Manual on Catfish Hatchery & Production

A Guide for Small to Medium Scale Hatchery and Farm Producers in Nigeria

By Kamthorn Potongkam and Jim Miller, Aquaculture and Inland Fisheries Project, May 2006

NATIONAL SPECIAL PROGRAMME FOR FOOD SECURITY (NSPFS)

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Forward

The Aquaculture and Inland Fisheries Project, (AIFP) otherwise known as Annex II of the Nigerian Special Programme for Food Security (NSPFS) was operational between 18 July 2003 and 30 June 2006 for 35 months. The AIFP's objectives included compiling an inventory and data base of inland water bodies, fish farms and feed mills, providing technical assistance to private fish farmers and assisting artisanal fishermen in community-based management of inland waters. A good linkage was forged between private fish hatcheries and the stocking of lakes for increased fish production. Efforts were also made towards reduction of post harvest loss of fish through improved fish smoking demonstrations. The project was successful in creating increased public awareness on aquaculture and fisheries bringing them to become national development priorities.

The project's original time frame was for 51 months and regrettably was cut short by 16 months with the closure of Phase I of the NSPFS.

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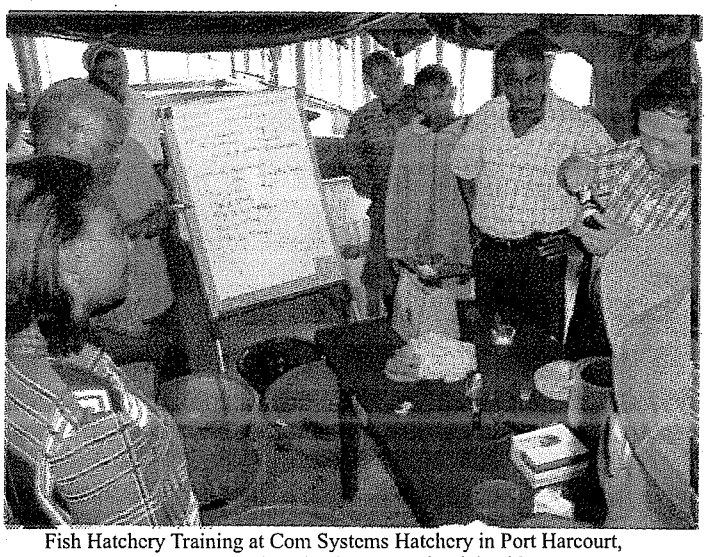
January 2006

"High quality fish seed and feed production are the basis for developing the aquaculture industry"

1. Introduction

Fingerling production and availability of quality fish feeds have been bottlenecks for development of fish farming in Nigeria for the past 40 years. Over the past several years, private sector fingerling production has increased from some 3 million per year in 2001 to more than 30 million per annum at present with several large producers delivering more than 300,000 fingerlings monthly. Domestic production of high quality fish feeds has also begun through the dynamic private sector. Relief on these two fronts and high demand for catfish has unchained the fish farming industry, which is now growing at a steady rate.



Fish Hatchery Training at Com Systems Hatchery in Port Harcourt, Rivers State. Mr. Potongkam is pictured at the right side.

In an effort to assist the small to medium fingerling producers, the Aquaculture and Inland Fisheries Project has carried out training programmes with more than 120 fish farmers benefiting. This manual addresses management of small to medium scale catfish fingerling production hatcheries and is based on three missions to Nigeria by Kamthorn Potongkam, TCDC Expert in Catfish Hatcheries, in 2004, 2005 and 2006 during which some 50 fish farms and hatcheries were assisted in the SW, SS and North Central Zones. As a result, a number of these farms greatly increased their fingerling production through sound technology applied in low-cost, simple methods, as discussed in this manual.

The Thai experience is very important to Nigeria because Thailand has a very dynamic catfish farming industry that has benefited from cross breeding between an indigenous, slow growing, tasty and much appreciated Thai species, *Clarias macrocephalus* and Nigeria's indigenous *Clarias garipinus*, which grows very fast and is easily bred with the Thai species. A similar cross has been made between *Clarias garipinus* and *Heterobranchus bidorsalis* for the "Heteroclarias" and others could be made to enhance certain favorable traits such as better body conformation (smaller head, more flesh), more hardiness, higher fecundity, improved survival of fry, adaptation to supplemental feed having less animal protein which is the most costly component in composed fish feed rations, etc.

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Techniques of Catfish Hatchery Management Used in Thailand

The Thais have *Clarias* indigenous catfish species in their waters but noted the fast growth of the *Clarias garipinus* species from Nigeria years ago and imported them to cross with their own *Clarias macrocephalus*, which has a yellow colored, very tasty flesh but slow growth (300 g/year) as compared with *C. garipinus* with white flesh and fast growth.

Broodstock Management: The Thais maintain the sexes in separate ponds or tanks. Males used are of the *Clarias garipinus* species, while the females are of *C. macrocephalus*. Males used are large size up to several kilogrammes while females are much smaller from 200 g up to 400 g. Commonly, one male can serve for fertilizing eggs from up to 10 females. Males are sacrificied and their testis removed. Males must be kept apart from the smaller females as they would prey on the females. Males are stocked in their ponds at 3 males per m2. Females are stocked in their pond at 4-5 fish/m2. Both types of ponds are maintained with fresh flowing water at all times; ponds are 800-1600 m2. Broodfish are commonly fed ground trash fish (bi-catch from marine fisheries) mixed with waste noodles from noodle factories. Other fish farms feed ground poultry waste (chicken heads and visera) which are mixed with waste noodles. Few fish farms feed catfish the expensive pelleted feeds we have in Nigeria; pelleted feeds are fed to the high value marine shrimp and the freshwater prawns. Catfish are sold very cheap in Thailand in small sizes of 3-4 fish/kg (250-333 g each) at about $US 1.00/kg (N130/kg); consumers prefer small catfish. Red tilapia, grouper, snakehead and sea bass are the highest price fish in Thailand. The Thais produce (in farm ponds) and export large quantities of marine tiger shrimp (*Penaeus monodon*) as well as fresh water prawns (*Macrobranchium rosenbergii*).

Induced Spawning: The Thais induce spawning in catfish year round in Thailand; after one injection of hormones, the females develop eggs every three months; there appears to be a residuel effect from the hormones. In nature, catfish only spawn once annually during the rainy season. Females are selected for sexual maturity as determined from their swollen stomachs full of eggs. Females are anestisized (to calm them) using Quinaldine (5-8 drops are added into 3-5 liters of water in a plastic basin) and injected with the LHRH hormone Motilium which comes in tablet form. In Thailand ½ of a Motilium tablet is used per kilogramme of female. Tablets are ground using a mortar and pestle and when reduced to a fine powder, a solution of 0.9% saline is added to put all the powder into solution for injection into the female. Added to this solution is Suprefact, which is a form of acid reducer in humans which also serves to evacuate the stomach of food quickly. This prepares the female's eggs for a higher percentage of fertilization. This comes in a liquid form in a bottle. The dose of Suprefact is 30 IU's per kilogramme of female fish. To inject a total of 5 kg of females, 2.5 Motilium tablets and 1.5 cc of Suprefact are mixed together with 9-10 cc of saline solution. Thus, a batch of females are prepared for injections at once. The males are anesthetized to calm them as they are to be sacrificed for their testis.

Thus females are weighed and prepared for injection. Small females are each injected with the prepared Motilium hormone and Suprefact, with 0.7-0.8 cc while the large females are injected with 1.1-1.2 cc. A quantity of hormone is prepared for the total number of females to be injected. This saves time and allows the hatchery manager to focus on a large number of spawns at once. Hatcheries in Thailand with a capacity of one million fry per month would maintain about 500 female broodstock and as many males. With good feeding, females can be ready for spawning again in three months time.

Stripping of Eggs & Fertilization: The injected females are held in a tank with flowing water for ten hours then stripped of their eggs. Before stripping, the females are anesthetized again, then gently stripped of their eggs, which are dark green. Eggs are caught in a shallow bowl and fertilized with sperm from the testis of the male. Testis are cut in quarters and a piece is placed in a cloth with loosely woven threads and squeezed to force out the sperm which is spread over the eggs and mixed with a feather with about 300 cc water. Then the fertilized eggs are placed on a framed screen or kakaban of plastic sheets from rice bags, positioned on stones in a tank with aeration (air stones). Hatching occurs within 24-30 hours at 29-30 C°.

2. Requirements for a Successful African Catfish Hatchery

A good fish hatchery operator seeks to produce high quality, fast growing fish seed using brood stock of known origins. This manual seeks to present ideas for consideration in locating, designing and managing a small-scale fish hatchery. Let us list requirements for a successful hatchery operation:

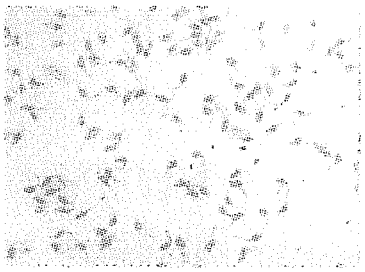
Requirements for a Successful Fish Hatchery

1. Water - High quality, unpolluted water supply in abundance year round, preferably with gravity flow water.
2. Market - Being near a market with high demand for fish fingerlings.
3. Brood Fish - Have selected brood fish of known origins for fast growth, high dress out weight and quality control.
4. Water Chemistry Monitoring - Have the means to monitor and maintain good water chemistry at the hatchery.
5. Management - Be a good hatchery manager with qualified, trained staff and a Management Plan.
6. "Know your fish" - A good hatchery operator constantly observes his fish from hatching to fry to fingerlings to table size fish. What is normal behavior for each stage of growth? How active are fish at different times during the day? What is their normal feeding response? What is the hatching rate of eggs, what is the survival rate of fry?
7. Feeding of fish — A good hatchery operator knows the feed requirements of each stage of fish production, from zooplankton, to supplemental feeds.
8. Handling / Transporting Fish - Be experienced in conditioning and transporting fish with high survival rates.
9. Record Keeping - Maintain good record keeping for proper planning.
10. Business Plan - Have a business plan to assist in qualifying for bank loans.
11. Marketing Strategy – A good fish hatchery has a marketing strategy, which minimizes expenditures and maximizes income. A good strategy includes a variety of clients or buyers of fish, not a limited few who may form a cartel for maintaining low prices to the hatchery operator. Remaining up to date on market prices is key.

2.1 Need for Specializations in Fry and Fingerling Production

Everyone cannot do everything and most fish farmers may well be best at producing table sized fish for the market and leaving fish hatchery management up to those who are best prepared and equipped with the means for intensive fry production to meet demand. Presently there is a one stage fingerling production of catfish in Nigeria with hatcheries carrying out induced spawning and rearing of fry and fingerings at the same farm facility. This calls for much specialization at one facility and may have some advantages, but a more efficient approach may involve a two-stage production as practiced in Asia.

Clarias There are 24 species of *Clarias* (Idodo-Umeh, 2003) in Nigeria and only the *Clarias gariepinus* has been singled out as the best fish for culture as it favored the *Clarias lazara* from Central Africa which was first cultured intensively by Dutch scientists working in Bangui, Central African Republic in the late 1970's. Stocks of *C. lazera* were taken to Holland to the University of Wagenengin where methods were developed for intensive cultivation of this species, which is very similar to the *C. gariepinus* found in Nigeria. A number of *Clarias* species in Nigeria do not have the propensity for growth as the *C.lazera* and *C. gariepinus* and in fact many fish farmers have purchased catfish fingerlings from the wild and found that they consumed large quantities of food and yet only grew to a size of 300-400 grams at some 30 cm in length. *Clarias* species of *C. macromystex, agboviensis* and *buthupogon* are several *Clarias* species lacking growth potential of the *C. gariepinus*. All *Clarias* species are commonly found in swampy waters or slow moving streams and reproduce during the rainy season. *Clarias* are known as the "walking catfish" as they are capable of moving on land from one water body to another, since they are equipped with an accessory breathing organ that enables them to live out of water for some time. This ability makes *Clarias* species very hardy, proving to be a fish adapted to African consumers (who lack refrigeration) and markets, where the fish are held in shallow tubs live for days.



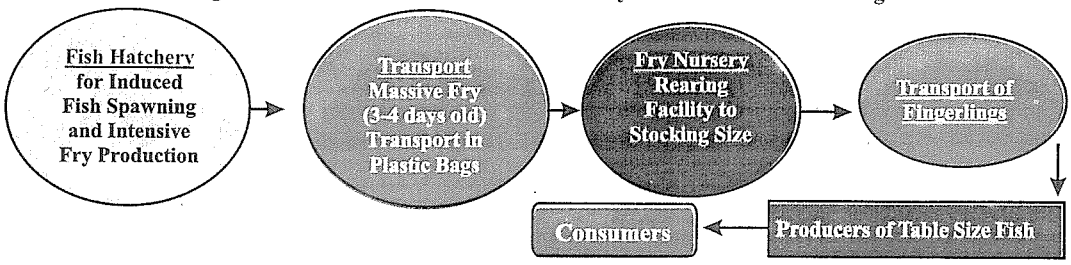
Catfish Yolk Sac Fry-1 day old

Catfish Fingerlings-1"-2-3 weeks

As presented in Figure 1., there may be an opportunity to create a niche market for nursery rearing of fry to fingerlings as has occurred in other countries. Hatcheries could produce large quantities of fry, which are easily transported, over long distances, in very large numbers at 2-4 days of age, once the fry lose their yolk sac and start feeding. Several tens of thousands can be transported in a plastic bag with mortalities at perhaps up to 50%, but this amount often dies in initial hatchery nursery production; the object is massive transport around the country as this will make more fingerlings

widely available and open up significant fish production outside of the South West, where most fish are presently produced. Fry could thus be produced at hatcheries then transported to nurseries for rearing for another 5-6 weeks to a stocking size of 2-3 inches in length for producers. This would create three types of fish farms: 1) hatcheries, 2) fry rearing nurseries, and 3) fish production farms for table size fish. This diversification of production could allow more specialization and focus on doing one thing well and improve overall production, all the while creating more employment. Such "specialists producers" have contributed to making Asia the producer of 75% of all aquaculture-produced fish in the world.

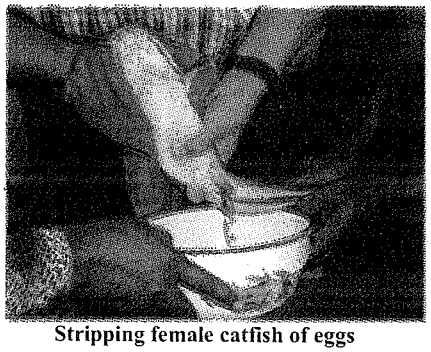
Figure 1. The Asian Model for Catfish Fry Production and Rearing



In such a scheme, a fish hatchery is specialized in holding brood stock and induced spawning. The transporter is specialized in bagging and transporting yolk-sac fry with oxygen, as well as handling and transporting large quantities of fish fingerlings and juveniles. The Fry Nursery is specialized in holding and rearing fry with specialized "natural" fish feeds, followed by feeding with high quality supplemental feeds. Fish would be fed at this facility 5 weeks or more until the fish attained a size desirable for the fish producers. Most Fry Nurseries in Thailand have high mortalities (30-50%) of fry, but this is to be expected at this early stage of growth; a Nursery could be receiving hundreds of thousands of fry per transport. Nurseries would produce fingerlings of sizes determined by the market. Commonly this would be 3-4" long fingerlings and 5-7" juveniles.

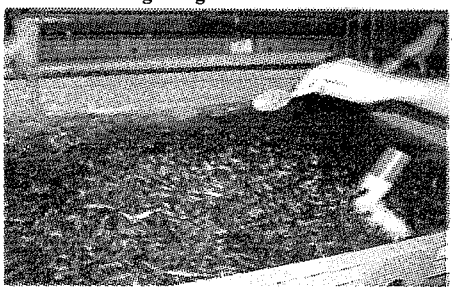
2.2 "Know your fish"

Water is an environment having conditions, which are poorly understood by most farmers who normally farm terrestrial animals or land crops. The fact that fish live in water makes us to know less about aquatic husbandry than traditional terrestrial husbandries. Some fish farmers are poor observers of their fish and they suffer from poor productions and may not even be aware of the extent of their losses or mortalities. How many hatchery operators are aware of the total number of eggs spawned by a female, their percentage of hatching, the survival of fry at one week, then at 4 weeks, etc.? So we must become very curious and learn all we can about our fish including their behavior, their feeding habits, their normal swimming habits, as well as changes that may occur in their behavior during a normal day from night to day, etc. Improved efficiencies and lower cost production can be achieved at fish hatcheries by "better knowing your fish", their spawning parameters, feeding and survival of fry and fingerlings.



Stripping female catfish of eggs

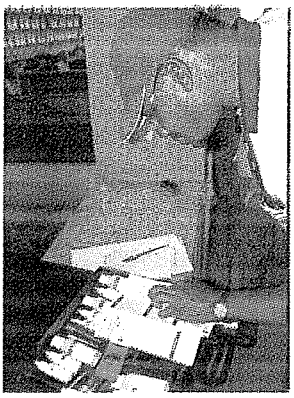
Intensive rearing and feeding of catfish fingerlings



3. Hatchery Facilities and Equipment

"A well-designed, equipped fish hatchery can make profit if efficiently managed"

3.1 Water Supply



Fish hatcheries require a year-round, unpolluted water supply. A backup water supply may be necessary in some areas as with a lake or borehole. Water should be of good quality with a neutral pH of about 7 and water $CaCO_3$ alkalinity and hardness of more than 25 ppm. Harder waters of 100 ppm or more are advantageous as they support higher productivities. More alkaline and harder waters are well buffered and with their mineral and nutrient content, provide the best conditions for high fecundity, high hatching rates and survival and growth of fry and fingerlings. The best hatcheries use a filter system for water filtration before entering the fish hatchery tanks to avoid entrance of wild fish eggs, fry, insects and suspended solids. Most hatcheries use UV lights as sterilizers to kill bacteria circulating in their water supply. Water should be tested regularly for quality. A reliable water test kit should be on hand at any fish hatchery. Water chemistry parameters are presented for hatchery water supplies. If it is necessary to use well water, it should be stored in an earthen pond for a few days to drive off carbon dioxide, increase the oxygen and generally condition the water. Pumped waters should be filtered.

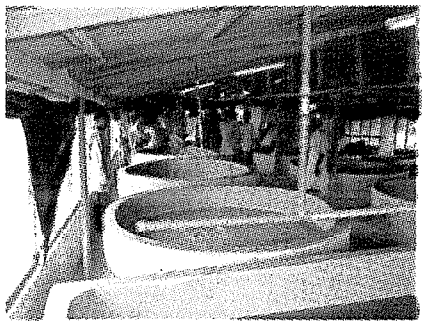
Water Chemistry Values for Fish Hatcheries

- Oxygen ..... 5 ppm-saturation
- pH 6.5-8.0
- Carbon dioxide ..... 0-15 ppm
- Total $CaCO_3$ Alkalinity ... 50-400 ppm
- Total $CaCO_3$ Hardness ..... 50-400 ppm
- Nitrate ..... 0-3.0 ppm
- Magnesium ..... trace for buffer
- Hydrogen Sulfide ..... 0 ppm
- Iron-Total ..... 0-0.5 ppm
- Phosphorous ..... 0.01-3.0 ppm
- Temperature ..... 28-32°C

3.2 Electrical Supply

Fish hatcheries require electricity to operate aeration and water sterilization equipment, not to mention computers and other needed facilities. At least one back up generator is a must for an intensive fish hatchery. As with all equipment, generators require regular service for maintenance for long life.

3.3 Tanks and Harvest Equipment

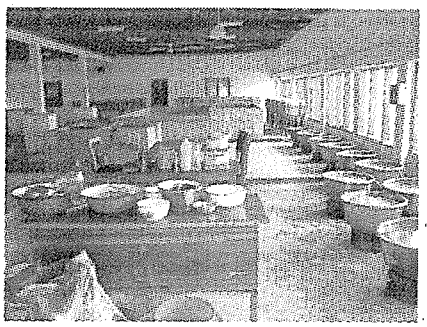


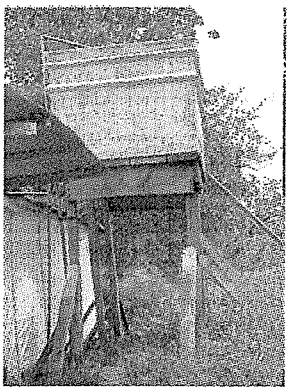
Tanks should be designed to facilitate easy observation and handling of fry and fingerlings. Many older tanks are deep and impractical for observing fish; some of these can be modified and put to good use. Fry tanks may only require a water depth of 20-45 cm and it is good to have tanks built above the floor, at waist level, to facilitate cleaning of tanks and siphoning of fry. Both rectangular and circular tanks may be used, however round tanks with conical bottoms are self-cleaning, easily maintained and lack corners for oxygen deficits. A design for a catfish hatchery is presented in Annex 1. It is possible to use plastic tanks bought new or recycled from metal framed, plastic vats (1 m3) used in importing soaps, oils and chemicals.

3.4 Fish Handling Equipment

Dip nets and tank harvest equipment is needed for easy retrieval of fish. A variety of dip nets of various mesh sizes are needed as are graders for grading out "jumpers" or "shooters" which are fish which may grow several times faster than others. Since

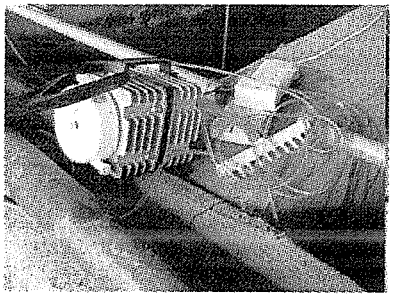
Catfish may prey on smaller size catfish, the faster growing fish need to be sorted out and reared separately. Hatcheries require a number of buckets and plastic tubs for holding and carrying fish, hatching eggs, etc. Buckets and tubs are needed for holding brood fish and for use of anesthetics to calm fish. Siphons of clear plastic are also used to siphon off wastes from the bottoms of tanks as well as for moving fry out of a tank.



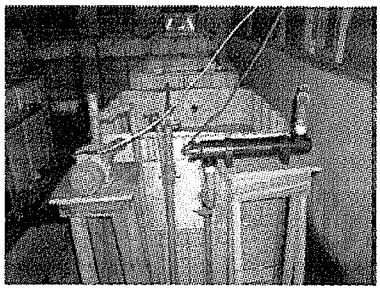


3.5 Gravity Flow Water & Aeration

Overhead water supply tanks need to have sufficient volume to provide water flow during emergencies. Nursery rearing of fry is intensive and lack of water flow, water sterilization and aeration can compromise the health of the fry and even cause massive mortalities. Good water aeration can greatly improve conditions for fish growth and even double present fish production in many cases. Tanks can be aerated individually with aerators equipped with diffusers or air stones. Most hatcheries operate with a central blower and air-lines running to each tank. An air stone or diffuser is provided in each tank to assure maintenance of good oxygen levels.



3.6 Disinfection of Equipment



A well-operated fish hatchery requires a tank or facility to permit regular disinfection of equipment such as dip nets, siphons, etc. Tanks also require regular disinfection to avoid disease outbreaks. Chlorine can be used to disinfect tanks and equipment. Although more expensive, formalin can also be used. As mentioned, Ultra Violent Light sterilizers are required to kill bacteria and micro organisms that could affect your fish.

3.7 Temperatures

Most hatcheries are in shed buildings with screened walls. However it should be noted that warmer temperatures are desirable (28-32°C) and needed for faster growth, etc. Thus it may be useful to put up black plastic sheeting over the screened walls. This will help maintain the desired warmer temperatures inside the hatchery and dim light encourages feeding and growth.

3.8 Facilities for Hatchery Manager

Intensive fish hatcheries require a manager on site 24 hours a day and thus living arrangements are needed for a managers' housing and support. It is important to invest in good management by hiring educated, qualified managers. Contracts with profit sharing of high production results are advantageous and encourage higher fish productions.

3.9 Security for Fish Hatchery

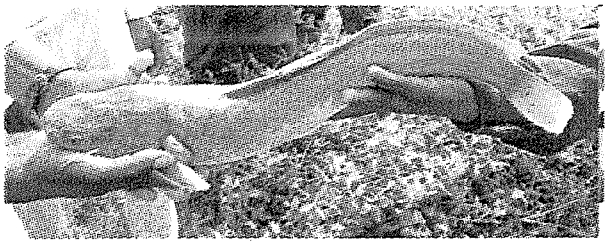
A fish hatchery should be protected from thieves and fish poachers by fencing and security guards. Some hatcheries and fish farms use dogs to patrol the grounds at night.

4. African Catfish

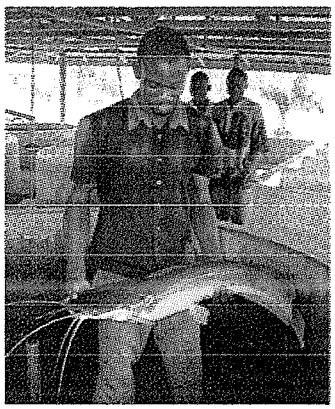
The African catfish is much appreciated for its hardiness and taste. Consumers in Nigeria have made the catfishes (*Clarias* and *Heterobranchus* sp.) the most consumed fish in restaurants, placing these fish in high demand in markets. Since these species can survive in almost zero oxygen conditions for some time as they have an accessory breathing organ. They are sold live in markets and are held in shallow tubs with little water, making them an ideal fish for African consumers who often lack refrigerators or means to hold meat and fish at home.

4.1 Feeding Habits in Nature

To culture a fish or animal, we need to have a good understanding of the natural habitat, biology and feeding in nature. As a predaceous feeder, the African Catfishes have short digestive tracts (stomach and intestine) which are muscular in comparison to that of a filter feeding fish such as a tilapia which can have a digestive system several times longer than the fishes total length. Fry feed on zooplanktons and phytoplantons. Juvenile fish feed on *Chironomid* larvae, ostracods, dragon fly, nymphs, insect larvae eggs and pupae. Fingerlings feed on micro-crustacean insect and larvae insects; much feeding is done at night. In nature, adults feed on crustaceans, obligochaetes insects, small fishes and mollocus. Two species of catfish are cultured in Nigeria, the *Clarias garipinus* and *Heterobranchus bidorsalis* or a cross of the two for the so called, "Heteroclarias".



***Clarias garipinus* broodstock**



4.2 Maturity

In nature or in ponds, *Clarias* of 8-12 months are sexually mature and start to have enlarged ovaries and mature testis. They carry out breeding migration in schools during the onset of the rainy season in April or May, moving from swampy areas or lakes into flowing shallow streams or flood plains to spawn. They spawn in grasses in shallow waters and the eggs hatch in a day. There is no paternal nurturing of the fry, which will swim in a school for a few weeks. The fry are easily preyed upon by insects and other fish. The *Clarias* is reported to be more fecund than the *Heterobranchus*, but the latter grows somewhat larger. The *Clarias* is the preferred farmed fish in the South West, while *Heterobranchus* is in the South-South region of Nigeria.

Stages of Maturation of Gonads

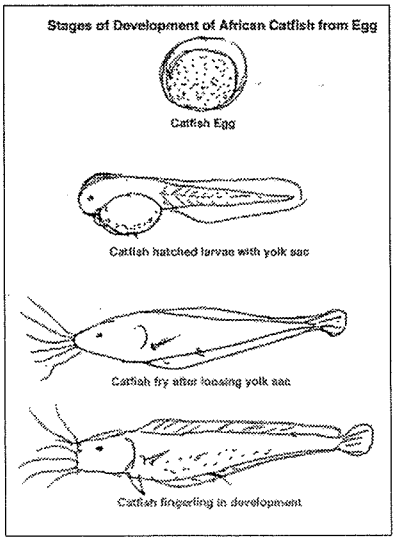
Stage I : Ovaries small egg microscopic translucent. Testis thread like are slightly long

Stage II: Ovarian cylindrical, oblong eggs are visible to the naked eye. Testis look like cerrated ribbon with pink color.

Stage III: Ovaries are enlarged, eggs already visible, small and yellow -brown in color. Testis swollen, serration forming lobes .

Stage IV: Ovaries are very large, occupying the whole of body cavity, dark green (sometimes brownish) colour. Testis well developed, lobes thick and pronounced, seminal vesicle large and swollen. Fish at this stage are ready for spawning.

Stage V: Post Spawning State: Ovaries shrunken



5. Hatchery Techniques for Spawning

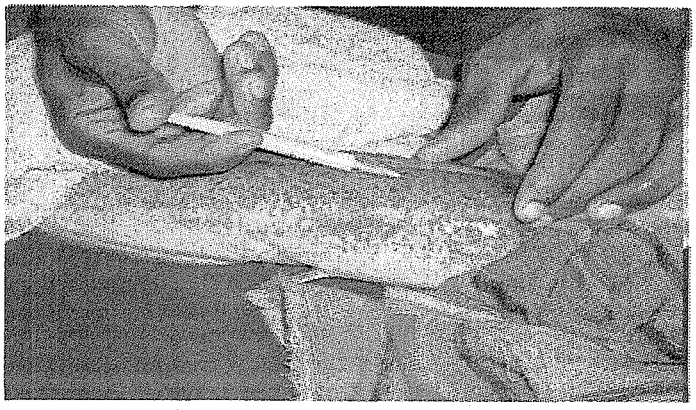
"Management techniques that avoid stressing your fish will always save you money"

5.1 Induced Spawning - Injections

Although Ova Prim has been used in Nigeria, other hormones are cheaper and available in the country, namely Suprefact and Motilium. As in Thailand, ½ of a Motilium tablet is used per kilogramme of female. Tablet's are ground using a mortar and pedestal and when reduced to a fine powder, a solution of 0.9% saline is added to put all the powder into solution for injection into the female. Added to this solution is Suprefact, which is a form of acid reducer and in humans serves to evacuate the stomach of food quickly. This prepares the female's eggs for a higher percentage fertilization. This comes in a liquid form in a bottle. The dose of Suprefact is 30 IU's per kilogramme (30 mg/kg) of female fish. To inject a total of 5 kg of females, 2.5 Motilium tablets and 1.5 cc of Suprefact were mixed together with 9-10 cc of saline solution.

5.2 Time of Injection

As early as 6.00a.m. 6.30a.m. is best for starting the process to finish in one day. Following injection,



wait about 10 hours for eggs to mature and be ready for spawning, then you can start to strip the eggs from the females. Start at 6.00a.m. wait 10hrs. till 4.00p.m. and start to strip eggs.

Hormone Primer for Catfish Induced Spawning

Hormones have been used for many years to induce spawning in fish and such methods have cleared the way for controlled spawning. This enables the hatchery operator to set his timetable for fish spawning. The best hatcheries are able to control the conditions of the fish to spawn them year round. Normally catfish only spawn in nature during the rainy season. Here are the commonly used hormones for induced spawning of African catfish.

Ova Prim has been the hormone of choice for induced spawning of catfish in Nigeria. This is available in pharmacies in 10 ml bottles for N5,500. Ova Prim is injected at 0.5 ml/kilogramme of fish body weight. Thus one bottle can inject 20 kgs of females or about 10 females at 2 kg average weight or 20 females at 1 kg each. This is about four times more expensive than other hormones.

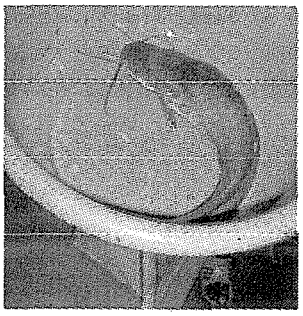
Pituitary – Pituitary glands can also be used from sacrificed fish. Acetone dried Carp puitataries can be purchased and only have to be ground up and injected with saline.

Suprefact – "buserelin acetate" mimics actions of gonadotropin releasing hormone (GnRH or Lutinizing release hormone). This is the hormone released from the hypothalamus gland in the brain. In humans Suprefact is used to treat prostate cancer in men and endometriosis in women. In Nigeria Suprefact is sold in tablet form at N800 for ten, 500 mg tablets. This is much cheaper than using Ova Prim for catfish spawning.

Motilium – "doperidone" is added to the Suprefact to speed up release of eggs in fish. In humans, Suprefact helps empty the stomach more quickly; it also serves to reduce acid reflux. In Nigeria Motilium is sold in tablets at N600 for ten tablets.

5.3 Area of Injection

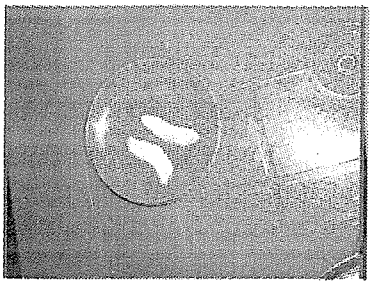
Insert the needle 2-3 cm at the angle of 30°-45° in the dorsal muscle while retracting the syringe after injecting the hormone. Use the finger to rub the injection area to move the hormone throughout the muscle.



5.4 Anesthetizing Broodstock

Before injection, put about 3 liters of water in the plastic bowl or basin, and add about 5-10 drops of Guinaldine, then put broodstock in the water with Guinaldine for about 2-3 minutes and the fish will sleep. At this time, it is convenient to inject and strip eggs from females as they will remain calm. After injection return the broodstock to a holding tank with oxygen and fresh water flow and they will wake up.

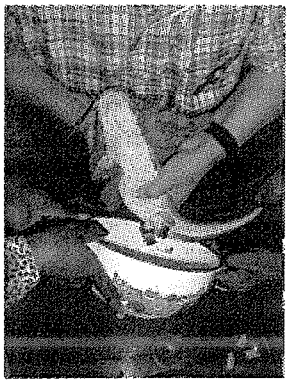
5.5 Collection of Milt

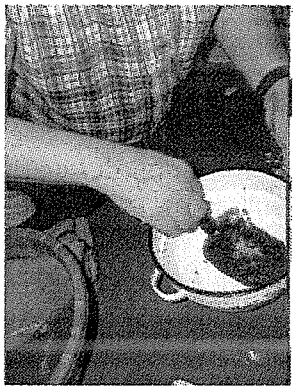


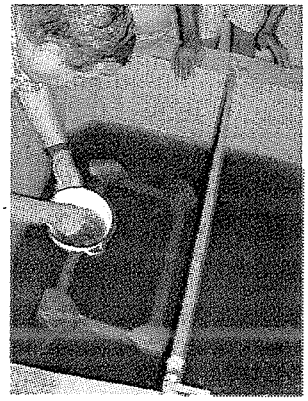
Ten hours after injection, place several males in the water with Quinaldine for anesthetization. Milt can't be collected in quantity by stripping; it can only be obtained by sacrificing the fish and dissecting the testis by scissors. Remove the two testis without squeezing them and put them in a plastic plate (see photo on right). Then use the scissors to cut each testis into smaller pieces and then put each piece into a loosely woven cloth to squeeze it and spermatozoa will come out and can be caught in a recipient for spreading over the eggs.

5.6 Stripping of Female Spawner

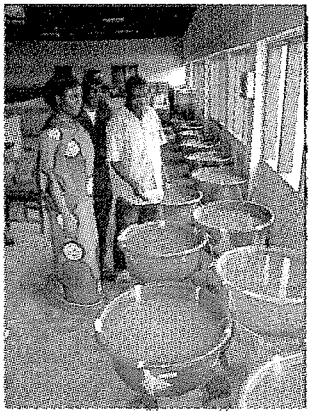
It the female has responded well to the earlier injection, the mature eggs will easily run out from her genital opening. Take the females and anesthetize them in water with Quinaldine, and then clean them with water and hold them gently with a towel. Then strip them gently and the eggs will come out into the bowl until there are no more eggs. Then pour the spermatozoa over the eggs and use a feather to thoroughly mix them by stirring. Add more water, then stir another half minute, then put the fertilized eggs on the screen with a frame in the hatching tank. Otherwise, the eggs can be placed in 60-80 liter plastic basins with aeration. Eggs will hatch in about 24 hours at 28-30°C. Wait about 36 hours to be sure all fertile eggs have hatched. After 36 hours it is essential to remove the fry to clean water as waste egg shells and dead fry will attract fungus and disease. After stripping, a female should be returned to an earthen pond; she will be ready to spawn again in three months with good feeding.







5.7 Preparing Plastic Basins for Fertilized Eggs.



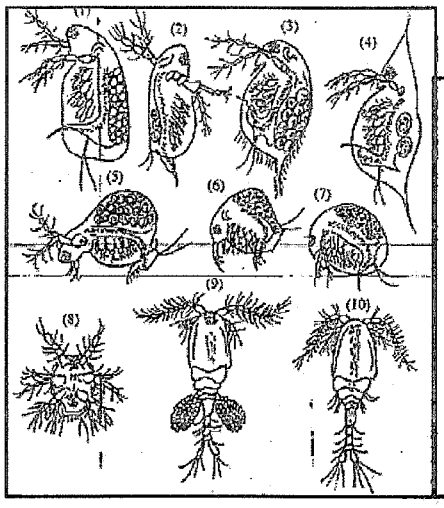
Prepare a plastic basin of size 60-80 liters, and install the air pump (see photo). Clean concrete or plastic tanks can also be used, but the plastic basins are inexpensive and easy to clean. As pictured, many spawns can be handled using these plastic basins. Pour clean water nearly full into the basin. After installing the fertilized eggs, the air pump must always operate as this will keep the eggs moving and rolling in the water. When all eggs are hatched, you can remove the fry with a dip net or siphon them to another basin with air pump and clean water. Aeration is essential to achieve a good survival of fry. It is possible to have up to 40,000 fry in one basin of 60-80 liters. Note that a one kilogramme female would have about this number of eggs.

Maintaining good water quality is also essential for good fry survival and growth. When you see water fouling with wastes, you must siphon out the wastes and in so doing renew the water quality with fresh water.

"Feed your fish the right food, in the right size, in the right quantity, at the right time and avoid overfeeding"

6.1 Rearing of Natural Fry Food

About 36-40 hours (1.5-1.75 days) after hatching, the yolk sac of larvae will be absorbed. Just prior to this, start giving the first food with zooplanktons or artemia produced in the hatchery (see below). Always maintain the air pump for aeration of the water and change the water if it becomes dirty.



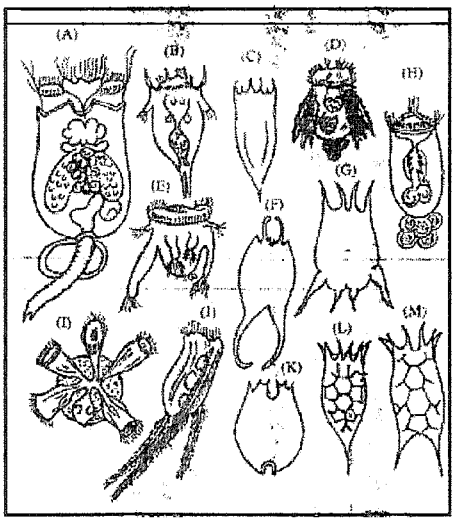
Common Zooplankton, comprise the most important first food of the catfish fry. Some of these can be seen with the naked eye in a clear glass, whereas a dissecting scope will reveal them more clearly. After 3 days of feeding the zooplankton food, transfer the fry to a larger nursing tank and start to give supplement foods, by reducing zooplankton to 50% of the ration and add supplementary food at 50%. After seven days of such feeding, you can feed only supplementary food.

Zooplankton

1. Sida spp
2. Diaphanosoma
3-4. Daphnia spp.
5. Moina spp
6. Bosmina spp
7. Chidorus spp
8. Cyclops larvae
9. Cyclops spp with eggs
10. Cyclops spp without eggs

Common freshwater rotifiers also make up zooplankton and, are also important natural food to the catfish fry.

(a) Brachionus
(b) Synchaeta spp.
(c) Polyartha
(d) Hexathra
(e) Brachionus
(f) Brachionus
(g) Asplanchna spp.
(h) Concehilus spp.
(i) Filina spp.
(j) Brachionus
(k) Keratella spp.
(l) Keratell

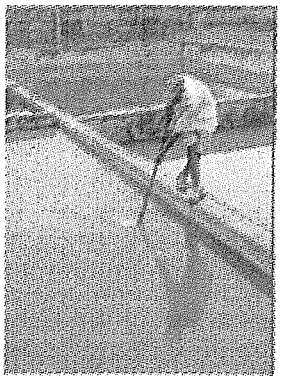


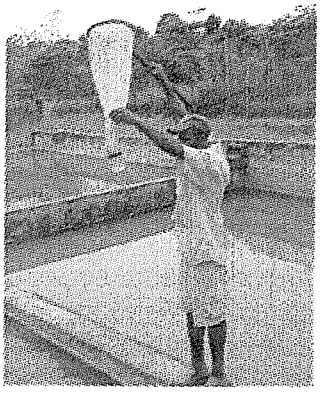
6.2 Artemia

Although expensive, Artemia cysts can be purchased and hatched out in the hatchery. Use the plastic basin of about 20 litres and add water to nearly full level. Add about 600gm (30 g/litre) of salt (NaCl) and add about 40-50 gm of artemia cysts (2 g/litre). The artemia will hatch out with an air pump with air stones for about 18-24 hours. The egg shells will float to the surface once the aeration is stopped. Then the Artemia can be siphoned out into a fine dip net and diluted in fresh water before feeding to the catfish fry. This provides excellent natural fry food, but Artemia are expensive. It is cheaper to culture zooplankton at the hatchery.

6.3 How to Make zooplankton

Select an earthen pond, such as the broodstock pond. Remove any small fish. The pond must have green water (phytoplankton). To prepare zooplankton for a 600-800m2 pond add 20 kgs of chicken manure, 5 kg of lime, 5 kgs N:P:K: fertilizer (16:16:16) and 2 kgs of fine fish meal. After 3 days, zooplankton will be growing or "bloomed" and can be seen as whitish swarms of tiny zooplankton around the pond in the green water. The green water is due to phytoplankton which is eaten by zooplankton. A plankton net can be used to collect the zooplankton as shown in the photos. One must be careful to avoid collecting any insects, small fish or other aquatic predaceous organisms as they will eat the fry.





6.4 Feeding Fry Making Supplemental Feed

Although imported fry feeds are superior and consistent in quality, they are expensive. For the small to medium hatchery operator, supplemental feed can be made by mixing finely ground Fish Meal (50-70%) with Chicken Feed (30-50%). To this is added Vitamin C at 1 teaspoon per 2 kgs of feed, plus vitamin premix at 1 teaspoon per 2 kgs of feed. Wheat flour can also be added to thicken the mix at 2 tablespoons per 2 kgs of feed. These ingredients must be finely ground and thoroughly mixed and blended. By adding a small amount of water, the feed can be pelleted in fine pellets or just sun dried. Such supplemental feeds could be fed with the higher quality imported feeds.

6.5 Vitamin C

Vitamin C is very important for culture of fishes. If there is no Vitamin C in the feed, the fish will develop "broken head" or curvature of the spine (Scoliosis or Lordosis). Vitamins help increase the survival (at least 50% is desired in the hatchery) and growth rate for both fingerling and adults.

Check List of Hatchery Equipment & Supplies

1. Work Tables
2. Water Test Kit
3. Back Up Generator for 24 hr electricity
4. Scale or balance to weigh
5. Mortar and Pestle
6. Scissors
7. Syringes
8. Towels, napkins
9. Plastic Basins of 20 liters, 60-80 liters
10. Enamal Bowl
11. Thermometers
12. Hormone – Motilium or Ova Prim
13. Suprefact – accelerator
14. Quinaldine – Anesthetic
15. Saline Solution – 0.9% NaCl
16. Air pump with air lines & air stones
17. Siphon hoses-1/4, 3/8, 1/2 inch, etc.
18. Feather for mixing eggs + sperm
19. Hatching frames/screens
20. Kakaban's for hatching
21. Dip nets – fine mesh and larger
22. Cleaning sponge on stick
23. Chlorine cleaner for tanks, basins
24. . Formalin
25. Potassium Permanganate
26. Small mesh seine
27. Plastic Buckets-20 liters
28. Fish Counting Table
29. Artemia Tank – 200 liters

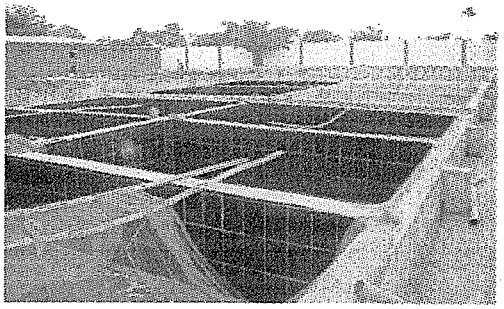
6.6 Water Management in Rearing the Fry

Intensive feeding requires good water management to ensure the best conditions for growth. Fry should be fed 3 times daily and the tank should be observed closely for waste feed accumulating in the bottom of the basin or tank. Such wastes should be siphoned out, with new water added. Such waste creates biological oxygen demand (BOD) and may stress the fish unnecessarily. After catfish fry larvae feed for 8-10 days they can be removed to an earthen pond for nursing.

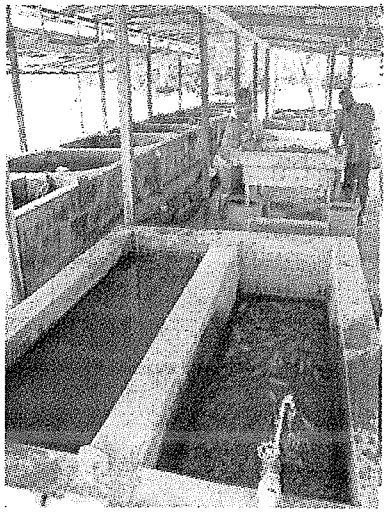
7. Rearing of Fry to Fingerlings

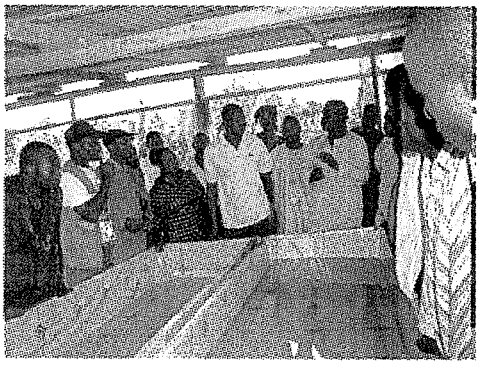
"Keep your fish happy by not stressing them"

7.1 How to Nurse Fry in Concrete Tanks



After the fry have absorbed their yolk sac, add zooplankton daily as the first natural foods for 3 days. On the third day, you need to add some supplemental feeds as already mentioned to get the fish accustomed to new feeds. On the fourth day, fry can be moved from the plastic basins to concrete tanks. A tank of 6 x 8 meter (48 m2) is good, but any size will do. Maintain the water depth at 10-20cm in and always maintain aeration with an air pump. In large concrete tanks both zooplankton and supplementary foods can be mixed starting on the 3rd day. After 3 days of mixed natural and supplemental feeds, only supplementary feed can be fed. Every morning clean the walls and bottom of the tank and siphon dead fry and wastes out. Drain 50% of water, replacing it with fresh water. Feed twice daily, once in the morning and once in early evening. Be careful in feeding as to not spoil the water in the tank. Avoid stressing the fish. It is easy to over feed and this is why daily cleaning is important. Also, it may be necessary to cover these tanks with mosquito netting to keep out predaceous insects. Fry which are well fed in the nursery tank will be easily accepting supplemental feed and ready for transfer to nursery ponds at 8-10 days of age. Alternatively they can continue to be reared and fed in concrete tanks. Fry need special attention and a protected environment with good feeding and aeration will ensure high survival and more income to the farmer.





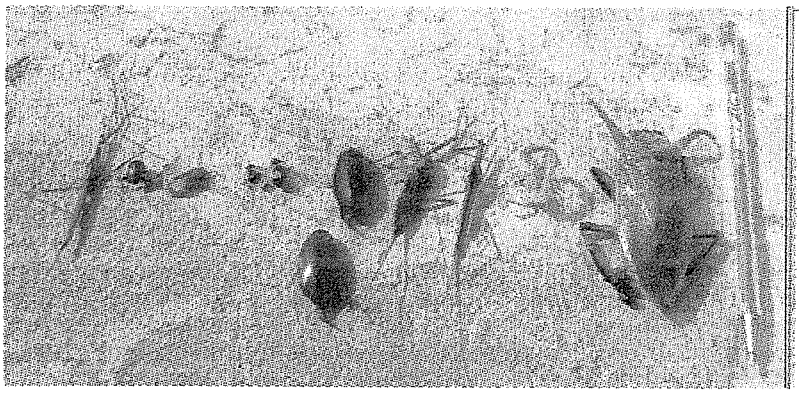
7.2 Rearing fry in plastic lined wooden boxes

Cost conscious small fish hatchery operators often use plastic lined wooden boxes to rear fry. This is much cheaper than plastic or concrete tanks and is highly portable. With aeration, such boxes make effective tanks. Should a disease outbreak occur it would be possible to discard the plastic liner and install another..

7.3 Preparing the Nursing Pond

Nursery ponds should be small, covering an area of some 100-500 m2 with an average size of 200 m2. They must be well fenced with plastic mosquito net or block walls to keep out frogs and snakes. These fences must be controlled regularly for maintenance. To prepare the pond, drain the water and leave the bottom exposed to the sun for 2 days. Following this, app ly lime (0.2

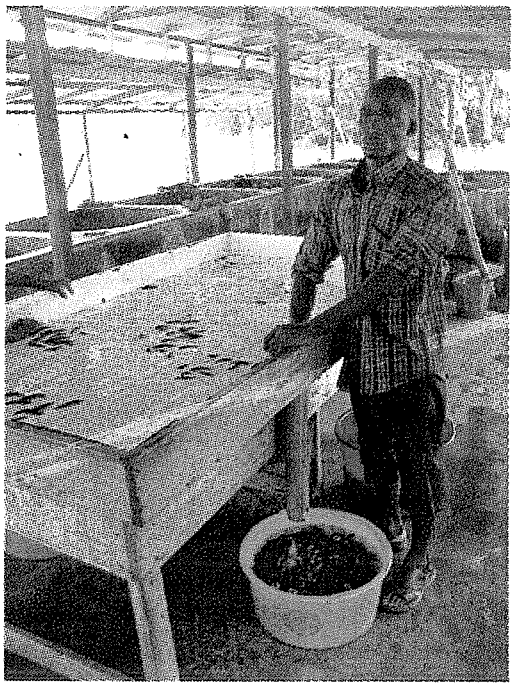
kg/ m2), chicken manure (3 kg/100 m2), and NPK (16:16:16) Fertilizer at 1 kg/100 m2. Maintain the water depth at about 30-40cm, before stocking the fry. To control for predaceous insects apply super gasoline along one side and it will spread across the entire pond and kill all air breathing insects. The



gasoline will evaporate. For the same purpose, some recommend using diesel fuel even though it leaves an oily residue. The control of insects in fry ponds must be maintained rigorously as they can inflict heavy mortalities on young fry. There should be no frogs or snakes if the pond has been properly dried out and fenced.

7.3 Stocking the 8-10 Day old Catfish large Fry to Nursery Ponds

The 8-10 day old fry can be moved from the indoor tank and stocked in a fenced, cleaned pond (200 m2) as previously described. For the first 3 days feed the supplementary ration in powder form, after which you can feed the small pellets made with the same formula. After 4-5 days the water depth can be increased to 60 cm. Some shade should be provided over the pond or some plants can be added around the pond for shade to the growing fingerlings. This helps reduce stress on fish. Closely monitor growth at feeding time. Feed should be fed at least three times per day. High stocking densities can be used in nursery ponds of up to 100,000 fry. Such ponds are maintained with aeration and some water flow. With careful management, after 4-6 weeks of good feeding, it is possible to achieve 60-80% survival. The small fingerlings will now be about 2-3 inches in total length and very hardy. These small fingerlings can be counted and sold to fish farmers or stocked in grow out ponds. Counting tables with slick surfaces and several holes are ideal. Buckets with water can be placed under the holes to receive the counted fish. Good workers will learn to count fingerlings in groups of five or ten and only good concentration is required during counting. Counting tables are extremely useful in preparing orders for fish fingerlings and their use reduces stress as would occur with individual hand counting.



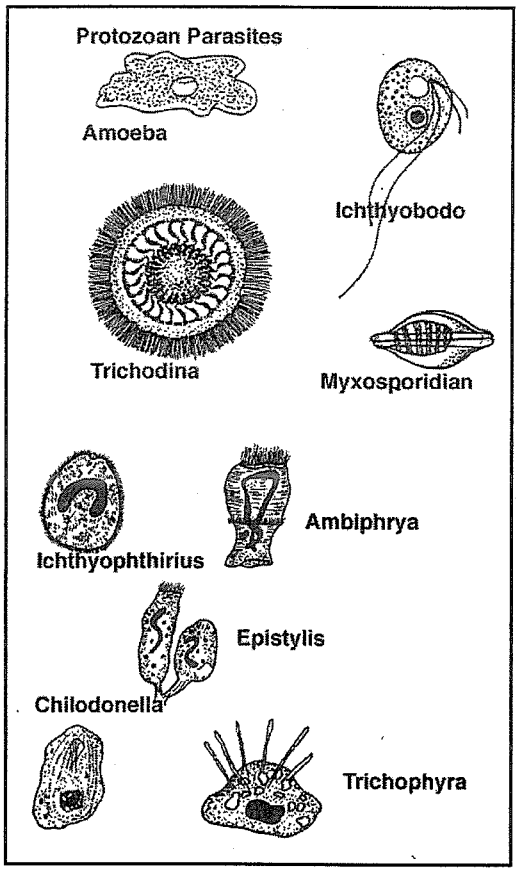
7.4 Harvesting of Fingerlings

When the fry have remained in earthen ponds for about 6 weeks, they will be fingerling size at 2-3 inches in length and can be harvested with nets of small mesh size. Fingerlings can be held for sale or culture or reared up to juvenile size, which fetches a higher price. Always work methodically and systematically to avoid stressing your fish.

8. Fish Diseases

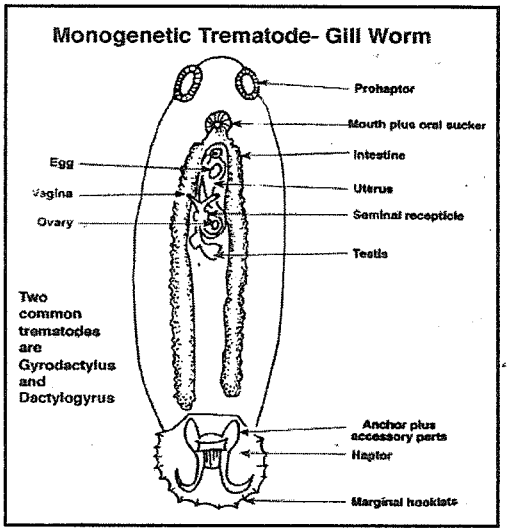
"An ounce of prevention is worth a pound of cure"

This manual is not intended to serve as a guide to fish diseases, so only this overview is provided. The health of the fry or fingerlings is determined by the water and cleanliness of the tanks or ponds. If the water is polluted or has limited oxygen, or if the tanks are dirty, such conditions will stress fish and diseases will appear. Typically, under poor conditions fish will succumb to bacterial infections, fungus or parasites. In highly rich organic conditions (as found in overfed, dirty tanks) ciliated protozoans are common and can swarm over gills and skin to sicken and even kill the fish. Always practice routine prevention and many disease problems will never occur.



Closely observe for unusual behavior of fry or fingerlings as abnormal swimming or not feeding could be indications of disease or parasites. Stressed fish exhibit unique behavior and the observant fish farmer will quickly pick up any indication of stress or the onset of disease.

Acriflavin, a bacteriostat, could be used as a preventative measure against external bacteria. Potassium Permanganate ($KMNO_4$) is effective for fungus, some bacteria and external parasites at 2 ppm in ponds as a definite treatment or as a dip at 10 ppm (1 gram/100 liters) for about 60-90 minutes. Formalin is widely used at 200-250 ppm (20-25 cc/100 liters water) as a dip for 30 minutes for external bacteria and some external protozoan parasites. Plain salt (NaCl) can be used on fingerlings with gill worms and some external protozoans at 10-25 grams per liter (25,000 ppm) of water for a short dip up to 20 minutes. This is about the least expensive of all preventative treatments. Plastic containers should be used and zinc basins should be avoided.

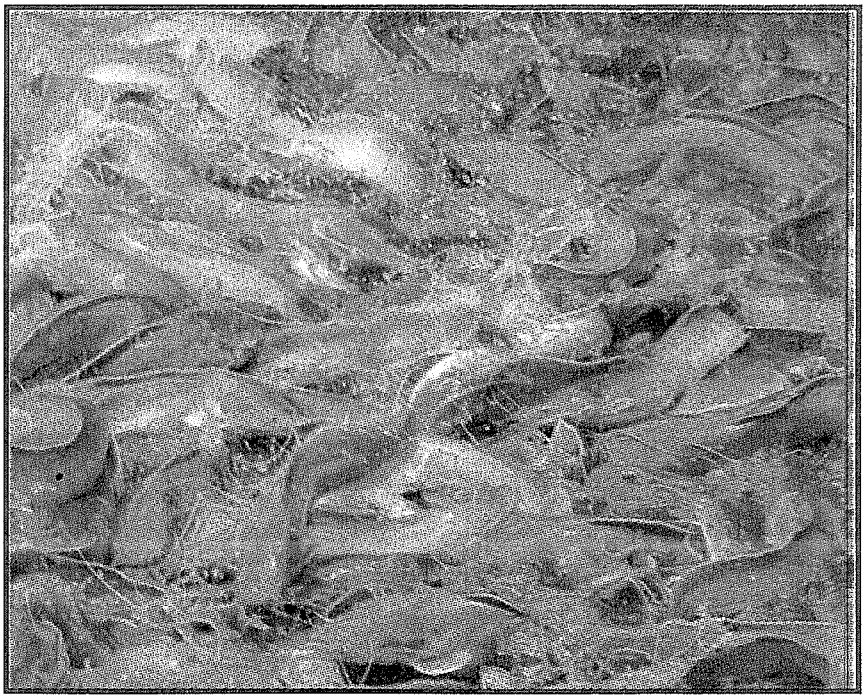


If fish have bacteria, fungus or parasites, they can be dipped in a tank or basin of 50 ppm Formalin (1000 litres of water with 50 cc of formalin) for 5 minutes. The fingerlings can be kept in a dip net during the treatment. This is good for sale of fingerlings as they will be disease free. Prophylatic treatment is a useful, "value addition" tool for marketing.

9. Catfish Production in Grow Out Ponds

9.1 Catfish Growout Ponds

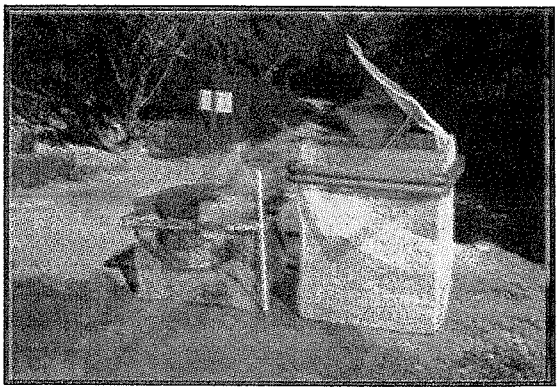
In Thailand, grow out ponds are some 1,600 m2 in area. Up to 100,000 small fingerlings (1.5 inches) can be stocked in such ponds. This equals a density of some 62 fingerlings/m2. Fingerlings are fed in grow out ponds for four months with flowing water. In Thailand such fish are fed ground trash fish from bi-catch in marine fishing. This is mixed with waste noodles from a noodle factory. Under such conditions, survival up to 70-80% can be attained for a production of 5,000-6,000 kgs of fish weighing 3-4 fish/kg or 250-333 grams each. From these ponds, the fish can be transferred to slightly larger ponds at a density of 40-60/m2 for topping out at 1 kg each or more.



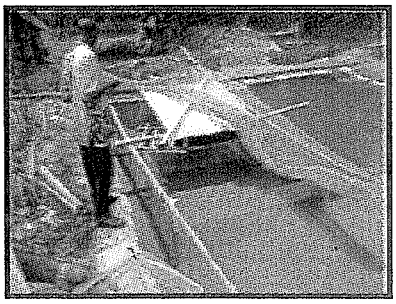
Catfish are very aggressive feeders as shown in this photograph. By using high quality feed, the hardy African catfish can yield superior growth and profitable fish production.

9.2 Alternative Cage Rearing of Catfish

It is possible to rear Catfish in cages as they are hardy and resistant to disease. One of the largest tilapia producers in Africa rears male tilapias in cages in Zimbabwe. Inconclusive trials have been conducted in rearing catfish in small cages in Nigeria. A major problem identified was potential theft of fish. If a secure location can be identified and high quality fish feeds used, it would be possible to conduct more practical studies on cage catfish farming. Results of ongoing studies using cages made of nylon nets, should be available soon.



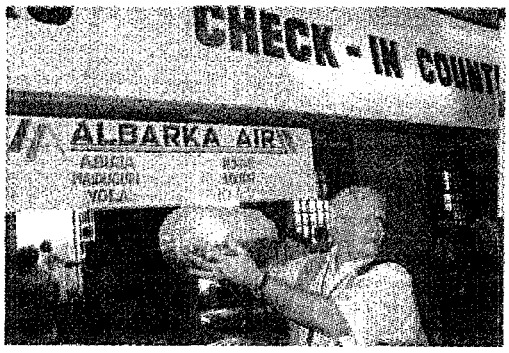
Note that fry can be reared in fine mesh cages called hapas as has been done in several locations in Nigeria.



10. Transport of Live Fish

10.1 Transport of fish

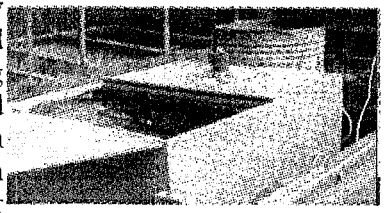
Transport of fish must be well organized and implemented or there is a price to pay: dead fish. First of all fish should be reared in tanks that are cleaned regularly with Chlorine to reduce risk of disease or parasites. As discussed, preventative measures always cost less than actual treatment of disease where fish loss and disfigurement are inevitable. Fish may survive the disease after treatment, but may be undesirable to consumers. Always remember, "An ounce of prevention is worth a pound of cure".



In preparing fish for transport, the fish should be counted and weighed for record keeping, then segregated and held in a tank with cool, flowing water, aeration and no feed for at least one full day of 24 hours. Fish may be held in a small net cage inside a tank as this will facilitate moving the fish into the transport box. The box pictured at right below is adapted to accept such small cages on hooks inside the box. Thus fish can be removed from the live haul box easily and without stress. Non iodinized salt is added at the rate of 0.4-5 lbs salt per 100 gallons of water according to the species of fish. This reduces stress on fish. Fish should be acclimatized at their destination to the water temperature in their new pond or tank. This may require an hour or more to bring the transport water to a similar temperature as that of the pond. Patience is required at this stage and a thermometer is necessary as shown. Always avoid stressing fish.

Transport of 3 inch catfish fingerlings in thick plastic bags. With fish held off feed for at least one day, up to 1000 fingerlings can be transported in such bags. Usually one third of the bag is occupied by water and fish, while two thirds is for oxygen. During transport, such bags should lie flat to maximize the oxygen / water interface. Insulated boxes are used to keep the water cool and to facilitate survival on long hauling trips. Fish should be acclimatized to the temperature of the water in the new pond or tank as shown to the right.

Hatchery managers involved in preparing fish for transport quickly learn that the first thing a fish does when moved from one tank or water recipient to another is to "ease himself" and foul the water. So if fish are not fed for 24 hours they will already have eased themselves before being transferred to an insulated fish transport box with aeration or plastic bag with oxygen. Keeping water clean and cool during transport greatly enhances conditions for survival of fry or fish. The cooler the water, the more capacity to maintain high levels of oxygen and hence less stress on the fish. Hot water has less oxygen and for lengthy trips, it is advisable to carry some block ice to add small pieces to maintain cooler temperatures. This also slows down the metabolism of the fish and hence risk in transport. Fish farmers should always avoid stressing their fish. Note the live fish transport box above as it is equipped with 12 volt powered water agitators and small mesh cages hooked inside each tank which facilitate moving the fish without stress.



Aeration with oxygen and air stones is better for transporting fish than agitators, which tend to heat up the water on long hauls. Up to 3-4 lbs of warm water fish can be transported per gallon of water in such tanks. (about 0.4 kg/liter). Fish must be conditioned before transport.

11. The Business of Fish Farming

"A satisfied customer will always return for more business and is the best advertisement for your business"

11.1 Provide technical advice to all customers

When a fish hatchery manager sells fingerlings he should ensure proper conditions are available for transport and the safe arrival of the fish in good condition. It is also advisable to provide each client purchasing fingerlings with a guide to rearing them, which should include comments on how to maintain fish, free of disease. This type of "embedded extension" to farmers is growing as an effective tool in the absence of adequate support from extension services. A good hatchery manager or fish farmer who sells fingerlings should always try to give technical advice to the buyer as this will enhance survival, increase fish production and keep the customers coming back.

11.2. Marketing

Although this is more of a technical manual for raising catfish, it would not be right to present all of this without discuss marketing. Clearly you should know your market before you produce fish or anything for that matter. Your success will depend on you knowing your market before you ever produce anything. Who wants to buy what you want to sell? Why would people want to buy it? How much would people want to buy? What price are people willing to pay for your product? How big is your market? Who are your competitors? Any private business person needs to answer this basic questions before entering fish farming or any business.

11.3 Good Record Keeping is a Must for a Successful Business

The best fish farmers keep good records of all activities, purchases and sales. Such information is used in developing a business plan which is essential for a bank loan. Credit is usually essential for expansion of fish farms and all businesses. Forms for technical management in fish farming (stocking, sampling, feeding, harvest) are provided in this manual. Records should be systematically kept in a well organized manner in notebooks or in files for easy retrieval. Records can be used in setting up and verifying the Business Plan.

11.4 Business Plan

Good business practices call for a solid, well thought out business plan. This is the basis for good management and obtaining bankable loans. It is useful to discuss this with a successful business friend to better understand the practicality and usefulness of a business plan as a tool for management. Below is an outline of a typical Business Plan as presented in "Setting up a Small Business. A Guide for Women in Business", by Dale Hermanson and Glen Hughes (CIDA).

Mission Statement of Business

State clearly in 2-3 sentences what you intend to do in business.

1. Executive summary

a) Description of your proposed business
1) describe your product or business
2) support with diagrams, illustrations or pictures (if available)
b) Summary of your proposed marketing method
1) describe the market you're aiming for
2) outline the way you plan to reach your market
c) Summary of your financial estimates
1) state the total sales you aim to reach in each of the first three years
2) state the estimated profit for each of the first three years
3) state the estimated starting capital you'll need

2. Statement of objectives

a) Statement of the desirability of your product or service

1) describe the advantages your product or service has, its improvements over existing products or services

2) state the long-range objectives and the short-range objectives of your proposed business

3) describe your qualifications to run the business

4) describe the 'character' you want for your business, theimage you'd like your customers to see

3. Background of proposed business

a) Brief summary of existing conditions in the type of 'industry' you're intending to enter

1) where the product or service is now being used

2) how the product or service is now being used

b) Detailed explanation of your place in the industry

1) describe the projections and trends for the industry

2) describe competition you face

3) state your intended strategy for meeting competition

4) describe the special qualities of your product or service that make it unique

4. Marketing strategy

a) A description of your marketing strategy

1) describe the market you plan to reach

2) describe in detail how you plan to distribute your product or service (retail shops, door to door, etc.)

3) describe the share of the market you expect to capture

5. Selling tactics

a) An outline of the activities to be used in selling the product or service

1) state the methods you expect to use to promote your product or service (word of mouth, radio, newspapers, etc.)

2) include a sample brochure or other promotional literature

3) present any data which supports your ability to meet your sales goals (i.e. actual orders, potential customers, etc.)

4) explain the margins of safety you've allowed in your sales forecasts

6. Plan of operation

a) Description of the proposed organisation

1) show an organisation chart describing the needed business functions and relationships

2) describe the key positions and identify the persons to fill them

3) list equipment or facilities and the space and location required

4) if manufacturing, outline the kind of production you'll do in-house and that to be sub-contracted

7. Supporting data

a) Information required to support the major points in the business plan

1) a set of drawings of the product(s) to be made or a detailed description of the service to be offered
2) show a list of the equipment you'll require for your business and estimes of the cost of that equipment
3) List the capital equipment you'll need and its estimated cost.
4) List a price schedule for your product line or service
5) Include your market survey data (perhaps from your focus group)
6) supply the following financial data:
   - projected statement and balance sheet for the first two years by the month
   - Income statement for two years
   - cash flow projection for two years

8. Conclusions and summary

a) statement of proposed approach in starting the new business

1) state the total capital you'll need and the safety factor you've used
2) state how much profit you expect and when you expect to show it
3) decide what percentage of ownership you want for yourself and your partners
4) indicate the total capital you'll need and how it's to be made up:
   - your share of the starting investment
   - how much you'll need from others and when you'll need the money
   - state what share of the business you'll give to investors or lenders
5) state your planned schedule for starting your business

12. Last Thoughts in Conclusion

In conclusion, to produce abundant and strong catfish fingerlings and table fish you must have:

A good market

A business Plan

- Good quality water in abundance year round (natural water)
- Good quality broodstocks of known origins
- Suitable nursery tanks, plastic tanks or plastic basins
- Maintain Temperature at 28-32oc (water & air)
- Have electricity and generator back up
- Use air blower or air pump for aeration
- Produce Zooplankton or artemia for natural fry food

  Have available Quality supplementary fry feed
- Hormones for induced spawning:

  Suprefact & Motilium are best now, but Ova Prim and Pituitaries also work
- Assure Day and night, 24 hour management
- Have a well qualified and trained farm/hatchery manager
- Keep good daily written records of all activities, purchases and sales
- Be located in a safe area without thieves
- Be willing to always seek to upgrade one's skills in raising fish as with annual training

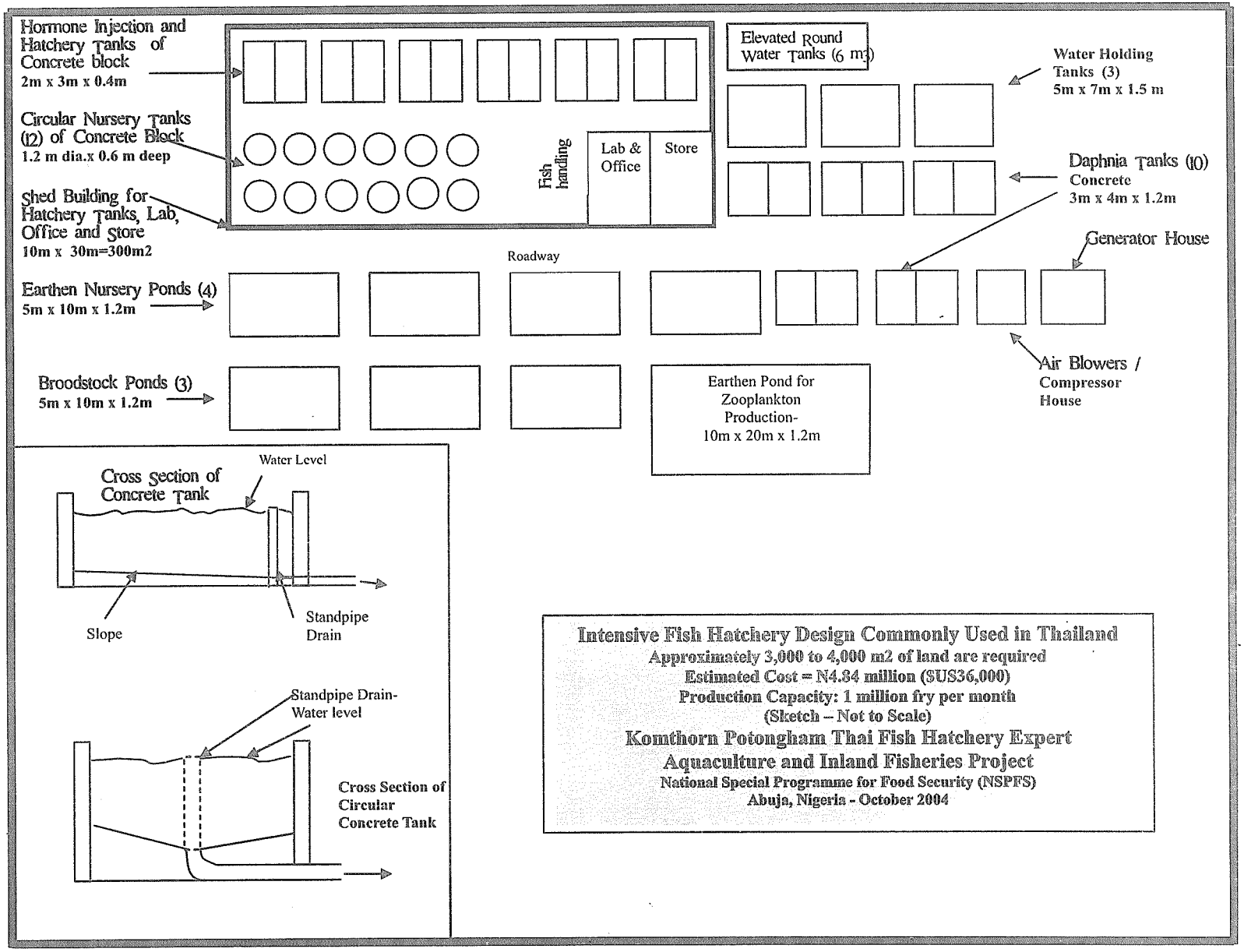
13. Cost of CatFish Hatchery in Thailand To Produce One million catfish fingerlings per month

Thailand produces 644,890 metric tons of fish from aquaculture each year with a total domestic fish production of 2.9 million tons of fish. Thais are large fish consumers with per capita consumption reported as high as 150 kg/capita. The high aquaculture production in the country relies on many small scale fish hatchery producers. Success in aquaculture can be attributed to a long tradition of fish farming in the society where fish are grown in tanks, backyard ponds, large fish farms and rice fields.

A common fish hatchery has an investment of less than $US 40,000 (N5,480,000) and produces one million catfish fry each month with some 500 female broodstock. Such a small farm would only require about 3,000 m2 of area. Thai hatchery operators sell three day old fry to fish farmers who rear them to a juvenile size of 1-2 inches in length in ponds in about four weeks. A survival of about 50% is obtained by these nursery operators, but they operate with massive numbers of fry. They sell the juvenile catfish to fish farmers who produce table fish for both the local and export markets. The following is a breakdown of requirements for such a fish hatchery.

Item	Description	No. Units	Unit Cost (N)	Total Cost (N)
1. Hatchery Tanks - Rectangular	3m x 2m x 0.4m deep hormone injection tanks-2.4 m3 each	10	N 16,714	N 167,140
2. Nursing Tanks - Circular	1.2-1.4m diameter x 0.6 m deep= 0.79 m3 each	20	N 20,048	N 400,975
3. Zooplankton Tanks - Rectangular	3m x 4m x 1.2m=14.4 m3	6	N 100,243	N 601,463
4. Water Storage Tanks Rectangular	5m x 7m x 1.5m= 52.5 m3	4	N 334,146	N 1,336,585
5. Elevated Tanks for gravity water flow	For a total of 6 m3- In Thailand for 6 m3 of water in elevated tanks, some $4,878 is needed. Here, 6 plastic round tanks of 1 m3 each can do.		N 150,000	N 150,000
6. Generator	5 kva	1	N 100,000	N 100,000
7. Air Blowers – Compressors	Compressors with air lines	2	N 100,215	N 200,430
8. Laboratory Equipment	Microscope, Binocular dissecting scope, water test kit, nets, hormones, pump, air lines, air stones, wind controller, grinder		N 1,002,429	N 1,002,429
9. Pond Construction	1 m3 earth work=N668 cost	1,000 m3	N 668,560	N 668,560
10. Small lab building	3m x 4m = 12 m2		N 68,500	N 68,500
11. House for Workers	To house ten laborers for fish strippiing, etc.		N 137,000	N 137,000
Total				**N 4,833,082**

Farm labor in Thailand earn about $US 5.00/day
This total of N 4,833,082 equals some $US 36,000.


Hormone Injection and Hatchery Tanks of Concrete block
2m x 3m x 0.4m
Circular Nursery Tanks (12) of Concrete Block
1.2 m dia.x 0.6 m deep
Shed Building for Hatchery Tanks, Lab, Office and Store
10m x 30m=300m2
Fish handling
Lab & Office
Store
Elevated Round Water Tanks (6 m3)
Water Holding Tanks (3)
5m x 7m x 1.5 m
Daphnia Tanks (10)
Concrete
3m x 4m x 1.2m
Generator House
Roadway
Earthen Nursery Ponds (4)
5m x 10m x 1.2m
Broodstock Ponds (3)
5m x 10m x 1.2m
Earthen Pond for Zooplankton Production-
10m x 20m x 1.2m
Air Blowers / Compressor House
Cross Section of Concrete Tank
Water Level
Slope
Standpipe Drain
Standpipe Drain-
Water level
Cross Section of Circular Concrete Tank
Intensive Fish Hatchery Design Commonly Used in Thailand
Approximately 3,000 to 4,000 m2 of land are required
Estimated Cost = N4.84 million ($US36,000)
Production Capacity: 1 million fry per month
(Sketch – Not to Scale)
Komthorn Potongham Thai Fish Hatchery Expert
Aquaculture and Inland Fisheries Project
National Special Programme for Food Security (NSPFS)
Abuja, Nigeria - October 2004

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15. Conversion Tables and Useful Information

English to Metric Conversions

Length

1 inch	= 2.54 centimeters (cm)
1 foot (12 inches)	= 0.283 m
0.39 inch	= 1 cm (10 millimeters)
1 foot (12 inches)	= 30.5 cm
1 yard (3 feet)	= 0.91 meters (m)
1 mile (5,280 ft)	= 1.609 kilometers (1000 m)

Area

1 square inch	= 6.45 cm^2
0.15 $inch^2$	= 1 cm^2
1 $foot^2$	= 929 cm^2
1 $yard^2$ (9 $feet^2$)	= 0.84 m^2
1.2 $yards^2$	= 1 m^2 (10,000 cm^2)
1 acre (4,840 $yards^2$)	= 0.4 hectares
2.47 acres	= 1 hectare (10,000 m^2)

Weight

1 ounce	= 28.35 grams
1 pound	= 454 grams (0.454 kg)
1 Gallon Water	= 3.78 kg (8.3453 pounds)
1 ton (2,000 lbs)	= 908 kg
2.205 pounds	= 1 metric ton

Volume

1 Gallon	= 3.72 liters
1 acre foot (43,560 ft^3) (water)	= 1,233.5 m3 (2,718,144 pounds)
1 ft^3 (7.48 gal)	= 28.3 liters (0.02832 m^3)

Flow Rate

0.035 ft^3 /second	= 1 liter/second
1 ft^3/second	= 28.32 liters/second
1 gallon/minute	= 3.785 liters/minute
0.264 gallons/minute	= 1 liter/minute
1 ft /second	= 450 gallons/minute

Fish Production

1 kg per hectare (kg/ha)	= 1.12 pounds per acre (lb/ac)
1 pound per acre	= 0.893 kg per hectare

Concentration of Chemicals

1 milligram per liter (mg/L)	= 1 part per million (ppm)
2.72 pounds	= 1 ppm per acre foot of water
1 gram per cubic meter	= 1 mg/Liter

All references to water are for fresh water.

Useful Information

1 Gallon = 8.34 lbs or 3.78 kgs

Temperature

$F = 1.8 \times C + 32$

$C = \frac{F - 32}{1.8}$

Formulas

Area

Square: $A = s^2$

Rectangle: $A = l \times w$

Triangle: $A = \frac{base}{2} \times height$

Circle: $A = \pi r^2$

Trapezoid: $A = \frac{top + bottom}{2} \times h$

Volume

Cube: $V = S^3 \times$

Rectangular Box: V = length x width x ht

Cylinder: $V = \pi r^2 \times$ length

Circle

Circumference $= \pi d$

16. Pond Management Record Forms

Pond Stocking Records
Fish Pond Management Sheet

Farm: ____________________ **Period of Management:**__________________ **Manager:** ____________

Pond No.	Date Stocked	Species	Number Stocked	Average Weight (g)	Total Weight (kg)	Source of Fish	Cost per piece (N)	Comment

Fish Sampling Records
Ponds should be Sampled bi weekly

Farm: ____________________ Period of Management:________________ Manager: ____________

Pond No.	Date of Sample	Days of Production	No. Fish Sampled	Total Weight (kg)	Average Weight (g)	Estimated Total Biomas (kg)	Estimated Weight Gain (kg)	Comment

Fish Feeding Records

With High Quality Feeds, lFish Should be Fed at 6% body we ight in first 6 weeks; 5% for next month; 4% for next month; then 3-4%till harvest

Farm: ____________________ Period of Management:_________________ Manager: ____________

Pond No.	Estimated Total Biomass (kg)	Feeding Rate (%)	Weight of total daily feed ration	Type of feed				Comment

Daily Fish Feeding Records

Farm: _____ **Month:**_____ **Manager:** _____**Ponds:** _____

Date	Pond Number												
	1	2	3	4	5	6	7	8	9	10	11	12	
1													
2													
3													
4													
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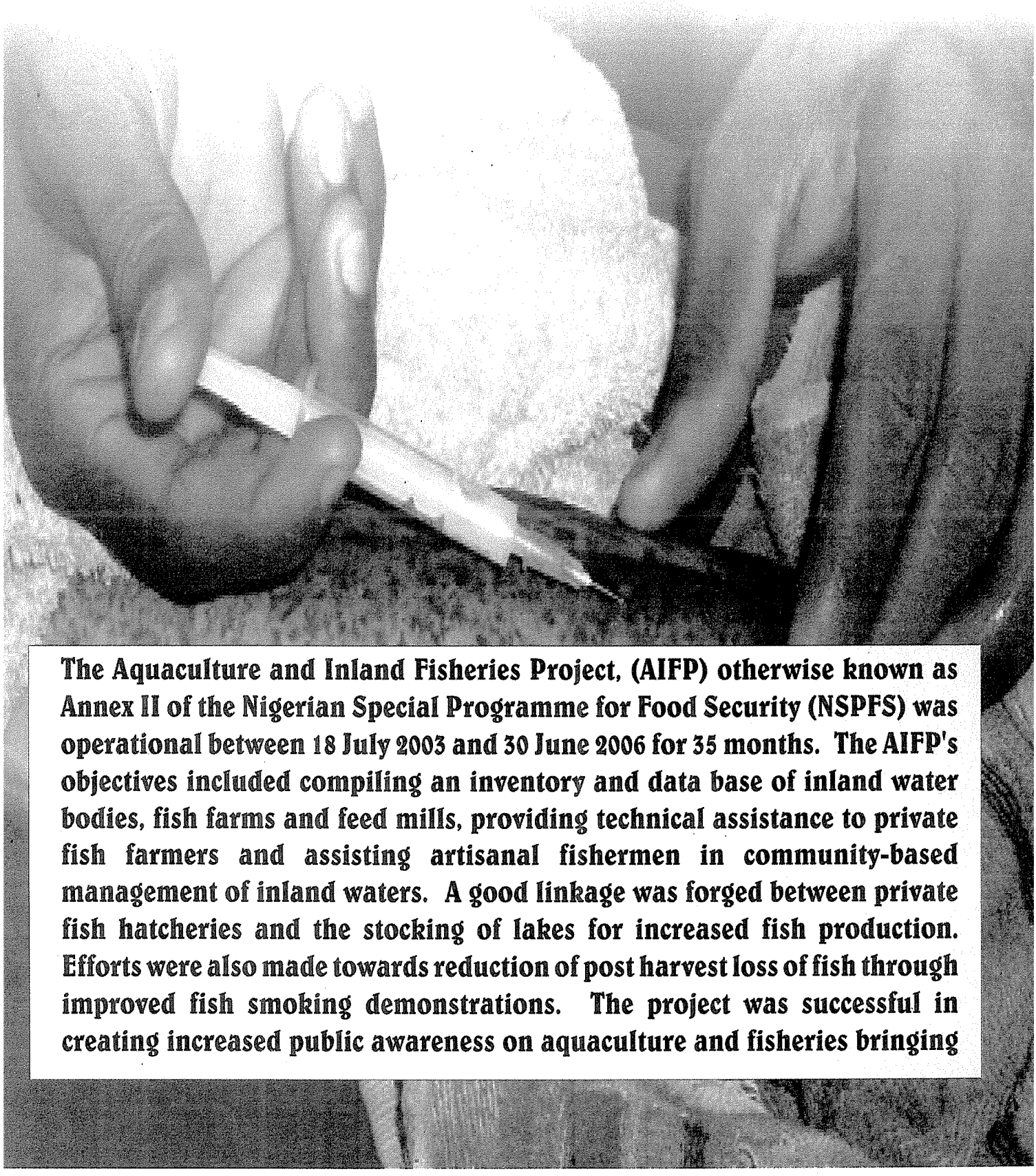

The Aquaculture and Inland Fisheries Project, (AIFP) otherwise known as Annex II of the Nigerian Special Programme for Food Security (NSPFS) was operational between 18 July 2003 and 30 June 2006 for 35 months. The AIFP's objectives included compiling an inventory and data base of inland water bodies, fish farms and feed mills, providing technical assistance to private fish farmers and assisting artisanal fishermen in community-based management of inland waters. A good linkage was forged between private fish hatcheries and the stocking of lakes for increased fish production. Efforts were also made towards reduction of post harvest loss of fish through improved fish smoking demonstrations. The project was successful in creating increased public awareness on aquaculture and fisheries bringing