7.9 Freshwater fish seed resources in Egypt

Magdy A. Saleh
General Authority for Fish Resources Development
4, Tayaran Street, Nasr City, Cairo, Egypt
salehmagdy2000@gmail.com

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ABSTRACT

Freshwater fish seed production in Egypt was reviewed. The development of the activity during the last three decades was assessed. The activity involved the production of seed of six species of finfish and a freshwater crustacean. The study covered subjects related to seed demand and supply, production facilities and technology, management, marketing and economics of the industry.

The study revealed that Nile tilapia is the most important cultured species in Egypt as it represents 40 percent of the country's aquaculture production. More than 1.2 billion Nile tilapia seed were produced by 520 hatcheries in 2004. Production of tilapia seed in commercial hatcheries is a new practice in Egypt. It was until the expansion of the modified semi-intensive and intensive pond aquaculture in the mid-1990s when the first commercial tilapia hatchery was established. Development of tilapia seed production was the reason behind the sharp increase in aquaculture production in Egypt during the last decade.

While most of tilapia seed production is by private hatcheries, seed of both common and Chinese carps are produced by ten governmental hatcheries. Apart from traditional aquaculture activities, carp seed are used for national projects such as weed control in irrigation canals and aquaculture in rice fields. A total of 227 million seed (common carp 138 million and 89 million Chinese carp) were produced in 2004.

The planned expansion of aquaculture to reach a target production of 1 million tonnes requires a parallel increase in seed production. It was concluded that development of seed production requires improvement of production technology, management, legislation and extension services.

INTRODUCTION

Aquaculture was known to Egypt since the beginning of written history. The traditional form of aquaculture "Hosha" known more than 500 years was common until a few decades ago in Northern Delta Lakes Region where it was practiced centuries before.

Aquaculture is considered as the only possible solution to increase fish production in Egypt. The activity is presently the largest single source of fish in the country. It is the fastest growing sector in the field of fisheries and is considered as the only available option for covering or reducing the gap between production and consumption of fish in Egypt.

Total aquaculture production of Egypt was 471.5 thousand tonnes in 2004 with a total local market value equivalent to US$684.2 million (US$1 = EGP5.725) (GAFRD, 2005). Aquaculture production represents 54.5 percent (865 000 tonnes) of the total fish production of the country and 43.3 percent (1.09 million tonnes) of the total fish consumption equivalent to 15.6 kg per capita/annum. At present, about 98.2 percent of aquaculture production is from private farms.

Modern aquaculture expansion started in Egypt only two decades ago. Production increased from a level of 17 000 tonnes in late 1970s to 45 000 tonnes in the mid-1980s. In 1986, aquaculture production was 51 000 tonnes which increased to 60 000 tonnes in 1990 and 72 000 tonnes in 1995. The sector witnessed great developments during the last decade with sharp increase in production from 340 000 thousand tonnes in 2000 to about 500 000 tonnes in 2004-2005. The current rapid development is associated with the application of higher levels of technology and change in the structure of fish farming communities. Aquaculture activities became more sophisticated and diverse supported by the expansion of feed mills and development of hatcheries. The number of fish hatcheries tremendously increased from 14 in 1998 (Barrania *et al*., 1999) to a present figure of more than 480 (GAFRD, 2005). More than 14 fish feed companies have been established during the last six years. Except for very limited and isolated cases, most aquaculture activities are located in the Nile Delta Region.

Majority of fish farms in Egypt can be classified as semi-intensive brackishwater pond farms. Intensive culture, in earthen ponds and tanks, is now developing very fast and substituting the traditional system. The new system depends on smaller, deeper ponds, with higher stocking densities, intensive feeding and aeration and producing on average 17.5-30 tonnes/ha/yr. Intensive cage culture is second in terms of total production. In 2004, more than 50 400 tonnes were produced in freshwater cages (GAFRD, 2005). The harvest is predominantly that of Nile tilapia (*Oreochromis niloticus*) and silver carp (*Hypophthalmichthys molitrix*). Integrated aquaculture in rice fields started in the mid1980s and production in 2004 was 17 200 tonnes, all common carp (*Cyprinus carpio*). Integrated desert agriculture-aquaculture started in Egypt in the late 1990s. This system generally applies intensive tank aquaculture and expanded very fast in the western desert.

Culture-based fisheries depend on the annual supply of fish seed to support wild stock in natural water bodies (e.g. lakes, canals, river). The total estimated production of the activity is about 16 000 tonnes mostly Nile tilapia. This figure is not included in aquaculture production statistics in the yearbook of the General Authority for Fish Resources Development *(*GAFRD) as it is included in the capture fisheries data.

More than 23 700 tonnes of stocked grass carp (*Ctenopharyngodon idella*) used for weed control were harvested from irrigation and agriculture drainage canals in 2004 (GAFRD, 2005). Hatchery-produced grass carp fingerlings are stocked annually as part of a national program for biological aquatic plants control in Egypt financed by the Ministry of Irrigation. Stocked fish are harvested by fishermen and the production figure is added to the capture fisheries statistics (GAFRD, 2005).

The majority of cultured fish in Egypt are either freshwater species or those that can grow in brackish water. Production of fish and crustaceans in salt water is still in its early stages and its development suffers from technical and economic problems. Presently, 16 different species of fish and crustacea (14 finfish and two crustaceans) are cultured in Egypt. Out of the 16 species, ten are native and six were introduced. The native species are: (1) Nile tilapia, (2) blue tilapia (*Oreochromis aureus*) (1 and 2 comprise 42.2 percent of aquaculture harvest in 2004), (3) African catfish (*Clarias gariepinus*) (0.1 percent), (4) grey mullet (*Mugil cephalus*), (5) thin-lipped grey mullet (*Liza ramada*) (4 and 5 comprise 28.3 percent of aquaculture harvest in 2004), (6) bluespot mullet (*Valamugil seheli*), (7) European seabass (*Dicentrarchus labrax*), (8) gilthead seabream (*Sparus aurata*), (9) meagre (*Argyrosomus regius*) and (10) penaeid

shrimp (6,7,8,9 and 10 together comprise 10 percent of the harvest). The introduced species are: (1) common carp (*C. carpio*) (15.9 percent of the harvest), (2) grass carp (*C. idella*), (3) silver carp (*H. molitrix*), (4) bighead carp (*Aristichthys nobilis*), (5) black carp (*Mylopharyngodon piceus*) (12.8 percent of the harvest) and (6) giant freshwater prawn (*Macrobrachium rosenbergii*).

Aquaculture development strategy is targeting a total production of one million tonnes by the year 2017. With limitations in water and land resources, this strategy will depend largely on a gradual change from the traditional extensive to intensive pond aquaculture. Although this approach was successful during the last ten years, it still requires a fast and large development in hatchery seed production and expansion of the fish feed industry.

Presently, there is no clear demarcation between cultured and captured fish, both can be sold for the same price in the retail market. Introduced species (carp and freshwater prawn) are not well accepted by consumers. The price of such species can never exceed 50 percent of the price of native fish except for African catfish which is not commonly accepted by the public. Besides the disadvantage of being a bony fish, carp, which is usually harvested at sizes larger than 1 kg/piece, is not preferred by Egyptians who have a general preference for smaller fish (200 g).

SEED RESOURCES/SUPPLY

Except for African catfish, fish seed utilized for freshwater aquaculture in Egypt are all hatchery-produced.

Tilapia

The Nile tilapia is the most commonly produced freshwater species. Seed production is carried out in commercial hatcheries or in farm-based hatchery units. The main activity of the commercial hatcheries is the production of fish seed (fry or fingerlings) and all its production are sold to grow-out farmers. Some fish farms may have smaller hatchery units sufficient to cover the requirements of fry and fingerlings; surplus production are sometimes sold to other farms. The majority of tilapia seed production comes from private hatcheries. Governmental hatcheries were originally designed for the production of different species of carp. Tilapia seed production is a side activity in the nine governmental hatcheries which produce in total a production of 38.03 million fingerlings (3-5 g) per year (GAFRD, 2005).

To reach the recorded 190 000 tonnes harvest of cultured tilapia, an estimated production of 1.197 billion fingerlings was required. The recorded production of the private hatcheries in 2004 (GAFRD, 2005) was only 109 million fingerlings which is a production figure from licensed commercial hatcheries – only a fraction of the other production units scattered in the country.

The present production of tilapia seed hardly covers the increasing demand of the continuous and fast growing aquaculture sector and is putting a lot of pressure on the supply of seed. As a result, tilapia seed are frequently sold as 0.5-1.0 g fry. Growers commonly carry out the nursing process to reach the required fingerling size for grow-out operations.

Common carp

Common carp seed are mainly produced in government hatcheries. Very limited numbers of common carp fry are produced in some private hatcheries. The total recorded production of common carp fingerlings in 2004 was 137.8 million (GAFRD, 2005). About 75 percent of carp seed are used for integrated aquaculture in rice fields, the rest are utilized for semi-intensive polyculture in ponds. Demand for common carp seed is presently growing to cover the gap in the supply for intensive pond culture which is not fully covered yet by carp.

PLATE 7.9.1
Egyptian freshwater aquaculture facilities

Semi-intensive ponds, Northern Delta Region

Integrated agriculture-aquaculture in intensive ponds and tanks, Western Desert, Egypt

A commercial tilapia hatchery, Northern Delta, Egypt

Indoor facilities of a government hatchery for carp

Indoor facilities of a tilapia hatchery

Indoor facilities of a private hatchery, Eastern Delta, Egypt

Chinese carps

Grass carp. All grass carp seed are produced in government hatcheries. In 2004, a total of 54.6 million fingerlings (10-50 g) were produced (GAFRD, 2005). About 78.5 percent of the produced fingerlings were used by the National Aquatic Weed Control Project (NAWCP) for weed control purposes in agriculture drainage and main

PLATE 7.9.2
Egyptian freshwater aquaculture facilities

Green house tilapia hatchery, Eastern Delta, Egypt

Tilapia seed from a private hatchery being prepared for marketing

Tilapia over-wintering tanks in a private hatchery, Northern Delta

Seed transport truck, purchased seed inspected by farmers on arrival to farm

Water boiler in a tilapia hatchery in Egypt

irrigation canals. A smaller number of fingerlings (0.75 million) were used for stocking inland lakes for weed control. The rest of grass carp seed were used for polyculture in ponds. The level of production and demand for grass carp is strongly affected by the changes in the numbers required by the NAWCP. The number of fingerlings sold to NAWCP in 2005 increased by about 11 percent. The demand is expected to increase greatly forthcoming years as the Ministry of Irrigation, the sponsor of the NAWCP, is negotiating increasing its purchase of seed by 20 percent. This increase can be covered by increasing the production in the government hatcheries and nursery stations.

Silver carp. The demand for silver carp seed increased greatly during the last five years. The fish is gaining acceptance in the market and was rediscovered by fish farmers as an excellent candidate for cage aquaculture. This fish is very attractive to farmers mainly because of its feeding behavior. Silver carps are grown in cages in the fertile waters of the Nile at the end of the western branch of the Delta. Silver carp grows to a large size without the need for artificial feeding, thereby greatly reducing production cost. In 2004, government hatcheries produced about 12.6 million fingerlings (2-3 g) of silver carp. The estimated production of silver carp fingerlings by private sector hatcheries was 33.2 million in 2004 (GAFRD, 2005). The demand is not expected to increase greatly as the maximum allowed number of cages had been reached.

Bighead carp. Although bighead carp was introduced to Egypt at the same time as with grass and silver carps, this fish is not yet well-known to the growers. Seed production of this species occurs in government hatcheries and they are sold principally to government farms. Data available from official documents indicated that the total production of bighead carp seed was 1.3 million fry, all produced by government hatcheries. Harvest of this fish is usually mixed with silver carp and the real demand for the seed of this species has not been evaluated.

Black carp. The success of biological control of aquatic weeds by grass carp encouraged the GAFRD to import black carps for the control of the snail intermediate host of *Schistosomiasis*, a historically widespread parasitic disease in Egypt. Brood fish were imported from Eastern Europe and fry and fingerlings were produced successfully. The production of seed of this species was reduced to a minimum as the Ministry of Health, the main target government client, was not yet convinced of the suitability of this fish to substitute the presently used chemicals to control aquatic snails. Negotiation is still going on, however, the expected agreement with the Ministry of Health will create a demand of about 10-15 million fingerlings annually which can be covered by the present capacity of the government hatcheries.

Freshwater prawn. Freshwater prawn was introduced to Egypt from Southeast Asia more than two decades ago. Seed were produced on a commercial scale in three government hatcheries during the late 1980s until the mid-1990s. Freshwater prawn was grown in many private and government farms but it was faced by marketing problems resulting from the limited acceptance by consumers. Broodstocks are still kept in two hatcheries but the reduced demand for seed resulted in reducing seed production to a few thousand post-larvae annually.

African catfish. The African catfish is a native fish in all the freshwater bodies of Egypt. The species is not commonly appreciated in the local market. In aquaculture, catfish is used to control of tilapia breeding in ponds. Although artificial breeding of catfish was successful on an experimental scale, catfish stocked in ponds are small juveniles collected from the wild. There is no data on the numbers of collected seed or the demand for it.

SEED PRODUCTION FACILITIES AND SEED TECHNOLOGY

There are ten large freshwater fish government hatcheries, five of which are located in the Delta and five located along the Nile in Upper Egypt. The recorded number of commercial private sector hatcheries was 480 in 2004 (GAFRD, 2005) with an estimated total number of 540 hatcheries most of which are located in the delta. Many of the fish farms have a hatchery unit with production dedicated to cover the seed requirements of the farm especially for tilapia. Most of these hatcheries have hapas in ponds; some may have hapas under a green house. The number and production of such units are not exactly known.

Carp hatcheries

The government hatcheries were mainly designed for mass production of different species of carp. Carp hatcheries are composed of three main units, namely: (1) broodstock ponds are earthen ponds each with 400-1 000 m^2 area and about 1.25-1.5 m deep, (2) indoor facilities consist of a building including a large hall with circular broodtanks, aquaria and hatching jars or containers, a laboratory, filtration and water quality control facilities, boilers and staff rooms and (3) nursery facilities include suitable numbers of earthen ponds each measuring 1-1.5 acres and 1.25-1.5 m deep.

Different carp species introduced to Egypt cannot spawn naturally in the local environment. Spawning occurs through induced breeding by injecting the ripe brood fish by locally prepared common carp pituitary extract and stripping of females and males. Fertilization takes place when eggs and milt are mixed in a plastic vessel. Fertilized eggs are then incubated in hatching jars with running water from the bottom to the top. Hatched fry are collected and kept in glass aquaria and then moved to nursery ponds.

Tilapia hatcheries

Tilapia seed are produced in hatcheries using different techniques. The system applied in the majority of industrial hatcheries (private or government) depends on indoor breeding tank systems. This system was developed to facilitate production of tilapia seed one or two months earlier than that produced in outdoor systems. In this system, broodstock are kept in small- to medium-size breeding tanks (2-10 m^3). Nile tilapias belonging to 1+ year group are selected from harvest of fish farms in late autumn. The target of selection is usually the fast growers of the recruits. Selected tilapia are sexed, males and females separated and kept under observation in special tanks for a period of three weeks. Diseased or weak fish are discarded. Broodfish are kept for two to three breeding seasons only and are substituted with younger brood either from the production of the hatchery or from fish farms. In late winter, broodfish are mixed using a ratio of three to four females to one male in each square meter of the breeding tanks. Water temperature is raised to the optimum breeding temperature (26 °C-29 °C) by boilers. Eggs of incubated females are collected with handnets, transferred to hatching jars where eggs are kept until hatching and yolk sac absorption. Fry are then transferred to nursery tanks (small shallow tanks each of 2-3 square meters size) and either fed with normal feed or hormone-treated feed for sex reversal to produce an all male stock. Hormone treatment extends to four weeks afterwhich fry are moved to outdoor nursery tanks (10-20 m^3) in green houses or to nursery ponds (0.25 to one acre). Mixed-sex fry are transferred to outdoor nursery tanks or ponds after three weeks. Depending on season and demands, seed can be sold as fry (0.5-1 g) or as fingerlings (3-5 g). Seed produced in such system are usually available at the beginning of the grow-out season of fish farming in late March or early April.

The second most common system of tilapia seed production is the use of hapas in ponds. This system was introduced from Asia and developed locally to suit local conditions. The hapa system is climate dependent, production starts during the natural breeding season of tilapia when water temperature reaches the levels required for breeding in mid-April until September.

Ponds used for such system varies in area ranging from 0.5-2 acres with a water depth of 1-1.25 m. Hapas made of 1 mm mesh netting material of a 2 × 2 × 0.75 m dimension are fixed in earthen ponds using four wooden poles, one at each corner. Hapas are usually arranged in parallel rows covering most of the water area of the ponds and are kept about 0.25 m above the bottom; broodfish are kept in water with a depth of 50-75 cm. In many commercial units, wooden catwalks are fixed on strong wooden poles that are constructed between the rows of hapas for easy access to each hapa unit.

At the beginning of the breeding season, selected brood fish are stocked in hapas using a ration of three to four females with one male per square meter. Hapas are examined for the presence of free swimming fry which are collected by scoop nets. Collected fry are usually stocked for nursery rearing in earthen ponds. Upon reaching market size, fingerlings are harvested by draining these ponds usually to a catch pond.

A modification of this system is presently expanding in the country for early season fry production. In this system, hapas are fixed in smaller ponds (500-1 000 m^2) or concrete tanks inside a green house. The increase in water temperature in green houses facilitates spawning in tilapia at least one month before the natural breeding season.

SEED MANAGEMENT

Carp

Common carp was first introduced to Egypt in 1936. Few hundred mirror carps were imported from Eastern Europe and kept in freshwater aquaculture research facilities of the Institute of Oceanographic and Fisheries (IOF) near Cairo. The species was successfully reproduced in captivity and the genetic line was kept as the original broodfish until the 1960s when some fish were imported from Russia and Hungary. It is not known if the newly imported fish were mixed with the offspring of the fish introduced in the 1930s. Seed produced from these fish were used by the first modern commercial fish farm in the mid-1960s. No other introduction of carp occurred until the establishment of the first two government hatcheries in 1978, when 400 broodfish were imported from East Germany. With the expansion in building commercial carp hatcheries by the government, more common carp broodstock (about 800 fish) were imported from 1984 to 1986 from Hungary. After some decades, all these fish and the offsprings of the broodstocks introduced earlier were unintentionally mixed together through the aquaculture production process. This occurred as government hatcheries regularly select fish for new broodstock lines from the harvest of the fish farms. Private sector hatcheries did not import any broodfish and built their own stocks from the harvest of the local farms. This is an indication that common carp is suffering from inbreeding which resulted in some problems with growth performance and morphology (individuals covered with scales characteristic of mirror carp). Presently, GAFRD is working on importing 10 000 to 15 000 common carp fry from Viet Nam and China to mix the local strains with new blood and in order to create a new line of broodstocks. The delay in the introduction of new carp strains was a result of legislation problems as introduction of alien species was restricted by a new law.

The three major Chinese carps (grass carp, silver carp and bighead carp) were first introduced from Hungary to Egypt by GAFRD in the mid-1980s. Black carp was introduced mainly as few brood fish and few thousand fingerlings during the mid- and late-1990s from Hungary, Israel and Thailand by GAFRD. In the late 1980s, few hundred brood fish and about 3 000 to 4 000 fingerlings of the major Chinese carps were imported from China. The fingerlings were grown in hatcheries to broodstock and mixed with those previously imported from Hungary. The performance of the three Chinese carps is still acceptable. The performance of black carp is not yet fully examined as only few thousands are produced each year and distributed in the canals of the government fish farms for snail control.

Carp hatcheries are very important to the country to supply the required seed for two major national projects [NAWCP and fish culture in rice fields (FCRF)] and the expected future project for the biological control of schistosomiasis In these projects, the production of marketable table fish is not the main target but rather the improvement of the environment and public health. As a result, broodfish in these hatcheries are kept under restrictive disease control and management programs. Broodfish are kept in

isolated ponds with no access to other fish or unauthorized persons. Fish are supplied with specially formulated 30 percent protein-rich manufactured feed and fresh clover to grass carp. Fish collected from brood ponds for induced spawning are usually sedated with tricaine methane sulfonate (MS 222) and kept in indoor facilities under optimum conditions until spawning. After spawning fish are injected with a prophylactic dose of a broad-spectrum antibiotic and treated from any fishing and handling trauma before they are moved to special ponds for spent fish.

All indoor facilities including incubators, tanks and aquaria are treated with strong antiseptic before start of the season. These facilities are also treated with antiseptic after each batch to avoid fungal infection.

Nursery ponds are usually prepared and treated just before the start of the season. Ponds are sun-dried and weeds are removed; dykes and bottom are prepared before soil fertilization program is applied. Water of prepared ponds are then treated with organo-phosphorous pesticides to kill aquatic insects, predatory larvae and crustaceans. Hatched fry are then stocked using a density of 0.5-1 million/acre. Survival rates from hatched larvae to fingerlings vary from 50 to 80 percent depending on management, climate, design of ponds and quality of broodfish. Nursing fry depend on natural feed until 0.3-0.5 g afterwhich grind feeds are given until they reach 1-2 g.

Tilapia

Production of tilapia seed in commercial hatcheries is a new practice in Egypt. Being a native fish that propagates naturally in all fresh and brackish water bodies of Egypt; commercial production of tilapia seed in specially designed establishments was not getting enough attention. It was not before the expansion of the modified semi-intensive and intensive pond aquaculture in the mid-1990s when the first commercial tilapia hatchery was established. The production of this native fish from aquaculture was no more 10-20 percent of the harvest during the 1970s and 1980s. During that time it was very hard for fish farmers to find tilapia fingerlings or fry in the market. All production depend totally on collection of smaller tilapia, fingerlings and fry from the harvest of fishponds and stocking them in nursery ponds until the second grow-out season. Tilapia collected in this way were usually a mixture of the four native species (*O. niloticus, O. aureus, Sarotherodon galilaeus* and *Tilapia zilli*) with at least 50 percent of the population from the inferior *T. zilli* and *S. galilaeus*.

Broodstocks are usually selected from harvests from grow-out farms and hatcheries with grow-out farms. It is usually the fast growers that are picked and kept for broodstock development. In some hatcheries where programs of production of super male broodfish are carried out, the valuable broodfish are well protected. The GIFT tilapia strain produced in research stations are not yet used on commercial scales. Collected eggs or fry are treated with similar techniques as those applied in carp. Nursery operations are carried out in earthen ponds or in greenhouse tanks but ponds are not usually treated with chemicals as in case of carp.

As tilapia breeding season occurs at the same time as the grow-out season, fry produced in summer and autumn are usually grown to fingerlings and kept for over-wintering. Over-wintering is carried out either in the fish farms or in nursery ponds (1-2 acres) in hatcheries. Ponds selected for over-wintering are usually deeper to ensure a water column of 1.75-2 m; this can protect over-wintering seed from sharp temperature fluctuations occurring in the surface water. In Egypt, surface water temperature in the sunny winter days may reach 19 °C to 20 °C followed by a sharp drop in temperature after sunset; at dawn, surface water temperature may reach 7 °C to 10 °C. Under those conditions, fish kept in shallow ponds suffer great stress and large mortalities can be expected. Surviving seed usually suffer from fungal infection and other over-wintering diseases. For economic and logistic reasons, over-wintered tilapia are usually kept in very high densities that result in low growth rates. On the

other hand, over-wintered seed usually become sexually mature at the beginning of the grow-out season which is usually associated with uncontrolled propagation in ponds if mixed-sex tilapia is used.

SEED QUALITY

Except for restrictions on marketing or distributing diseased fish seed or seed that are known to carry a disease causing organisms, there is no written orders or legislations related to seed quality. On the other hand, it is the market preference of the product that has the greatest effect. Fish farmers avoid dealing with hatcheries with a known history of inferior quality seed in terms of growth performance, mortality rates, deformities and others. The very fast expansion of aquaculture in general and the uncontrolled increase in the number of hatcheries in a very short period scattered in rural areas was far beyond the capacity of the government extension personnel doing follow-up program. Although it is against the law to establish an aquaculture facility (a farm, cage or hatchery) without a licence from the GAFRD, the current number of licensed hatcheries is no more than 10 percent of the operating units. It is only the government hatcheries and the large commercial private hatcheries that are covered by the quality control follow-up program. Under this program, GAFRD veterinary directorate staff regularly inspect broodstock and seed for disease as well as application of the hygienic measures.

The survival rates from egg to marketed fish are not really known in tilapia produced by many private hatcheries. On the other hand, the recorded mortality rates of tilapia in an extensive study extended to three seasons in governmental and private fish farms (GAFRD, 2002) from fingerlings to market size was 2-5 percent. The same study indicated that losses due to mortalities in nursery (fry-fingerlings) varies greatly between 7-35 percent and mortality in fingerlings was highest during over-wintering.

Seed of common carps produced in many of the government and private hatcheries are having problems with deformities and poor growth performance. This can be due to the long-term inbreeding of the species.

SEED MARKETING

Freshwater fish seed are sold without any limitation on the numbers to farmers from both government and private hatcheries. Prices are fixed in the government hatcheries and are decided by a committee of experts through a decree issued by the GAFRD chairman. Government prices provide guidance to private hatcheries but pricing is totally flexible depending on the supply and demand but it is usually kept lower than the government price. Government prices may change for some species or all species depending on the development strategy.

Tilapia

In most cases, farmers purchase directly from hatcheries. It is a direct and simple procedure where farmers pay the price and carry the purchased goods with no written rules. In this case, farmers usually inspect and examine random samples of seed to check size and quality. Fish farmers have their own choice of hatcheries to purchase seed; close distance of hatcheries for grow-out farms offer an added advantage to sellers. Among the private sector establishments, if a large number of seed are purchased, a verbal or sometimes a written agreement is organized and the hatchery usually delivers the seed to the farm site. This may be in one or several successive days as agreed between the two parties. In this case, hatchery operator covers the cost of losses due to mortalities during handling and transport. Seed are inspected on delivery and numbers are counted. Farmers can refuse any delivery if the size or the quality or numbers do not conform to what has been agreed upon. The refused good can be sent back to the hatchery or an agreement can be reached through a discount offer or others.

In some cases, hatcheries may deliver seed and collect the price after the harvest of the crop from the farm.

Seed prepared for sale are harvested from nursery ponds and moved to indoor marketing tanks or outdoor hapas. Seed in marketing tanks or *hapas* are usually kept in high densities and are starved two to three days before sale. Seed are counted by filling a small handnet, counting the number of fry or fingerlings from three full nets and getting the average count. Counting of the purchased seed is carried out by calculating the number of handnets multiplied by the average number of seed in each net.

Price is usually per one thousand seed and it varies according to sizes which are divided into three categories: (i) fry, from 0.5-1 g, (ii) fingerlings, from 3-5 g and (iii) juveniles, 15-25 g. Price of tilapia seed also differs greatly depending on the time of the year. Over-wintered fingerlings are sold in March for prices that can be seven to ten times its price in October and prices of fry also decrease gradually from April to November.

If small numbers are purchased, seed are packed in plastic bags filled with one quarter of water, inflated with compressed oxygen and transported by cars or pick-up trucks. Bags and oxygen are supplied by the hatchery operators. Other farmers use plastic barrels or small fiberglass or metal tanks on pick-up trucks with compressors or air cylinders. If large numbers are sold, special live fish transport trucks are used. Seed are usually transported either very early in the morning or after sunset to avoid the heat of the sun. In many cases seed are sedated during transport by adding ice to transport water.

Carp

Carp seed are sold to the private sector as in the case of tilapia. In case of large contracts such as those of the NAWCP (54.6 million fingerlings) and FCRF (about 100 million fingerlings), seed are purchased through a pre-negotiated contract signed between the GAFRD and the relevant party. The specifications of seed, numbers and delivery conditions are described in the contract. Representatives from buying parties observe the counting of seed/delivery at every hatchery. The procedure involves several paper works and strict inspections for sizes, quality, species, health conditions and counting. A fleet of more than 30 trucks each with six to eight insulated fiberglass tanks supplied by compressed air are used for transporting and distributing seed over a period of four to five months, 24 hrs and 7 days/week work.

SEED INDUSTRY

As stated before, the activity of seed production for aquaculture involves a wide range of production facilities/establishments that varies from a simple unit designed to supply a single farm to highly sophisticated industrial hatcheries with an annual production of 50-70 million fingerlings per year.

The staff of government hatcheries consist of both of males and females with no restrictions except in the pond fishing and service labor sectors where employees are all men. Women work in hatcheries as engineers, veterinarians, biologists and in administration and are paid equal salaries and have the same duties as men. It is also not uncommon to find female staff in the commercial private hatcheries. In the smaller units where business is a family-operated, all members of the family work together. However, the business of seed production is generally dominated by males.

SUPPORT SERVICES

GAFRD is carrying out extension programs on fry handling and transport. The program targets private fish farmers and young graduates recruited to work in the field of aquaculture. The program was dedicated originally to reduce losses in delicate marine species especially mullets, but it also covers the different aspects of handling

larvae, fry and fingerlings. GAFRD also cooperates with the Ministry of Agriculture extension services in the program of integrated aquaculture in rice fields which involve many details on handling of fry. GAFRD also issues a number of extension publications for distribution among farmers; many of which deals with subjects related to seed production and management. Different GAFRD hatcheries and farms found virtually in all areas of aquaculture were established to be extension and production units. GAFRD organizes local and international training courses in applied aquaculture. Other centers, like the Fish Research Center (an Agriculture Research Center unit) and the World Fish Center in Egypt also organize local and international training courses in aquaculture. Research institutes, centers and the Departments of Applied Research of GAFRD, the National Institute of Oceanographic and Fisheries and many universities carry out programs of technology transfer.

SEED CERTIFICATION

There are two kinds of certificates issued, first is the Health Certificate which is issued by the General Authority for Veterinary Services (GAVS) and the Certificate of Origin issued by GAFRD. The health certificate is issued for batches of seed approved as free of contagious diseases and pathogens or parasite or its infectious stages. The procedure involves a series of detailed inspections and laboratory examinations. The certificate of origin defines the source of the seed, brood, establishment and date of production. Both certificates are issued if requested by the buyer especially for export purposes.

LEGAL AND POLICY FRAMEWORKS

Aquaculture activities are regulated basically by Law No. 124/1983 and Presidential Decree No. 190 authorizing GAFRD to issue and implement the acts and decrees organizing aquaculture. Articles 47-51 of the law and Article 38 of Chapter 6 of the Execution List of the same law are aquaculture-related articles.

Presidential Decree Nos. 190 in 1983 and 465 in 1983 define the land and water bodies that the GAFRD can develop and where application of fisheries and fish farming laws will be supervised. The decrees gave authority to GAFRD to lease out wetlands and all lands that are within 200 meters distance of sea and lakeshores. The Fisheries and Fish Farming Organizing Law No. 124 in 1983, Section 3, Articles 47 to 51 includes the different requirements to construct fish farms.

Article 48 of the law states that it is forbidden to construct a fish farm except on wasteland, which is not suitable for agriculture and agriculture drainage or lake waters are the only source of water for these farms and it is strictly forbidden to use irrigation water. Exempt from this rule are government hatcheries, water volume provided to such hatcheries is decided by arrangement between GAFRD and the Ministry of Irrigation (MoI).

Article 48 of Law 124/83 stipulates that no fish farm or hatchery construction will be allowed without a license issued by GAFRD. This requires an approval from the MoI who defines the water volume allowed for, the source, size of inflow sluice and the method of draining.

Item No. 38 of the Executive List of Law 124 defines the required steps for public-land lease and licensing for fish farming such as:

1. The applicant should submit a license application to GAFRD office with the following forms attached:
   - A site map (scale 1/2500) with the proposed farm and its area sited on it.
   - Defining the source of water and the drain
   - A certificate from the area agriculture office stating that the land applied for licensing is wasteland and not suitable for agriculture
   - Detailed design and layout maps for all constructions and excavations.

2. If GAFRD approves the site and design, a copy of the application with site maps, design maps, proposed irrigation source, drainage outlet and specifications of irrigation and draining pumping stations (if required) is to be submitted to the MoI for approval.

When the MoI approves the application, the applicant should apply for the construction works according to the design maps approved by MoI and under the supervision of the irrigation engineers.

In the second chapter of the Law of Fisheries and Aquaculture Organization No. 124/83, Article 17 states that it is not allowed to use or introduce alien fish, eggs or larvae into Egypt for any reason except after obtaining a written permit from the GAFRD and after technical consultation with the National Institute of Oceanographic and Fisheries (NIOF).

ECONOMICS

Although the growing development in aquaculture has created an increased demand for freshwater fish seed, fast development in seed production facilities is covering the present demands. Tilapia, the top cultured species, is a good indicator of the status of supply and demand. However, the overlap between breeding and grow-out seasons has created problems in supply and demand. Accordingly, the demand and prices differ greatly during the year. It was observed that there is usually a shortage in the availability of seed at the beginning of the grow-out season. This is due to the fact that production from indoor tilapia hatcheries and the harvest of over-wintered tilapia are far from covering the demand. Prices usually become higher and buyers may not be very strict in counting the numbers (which could also be a factor in increasing the price), size or the quality of seed. This condition may last during the first six weeks of the season (between 15th of March and 1st of May) where prices start to decline as demand decreases and production increases. The lowest price is encountered during late September when production suffer great losses of fry during over-wintering. Hatcheries which utilize outdoor systems (hapas, etc.) are usually the suppliers of cheaper seed. Nevertheless, they can still have a good profit margin.

Of the different carp species, only silver carp seed used to have increasing demand. Demand is presently lower than supply as many hatcheries had slowed down their culture activities. This had not strongly affected the returns of the producers as production of silver carp is a side activity in tilapia. Prices of silver carp decreased gradually with the increase in demand. Private hatcheries have much more flexibility in pricing. With this advantage, private hatcheries were able to cope with the changes resulting from the increase in supply. This was not the case in government hatcheries where prices are fixed. This had resulted in sharp decrease of sales of silver carp from government hatcheries. On the other hand, government hatcheries have the advantage of being able to take large contracts with national projects and thus gain good profits.

STAKEHOLDERS

GAFRD is the government authority in charge of fisheries and aquaculture development in the country. GAFRD's main mandate is planning, coordination, extension, training and regulating activities of fish production (capture and culture). GAFRD is under the Ministry of Agriculture and Land Reclamation which is responsible for fisheries policy and strategy as a part of the development strategy of the ministry.

There are a large number of government research institutions and university departments specialized in research and studies of fisheries subjects in Egypt (Table 7.9.1). The kind of research, its levels and the degree of specialty varies between applied research or basic science and theories as described in Table 7.9.1 below.

Subjects of research are usually dealing with matters that can help improve production efficiency and solve production problems. Those subjects are decided

TABLE 7.9.1
Government research institutions and university departments specialized in research and studies of fisheries subjects in Egypt

University	College/Institute	Degree
Cairo, Ein Shams, Alexandria, Suez Canal, El Azhar, El Mansura, Tanta, Asuit, Zagazig and Upper Egypt.	Science	B. Sc. M Sc Ph D Marine biology, aquatic science, oceanography and hydrobiology
Cairo, Ein Shams, Alexandria, Suez Canal, El Azhar, El Mansura, Tanta, Asuit, Zagazig, El Fayum and Aswan.	Agriculture	Fish husbandry, production, genetics, feeding, aquaculture
Cairo, Alexandria, Suez Canal, Asuit and Zagazig	Veterinary medicine	Fish disease, food hygiene, aquaculture hygiene
Academy of Scientific Research	National Institute for Oceanographic and Fishery	Research only
Agriculture Research Center	Aquaculture Research Center	Research only

usually through direct contact between the research institutions and the producers or GAFRD or both or the Egyptian Aquaculture Society. Conferences, workshops and meetings are frequently held and producers are invited to discuss production problems with scientists.

Depending on the kind of research, methods and requirements, on-farm participatory research is very common both in the government pilot farms or hatcheries and in private enterprises (farms, hatcheries and feed mills). Results of work are usually published in scientific journals, but simplified forms are published in magazines and other publications of the local aquaculture societies. This can be the source of information for educated farmers, experts and technicians. GAFRD extension and training directorates are in charge of transferring information to traditional and uneducated farmers. GAFRD publishes a large number of simple extension papers for distribution to farmers. Free training courses are also offered by GAFRD on different subjects of aquaculture technology.

Although the major part of seed production is from private sector hatcheries, most of the producers are not organized in associations or cooperatives. The sector is still not fully organized and information on its organization is not as developed as its activity. As the exact number of production unit is not yet known, much effort and work should be carried out to study this sector especially those related to socio-economic aspects.

FUTURE PROSPECTS AND RECOMMENDATIONS

The GAFRD aquaculture development strategy which is part of the National Agriculture Development Strategy 1997-2017 (NADC, 1996) is targeting an annual production of 1 million tonnes of cultured fish by the year 2017. The target production for freshwater cultured species is 750 000 tonnes. This production is about 1.6x more than the production for 2004. This will require a large increase in freshwater seed production especially of tilapia.

NPAWD is planning to duplicate the number of required fingerlings by 2010, which is anticipated to be the maximum forecasted requirement for grass carp seed. The expected start of the National Project for Snail Control will require at least 20 million fingerlings by 2010.

Current trend in tilapia seed production goes in two parallel directions: the first is improving the indoor seed production and the second is developing better over-wintering techniques. Expansion the use of water recycling system is expected to reduce production cost (e.g. heating water) dramatically. Further development of over-wintering methods can reduce losses and thereby increase availability of seed. Such development is expected to encourage more investments in the field of fish seed production.

It is strongly recommended to improve the GAFRD licensing systems and the data collection techniques to cover the present gap resulting from the very fast increase in the number of hatcheries. This will greatly improve the implementation of regulations concerning quality control and extension.

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