RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security
CGIAR
CCAFS
This project is funded by the European Union

Manual for production of Chamo strain Nile tilapia fingerlings and preparation of fish feeds from locally available material

Tewodros Abate, Abebe Getahun (Prof), Akewake Geremew (PhD), Gebermedihin Ambaw and John W. Recha

Correct citation:
Abate T, Getahun A, Geremew A, Ambaw G, Recha JW. 2020. Manual for production of Chamo strain Nile tilapia fingerlings and preparation of fish feeds from locally available material. Wageningen, the Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

About CCAFS
The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is led by the International Center for Tropical Agriculture (CIAT) and carried out with support from the CGIAR Trust Fund and through bilateral funding agreements. For more information, please visit https://ccafs.cgiar.org/donors

Contact Us
CCAFS Program Management Unit, Wageningen University & Research, Lumen building, Droevendaalsesteeg 3a, 6708 PB Wageningen, the Netherlands. Email: ccafs@cgiar.org

DISCLAIMER:
This manual has been prepared as an output for the CCAFS East Africa Regional Program and has not been peer reviewed. Any opinions stated herein are those of the author(s) and do not necessarily reflect the policies or opinions of CCAFS, donor agencies, or partners. All images remain the sole property of their source and may not be used for any purpose without written permission of the source. The authors accept full responsibility for the contents of this manual. The manual does not necessarily reflect the views of the European Commission or IFAD.

Acknowledgement
Funding for the research work in this report was provided by the CCAFS-EC grant reference 2000002575: Building Livelihoods and Resilience to Climate Change in East and West Africa: Agricultural Research for Development (AR4D) for large-scale implementation of Climate-Smart Agriculture. The funds are administered by the International Fund for Agricultural Development (IFAD), Rome Italy while the project is implemented by Alliance of Bioversity International and CIAT.

IFAD
Investing in rural people

Funded by
the PRUNSAR programme
of the European Union

About the authors

1. Tewodros Abate Alemayehu (ttabate@gmail.com), PhD candidate in Aquatic Sciences, Fisheries, and Aquaculture, Addis Ababa University, Addis Ababa, Ethiopia
2. Abebe Getahun (Prof.) (abebe12002@yahoo.com/abebe.getahun@aau.edu.et), Professor at Department of Zoological Sciences, College of Natural and Computational Sciences, Addis Ababa University, Addis Ababa, Ethiopia
3. Akewake Geremew (PhD) (khaliger@yahoo.com/akewake.geremew@aau.edu.et), Assistant Professor at Department of Zoological Sciences College of Natural and Computational Sciences Addis Ababa University, Addis Ababa, Ethiopia
4. Gebermedihin Ambaw (g.ambaw@cgiar.org), Research Officer, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) East Africa, International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia
5. John W. Recha (j.recha@cgiar.org), Scientist – Climate-Smart Agriculture and Policy, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) East Africa, International Livestock Research Institute (ILRI), Nairobi, Kenya

Table of Contents

List of figures

1. Introduction

Climate change has resulted in increased local temperatures that in turn have increased evapotranspiration, and negatively affected the breeding grounds of several important fish species due to reduction in the water levels of water bodies (Ficke et al. 2007). The rise in local temperature also affects the physico-chemical properties of water, including temperature, pH, dissolved oxygen, salinity, and concentration of different ions in water bodies (El Morhit & Mouhir 2014). These changes negatively affect the physiological (e.g. reproduction) and behavioral dynamics of fish as well as their natural feed leading to lower production of capture fish (Chabot & Guénette 2013).

To increase production of capture fish, there is need for a reliable method for mass production of fry. Although tilapia breed freely in ponds, it is important for farmers (producers) to consider using properly produced fingerlings. However, there are quality challenges with semi-natural or hormone-induced propagation of fingerlings. Quality fingerlings in tilapia aquaculture are needed for improved production. For this reason, it is advisable for farmers to generate their own fingerlings if they cannot ascertain the quality of those from other sources. Poor fingerlings result in poor harvests. Therefore, artificial propagation under controlled environmental conditions in a hatchery has become a necessity to ensure production en-masse of fry and fingerlings.

Artificial propagation by induced breeding through hormone treatment, followed by artificial fertilization and incubation of fertilized eggs and subsequent rearing up to fingerling size has several advantages (Woynarovich & Horvath 1980) as listed below:

- Improved rates of fertilization and hatching
- Protection against enemies and unfavorable environmental conditions
- Improved conditions for growth and survival

Developing a hatchery will allow farmers to have ready fingerlings whenever they need them. Therefore, farmers need to invest in and be guided on how to operate hatcheries for fry and fingerling production, thus, producing quality fish fingerlings artificially to

maintain their population in the water bodies. Also, developing different types of aquaculture ensures a steady supply of fish for food and nutrition security. In addition, if the demand for fingerlings exists, a well-managed hatchery can turn out to be a good business.

It is for this reason that this manual was developed, with a focus on the popular Chamo strain Nile tilapia fingerlings in Ethiopia.

2. Steps for producing Chamo strain Nile tilapia

Recirculating aquaculture system (RAS) can be used to culture the broodstocks and produce fingerlings of Chamo strain Nile tilapia (Fig. 1) (Stickney 2005). Water quality parameters such as dissolved oxygen, temperature, pH, and nitrogenous compounds in the culturing water should be maintained at the optimum level for the culturing and production of Nile tilapia (El-Sayed 2006).

2.1 Maintaining the parameters

1. **Dissolved oxygen levels**: should be more than 5-6 mg/l using central air compressor (e.g. MEI YI, model, 50lit capacity)(Fig. 2a).
2. **Culturing water temperature:** must be between 28-30^{0}C. Adjustable heaters can be used to maintain the recommended temperature level (Fig. 2c).
3. **Disinfection:** submersible ultraviolet (UV) lamp (e.g. BiViSEN model, 15W) can be used (Fig. 2b) to reduce the chances of disease occurrence in the system. The lamp has to be placed at the bottom of the collector tank.
4. **Biofiltration:** bioballs (Fig. 2d) should be used to enhance the process that converts ammonia to less toxic nitrate in the culturing unit.

Figure 1. Recirculating aquaculture system for culturing broodstocks

Figure 2. Equipment for maintaining water quality parameters in the system (air compressor (A) ultraviolet (UV) lamp (B), heaters (C), bioballs (D))

Maintaining pure, high-quality broodstock is the core of successful seed production. The selection of suitable brood fish and management certainly has subsequent effects on the quantity and quality of the fingerlings produced.

2.2 Steps for successful seed production

For successful seed production, the following steps should be followed (Hussain 2004, Nandlal & Pickering 2004)

2.2.1 Broodstock collection

This can be done from natural water bodies such as rivers and lakes. They can also be collected from Fishery and other Aquatic Life Research Centers. After collection, those broodstocks that are (i) in good health; (ii) without diseases, deformities and physical injuries or wounds; and (iii) bright in body color, strong, swimming vigorously, and have clear side stripes should be selected.

2.2.2 Conditioning

Male and female Nile tilapia should be conditioned in separate fish tanks (Fig. 1) and are provided with good-quality feed before spawning to increase the quality and quantity of seed produced.

2.2.3 Feeding

The brood stocks should be fed at 4% their body weight with formulated feed (45% Crude Protein) three times a day as the optimum and recommended feeding regime for broodstock.

2.2.4 Selection for spawning

Quality broodstocks must be selected (Fig. 3a) and stocked with a female to male ratio of 4:1 in nylon hapas suspended in 3000 lit fish tanks. The hapa net with a depth of 0.65m should be used for easy management and harvesting during egg collection (Fig. 3b).

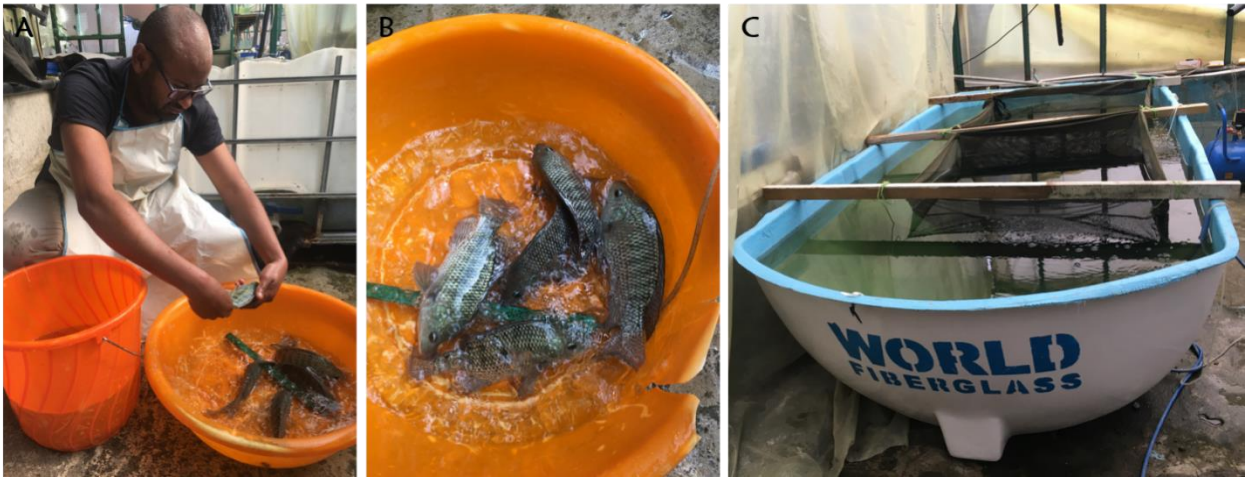

Figure 3. Photo showing brood fish selection (A), and fish tank with hapa nets for breeding (C) of Chamo Nile tilapia

2.2.5 Collecting fertilized eggs and yolk-sac larvae

After 5-7 days, fertilized eggs as well as yolk-sac larvae should be collected from the mouths of brooding females using the following steps (Fig. 5a, b & c):

Step 1. Prepare incubators (jars) and growing trays in the hatchery (Fig. 4).

Step 2. Check if the water quality and flow rate is consistent.

Step 3. Arrange the scoop nets for collecting the eggs from the mouths of females.

Step 4. Arrange adequate bowls to collect eggs.

Step 5. Scoop two or three fish from the water, holding both nets in the left hand so that the right hand is free.

Step 6. With the right hand, catch every fish and observe the mouth and papillae. If they are male, they can simply be thrown back into the hapa in tank.

Step 7. If eggs or larvae are found, they can be dislodged by putting a forefinger into the mouth of brooding females and shaking to release eggs or yolk-sac fry, which are collected in the scoop nets (Fig. 5a).

Step 8. Transfer eggs and larvae to plastic bowls with sufficient water to remain submerged (Fig. 5b & c).

Step 9. Eggs and larvae are cleaned and separated by the development stage and kept in different bowls so that they can be transferred to separate incubators or growing trays.

Step 10. Put the eggs into a scoop net and dip them in 250ppm formalin (4 ml/2lit of water) solution for 1-3 min to disinfect. Younger eggs need to be in this solution for longer, i.e. 3 min, while swim-up fry only needs 1 min.

Step 11. Rinse them using clean water in a separate bowl for 30 seconds.

Step 12. Place the disinfected eggs into incubator jars which are supplied with constantly flowing water (Fig. 4).

Step 13. If the eggs are hatched, they are directly placed in the growing tray system.

Figure 4. Recirculating aquaculture system for hatching Nile tilapia

2.2.6 Incubating Nile Tilapia eggs

The eggs collected from the mouths of females reared in hapas in a 3000-liter tank should be incubated in a down-welling incubation system made of round bottomed conical shape 500 ml plastic jars (Fig. 4).

1.1. A 30 cm long polyethylene tube has to be used as a water inlet for each incubation jar.

1.2. Since tilapia eggs are non-adhesive, heavy and remain at the bottom, constant water flow should be maintained to prevent the accumulation of waste products and allowing gas exchange between the egg and the surrounding water.

1.3. Simple transparent plastic jars have to be used to observe and manage egg movement, water quality, and hatching activities (Fig. 4).

2.2.7 Transfer into nursery fish tank

After completing the yolk-sac, the swim-up fry should be transferred into the nursery fish tank fertilized with poultry manure (Fig. 5d).

2.2.8 Fish meal supplementary feed

In addition to the planktons in the nursery pond, they should be given a fish meal supplementary feed.

Figure 5. Photos illustrating egg collection from female Nile tilapia up to fully grown fry in the nursery pond

3. Steps for preparation of fishmeal and fish feeds

Nile tilapia is considered an omnivorous fish, feeding on bacteria, protozoans, microcrustaceans and algae (Gatlin III 2002). Young Nile tilapia is carnivorous and prefers feeding on zooplankton. As they become juveniles, their diets shift to plant material or detritus of plant origin or both food sources (Suresh & Bhujel 2012). These are the foods that Nile tilapia can get in natural environments or extensive culture systems. However, as stocking rates increase, the contribution of natural food decreases and more nutritionally complete diets are needed. Particular emphasis has to be given on the level and types of protein, lipid, vitamin, and energy contents of formulated diet for optimum growth as well as health of Nile tilapia in aquaculture (Shiau 2002, El-Sayed 2006).

Aquaculture feeds are formulated with various ingredients to supply the fish with its nutritional requirements to perform its normal physiological functions, including maintaining a highly effective natural immune system, growth, and reproduction (Encarnacao 2016, Nates 2016). For Chamo strain Nile tilapia culture, fish meal and soybean meal are important sources of protein, lipid and other nutrients.

3.1 Steps for preparation of fishmeal

Fishmeal can be produced from different fish species using the following steps:

1. Chop whole fresh fish into smaller pieces and soak in hot water for five minutes to reduce the fat content.
2. Rinse the flesh with clean water.
3. Dry the flesh in an oven at a temperature of 65-70 ^{0}C for 24hrs.
4. Store dried fish meat in a deep freeze at a temperature of -18 ^{0}C with airtight bags.

3.2 Steps for preparation of formulated fish feed

To prepare formulated fish feed the following steps should be followed.

1. Dehull soybean by heating the grain in an oven at a temperature of 105^{0}C for 40 minutes to reduce the fiber content of the ingredient.
2. Grind each ingredient (dehulled soybean, corn, wheat, and dried fish meat) using an electrical mashing machine (Fig. 6a) and sieve (0.5mm mesh size sieve) to obtain a homogenous mixture (Fig. 6b).
3. Mix soluble powder of vitamin/mineral premix. The composition of the premix is presented in Table 1.
4. Supplement the composition with additives (e.g. prebiotics) to boost the health and growth of Nile tilapia (Bai et al. 2015, Encarnacao 2016).
5. Mix binder e.g. (carboxymethyl cellulose (CMC)) at a weight of 20 g kg^{-1} to increase the water stability of the formulated feed.
6. Each ingredient should be weighed based on the formulation (winfeed, 2.8 software) and mixed until it becomes uniformly mixed (Fig. 6c & d).
7. Add 20%-30% of dechlorinated water to make a dough.
8. Extrude the dough using a meat mincer (e.g. Model TJ 22) (Fig. 6e) and dry the pellet in an oven (35^{0}C) for 48hrs.
9. Grind and sieve the dried pellets to produce a suitable crumble and store at -18^{0}C in an airtight bag until usage.

Figure 6. Photos illustrating steps of fish feed preparation

Table 1. Composition of soluble powder of vitamin/mineral premix

Vitamins and salts with vitamin	Amount per gram of powder	Minerals	Amount per gram of powder
Vitamin A	7000IU	Potassium iodide	0.3mg
Vitamin D_a	1500IU	Manganese sulphate	25mg
Vitamin E	3.0mg	Copper sulphate	2.5mg
Vitamin C	11.2mg	Zinc sulphate	10.0mg
Vitamin K_a	1.5mg	Ferrous sulphate	15.0mg
Vitamin B_2	2.5mg		
Vitamin B_6	0.3mg		
Vitamin B_{12}	6.0μg		
Nicotinamide	8.0mg		
Calcium pantothenate	3.0mg		

4. References

Bai SC, Katya K, Yun H. 2015. Additives in aquafeed: an overview. In: *Feed and Feeding Practices in Aquaculture*, pp. 171-202, (Davis, D. A. ed). Woodhead Publishing, UK.

Chabot D, Guénette S. 2013. Physiology of water breathers: effects of temperature, dissolved oxygen, salinity and pH. *Climate Change Impacts, Vulnerabilities and Opportunities. Analysis of the Marine Atlantic Basin*, pp.16-44.

El Morhit M, Mouhir L. 2014. Study of physico-chemical parameters of water in the Loukkos river estuary (Larache, Morocco). *Environmental Systems Research*, *3*(1), p.17.

El-Sayed A-FM. 2006. Tilapia Culture. CABI Publishing, London. 277pp.

Encarnacao P. 2016. Functional feed additives in aquaculture feeds. In: *Aquafeed Formulation*, pp. 217-238, (Nates, S. F. ed). Academic Press, USA.

Ficke AD, Myrick CA, Hansen LJ. 2007. Potential impacts of global climate change on freshwater fisheries. *Reviews in Fish Biology and Fisheries*, *17*(4), pp.581-613.

Gatlin III DM. 2002. Nutrition and Fish Health. In: *Fish Nutrition*. 3rd ed., pp. 672-699, (Halver JE, Hardy RW. eds). Academic press, USA.

Hussain MG. 2004. Farming of tilapia: Breeding plans, mass seed production and aquaculture techniques. 149 p.

Nandlal S, Pickering T. 2004. Tilapia fish farming in Pacific Island countries. Volume 1.Tilapia hatchery operation. Noumea, New Caledonia: Secretariat of the Pacific Community

Nates SF. 2016. Feed additives. In: *Aquafeed Formulation*. (Nates SF. ed). Academic Press, USA.

Shiau S. 2002. Tilapia, *Oreochromis* spp. In: *Nutritional requirements and feeding of finfish for aquaculture*, pp. 287-306, (Webster CD, Lim C. eds.). CABI publishing. London.

Stickney RR. 2005. *Aquaculture:(an introductory text)*. CABI Publishing, USA.

Suresh V, Bhujel RC. 2012.Tilapias. In: *Aquaculture: Farming of Aquatic Animals and Plants*. 2nd ed., pp. 338-364, (Lucas, J. S. and Southgate, P. C. eds). Blackwell Publishing Ltd. UK.

Woynarovich E, Horvath L. 1980. The artificial propagation of warm water fin fishes, a manuel for extension. FAO Fish. Tech. Pap., 201. 183 pp.