

Feed, fry production and energy account for the highest share in the total production costs. Other expenditures include depreciation of infrastructure.

It is estimated that the selling price of seed is between 15 and 20 percent above the production costs, depending on the species and the buyer.

Depending on the species, in order to produce one tonne of fish, an estimated 12 thousand tilapia, 10 thousand carps and 14 thousand *Clarias* fingerlings are needed.

INFORMATION AND KNOWLEDGE GAPS

Seed production intensification and mass production are challenged in the country by the fact that there is a total dependence on exotic species, whose broodstock needs to be renewed periodically, and thus require a close follow-up to avoid the introduction of exotic pathogens into the country. This also entails detailed genetic selection and manipulation for which the country is not yet prepared. Another issue is the availability of seed feeds, which are sometimes limited.

PERSPECTIVES AND RECOMMENDATIONS

Planning at national level has allowed to evenly and thoroughly distribute seed to all provinces, not only to cooperatives and individuals, but also to agrifarmers. This has resulted to a logistics strategy for approaching seed to grow-out farms, thus linking them to the production-processing-commercialization chain.

It is recommended that, even though the demand for seed is currently met by the existing fry production stations of MIP, non-governmental companies are stimulated

to produce seed, in order to further increase the current production capacity of the country, in view of future developments of the industry. This could include improved technologies and increased culture densities.

Genetics and nutritional research should be fostered in order to avoid international dependency.

STAKEHOLDERS

Agrifarmers (seed production and exchange). In general, such producers are classified within the technical staff of the seed production stations. There are approximately 3 000 and include technicians and the rest of the qualified staff that operate the stations. There is a small group of rural farmers that use small impoundments and earthen ponds, organized in state cooperatives. There are also a small number of private owners of small farms and households who culture fish in their backyards. They all produce and exchange seed, especially seed of tilapia. It is estimated that the total number of such farmers are above 1 500 in the country. Such farmers produce and exchange small amounts of seed among themselves. It is estimated that approximately 10 percent of the total seed production of each seed station, is destined for small producers.

Local institutions. As previously stated, there exists an Aquaculturists Association (SCA) which is part of the Cuban Association of Animal Husbandry (ACPA). The SCA provides technical assistance to small farmers and promotes the integration of agriculture and aquaculture systems. There are other national programs of extension that also provide training and apply research results. Technical dissemination is carried out through a number of technical fora that are organized nationwide at national, provincial and local levels. Handouts, technical update talks at farm level, as well as technical operation manuals are also distributed to farmers.

Handouts and technical manuals include all parts of the culture process, from broodstock management and breeding, through larval culture, grow-out to harvesting.

Small hatcheries (intended local market). Fry distribution is realized in every town, and responds to a central state planning which organizes aquaculture farmers associations and local people´s councils. The latter takes care of seed needs for households and schools. Seed exchange among these households takes place although in small scale. Only a comparatively small proportion of the seed produced in the country are used by these rural farmers, some of which are intended for stocking small reservoirs and small ponds.

Large breeding and seed production stations (intended for technology innovation). The central government wishes to develop freshwater aquaculture in a balanced manner, so that all regions are capable of producing enough fish protein for their

TABLE 7.7.5
Mean fry (average weight of 8 g) production costs of the main freshwater aquaculture species (costs in US$)

Item	Tilapia	Cyprinids	*Clarias*
Cost of breeders (each)	1.18	1.7	2.3
Fry (thousand)	2.00	3.0	98.14
Feed, fertilizers	7.55	2.65	18.95
Fishing gear	0.09	0.09	0.62
Energy: Water, electricity	1.52	5.1	22.04
Labour	0.91	3.94	0.93
Other expenditures	2.45	4.31	16.93
Indirect costs	1.69	7.31	0.07
Total costs/thousand	17.15	28.10	159.98

population. CEPAM is the main aquaculture research and development centre of MIP and is responsible for technological innovation and technology transfer to both state aquaculture enterprises and extension workers.

Associations. ACPA is the entity that integrates aquaculture producers and provides technical assistance and training. Technical assistance and training are also done by CEPAM and the Fisheries Research Centre (CIP); both institutions belong to MIP.

Government institutions. The state enterprise INDIPES is responsible for commercial production and nationwide distribution of seed to other farmers and for their own use in their grow-out operations. Fish produced by the company are sold only to organizations outside those belonging to the Ministry of Fisheries. Seed market price is fixed. Species such as cyprinids, which are not very popular, are processed as fish balls, smoked fish, etc. to improve its acceptability. There are more than 20 different value-added products derived from freshwater fish species.

Researchers. The Fisheries Regulation Directorate of MIP is the governmental agency responsible for the supervision and control of research activities, including the work by the Science and Technology Forum (agency that organizes technical events for innovation transfers to producers). It has five specialists whose duties are to supervise research programs, which are in turn the direct responsibility of research centres such as that of Mamposton. The state enterprise INDIPES takes up successful research results and implements them for the improvement of their production operations. Currently, MIP runs a specific freshwater aquaculture research program. There are 12 projects, four of which are directly related to seed production. Research programs involve all fields of knowledge related to aquaculture, such as disease control and nutrition. Other relevant areas will be covered within the next few years, such as those related to environmental protection. There is a national program underway, whose main objective involves extension services, especially related to freshwater fish seed production techniques for rural households. There are also other projects in cooperation with non-governmental organizations, aimed at technological innovation and training of state and private producers.

Some examples of these collaborative projects include that of the National Laboratory Animal Production Centre (CENPALAB), which involves a wide range of fields such as nutrition, larval rearing of different fish and shell fish species, automatic control of processes and strategic planning. There are also a number of links with

TABLE 7.7.6
References, websites and persons consulted for the freshwater fish seed survey

Name of entity of person	Website or email address	Documents
Ministry of Science, Technology and Environment	www.medioambiente.cu	national strategies
MIP INDIPES	rmorales@tindipes.telemar.cu	maps of stations
MIP CEPAM -INDIPES Noris Millares (Investigadora) Trabajos AQUACUBA 2005	rmorales@tindipes.telemar.cu	tables
MIP Direccion de Palificacion y Dirección de Contabilidad	nelly@telemar.cu	information bulletins and statistics
MIP DIR. Regulaciones Pesqueras autora del Trabajo: Magali Coto, Especialista, Presidenta Sociedad Cubana Acuacultura – ACPA	mcoto@telemar.cu	compendium of data and analysis
MIP Dir. Pesca y Acuicultura Autor del Trabaho: Wilfredo Acuna Director	acuicola@mip.telemar.cu	compendium of data and analysis
MIP Dir. Regulaciones Pesqueras Dr Julio Baisre	regpes@telemar.cu	MIP strategy
MIP Dir. Relaciones Internacionales	mreyes@mip.telemar.cu	

academic institutions such as universities, the CITMA, the Animal Science Institute, the Higher Institute of Agricultural Sciences, the Centre for Biotechnology and Genetic Engineering and others.