AFRICAN UNION
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# WILL THE FARMING OF THE GIFT TILAPIA FISH BE A PANACEA OR ENIGMA FOR AFRICA?

Policy Brief: 18

## KEY MESSAGES

- *Addressing bottlenecks in the tilapia production value-chain will enable African farmers to respond to ever changing consumer demands and environmental conditions.*
- *For long-term sustainability, greater effort should be on harnessing the comparative advantage of Africa's indigenous aquaculture species that are adapted to the local environments.*

## INTRODUCTION

Most African tilapia farmers typically run unprofitable operations that yield poorly due to input supply failures, notable among which is fish seed. The need to improve supply and accessibility of good quality seed to improve tilapia production, and profitability has compelled African countries to seek immediate solutions. Genetic technologies are strategies to increase efficiency and promote diversification. As genetic technologies increase in their frequency of application and in their alteration of the phenotype, there may be more concern for environmental biosafety, biodiversity and biosecurity. The importance of genetic applications to aquaculture development was recognized by the international community when it drafted the FAO Code of Conduct for Responsible Fisheries. The levels of productivity sought from the successful introduction and integration of the genetically improved farmed tilapia (GIFT) into African production systems are such as to contribute to Africa's food and nutrition security and targets enshrined in the continental bold initiative, the Comprehensive Africa Agriculture Development Program (CAADP). The inability of Africa's fisheries to sustainably meet the continent's rapidly increasing demand for fish and associated socioeconomic benefits single-handedly, is unquestionably evident. In Africa, GIFT have yet to make a significant contribution to national freshwater aquaculture production, but this is likely to change, because the availability and popularity of farmed tilapia are increasing. A debate on the merits and de-merits of importing genetically improved strains as a short-cut to developing local strains from native stock has been triggered. The potential impact or benefit both producers and consumers of culturing the improved tilapia strain needs to be carefully analyzed in Africa.

## POLICY RELATED ISSUES

Efforts to accelerate aquaculture growth must address among others:

- Africa lags far behind in the implementation of aquaculture breeding programmes. Only about one per cent of this type of aquaculture production takes place in Africa. The application of the genetic principles to aquatic species used in aquaculture is a relatively recent and it has not yet made full use of the available technologies to increase the production. Currently the most pertinent challenge for in Africa is to start breeding

programmes to assist in the conservation of aquatic genetic resources and in the main time protect the wild biological diversity. Genetic improvement including advances in pedigree-based breeding programmes for both tilapia and catfish are in various stages of development by Egypt, the public and private sectors in the Republic of Ghana, the Republic of Uganda, the Republic of Kenya, the Republic of Côte d'Ivoire and the Federal Republic of Nigeria.

- Access to high quality feeds for the farmed species being raised and the production system used to a great extent determine levels of production and profitably. The challenges affecting supply and accessibility to high quality aquatic animal feeds in Africa are twofold, notably those associated with the manufacturing and supply chain and those associated with use at the production level. Improper storage of primary ingredients after harvest, storage capacity and the status of storage facilities at feed manufacturing plants affect the quality of ingredients used in the manufacturing process. The availability of feed additives to enhance aquatic animal feed quality is another challenge.
- Aquaculture has been identified as a significant threat to natural environments and to aquatic biological diversity through the release of pollutants (feeds, drugs, genetic pollution from fish escapes, etc…) and the interaction, e.g., interbreeding, of farmed species with native species. Specific genetic technologies, like the GIFT, have been identified as being potentially dangerous. Biosafety, quarantine, and other environmental safeguards have not yet been adequately applied in many developing countries with respect to aquaculture development and related research.
- Another constraint for development of aquaculture may be price fluctuations, which affect the investment willingness of interested investors. The feasibility of tilapia exports has not been thoroughly studied in Africa. Increased productivity and reduced production costs alone are not sufficient for tilapia producers to tap export markets. The types and range of products, certification, traceability, packaging, promotional efforts, pricing, and distribution channels are key factors to consider in accessing tilapia export markets. To promote the industry governments have been trying to improve on some of the issues such as developing technologies and providing fingerlings of local species, creating framework for aquaculture, relaxing institutional and investment constraints, mapping out suitable sites developing public-private partnership agreements to establish credit schemes for small and medium -scale fish farmers.
- The quantity and quality of fish seed available and accessible to fish farmers is largely inadequate and inconsistent. This negatively impacts enterprise performance as production management plans cannot effectively be implemented as units are not stocked on time nor with the correct number of fish and seed costs, stock performance and survival are inconsistent. Consequently, the volume and quality of farmer's yields is highly variable which in turn makes it difficult for producers to ascertain supply to markets at a competitive price. This situation arises partly due to the limitations of the seed production systems employed to produce and distribute the required amounts of

quality fish seed in a timely and consistent manner.

- The facilities for fingerling production are sometimes available but not operational due to lack of funds. Non-availability of fry and fingerlings in quantity and in quality constitutes a major constraint to the development of aquaculture in Africa. This arises from the challenges hatchery operations face in accessing inputs, technology and appropriately skilled manpower. Poor access to quality broodstock feed negatively affects nutritional status of broodstock, number and quality of eggs produced and consequently the number and quality of juveniles produced. Most hatcheries have inadequate facilities and equipment to temporarily hold and handle live fish juveniles without stress during regular management operations such as grading, counting and transportation. As a result, best aquaculture practices are not followed because of the stress related losses such as disease and mortality that ensue.
- In order to counter the challenges, smallholders need to change the way they farm in terms of what they grow and how they grow it, but they lack the skills, knowledge and capacity to improve their productivity within this context. As a strategic enabler of impact, capacity development is important and is required to support development outcomes. It is also not uncommon to find hatchery personnel and farmers who cannot distinguish between the different tilapia genera and species. It is not surprising therefore important criteria for tilapia seed quality such as the fishes' age, nutritional and health status, genetic profile, sex, size, livability, hardiness and even species cannot be assured by seed producers. Production risks are high and costs are consequently high which affects the sustainability of hatcheries and of the sector at large.

## *LESSONS LEARNT ON GIFT FARMING IN AFRICA*

### The genetically improved farmed tilapia (GIFT)

The GIFT was 'created' to improve the deteriorating performance of farmed Nile Tilapia in Asia. This was done by importing and crossing wild Nile tilapia populations from different African ecological zones with the farmed Asian populations. This breeding program was undertaken at the then International Center for Living Aquatic Resources Management (ICLARM), Philippines starting 1987. This generated a 'base population' with composite genetic material which through a process of several generations of family selection, yielded what is known as the GIFT strain.

### The dissemination of the GIFT in Africa

The outcome of the GIFT project generated interest from Africa, both in terms of developing their own aquaculture strains, and also in gaining access to the GIFT germplasm. The pressure for the dissemination of the GIFT germplasm to Africa seemed to reach a head in 2007, when the WorldFish Center approved the Policy on the Transfer of GIFT from Asia to Africa, making the GIFT strain available to any African government that can

demonstrate procedures to manage environmental and biodiversity risks, among other conditions. Although the decision to allow the GIFT strain into Africa seems to have been reached through a logical scientific process, the policy evoked mixed reactions in Africa. While most fish farmers and development agents generally seemed to favor the new policy and its potential benefits towards increasing farm profits and reducing poverty, a number of scientists and conservationists spoke quite passionately against it, citing the potential negative genetic and ecological impacts of the introduction. The GIFT technology has been disseminated to Kenya, Cote d'Ivoire, and Egypt. In Ghana, the Aquaculture Research and Development Center (ARDEC) took delivery of the GIFT strain officially in 2012, with the expressed objective of comparing its growth performance with the locally improved Akosombo strain. Considering the porous nature of African borders and inadequate capacity to monitor the transfer of genetic material, the GIFT strain is currently in several other countries in Africa.

## Impacts of tilapia introductions

*Ecological*

The impacts arose as a result of increases in use of processed feeds, drugs, hormones, and non-indigenous genetic resources in intensive aquaculture. The transfer of both genetically-altered and unaltered tilapia species outside their native ranges for aquaculture purposes also is expected to result in negative impacts upon natural aquatic ecosystems. Tilapia introductions into Madagascar, Lake Victoria, and Zimbabwe led to habitat alteration, such as declines in aquatic plants and decreases in the availability of breeding areas for native species. Also, the establishment of Tilapia graham in Kenya's Lake Nakuru led to the emergence of a fish-eating bird population. Another potential impact of introducing the genetically improved tilapia strain from Asia to Africa is the risk of disease-causing vectors and pathogens from Asia.

*Genetic*

There is a paucity of studies on the impacts of aquaculture on locally-adapted gene pools of tilapia in receiving ecosystems. Interbreeding of natural fish populations with escaped cultured stocks is arguably the biggest direct effect. When genetically altered cultured fish escape or are released, the receiving population may experience a reduction in genetically effective population size, (Ne), a phenomenon referred to as the Ryman-Laikre effect. Release or escape of the GIFT strain into African waters may have the potential to be highly damaging systems of natural populations adapted to three extreme thermal regimes showed thermos sensitivity of sex differentiation, indicating either genotype-environment interaction or epigenetic effects upon sex determination. This requires urgent attention into the genetic conservation of the wild relatives of cultured species.

## *SETTING THE POLICY AGENDA*

The Agenda setting for policy discussions, formulation and the communication of the policies should consider:

**Feed quality and feed standards**

To address the issue of feed quality and feed standards, it is imperative that there exist continental approved lists and guidelines for the supply and use of substances for veterinary use (including feed additives) in aquatic animals.

**Broodstock, seed and growout management practices**

The quality of fish seed has different dimensions. Most quality attributes are a factor of, and are thus substantively determined by the management practices employed. The implications of management practices on seed quality should therefore be distinguished and evaluated independently from those associated with the genetic potentials. Where best management practices are not employed, the quality and performance of seed produced becomes compromised irrespective of whether wild-stock or improved strains are used. This means that it is essential to develop standard operating procedures for genetic management of the broodstock at the hatchery level.

**The resources required to produce and maintain the genetic quality of the introduced strains vis-à-vis a locally developed strain**

In both cases, comprehensive breeding programs with the matching infrastructural, skilled labor, management and cost structures need to be provided. In the case of GIFT, this would entail importing and maintaining the necessary pure parent lines to generate F1 in volumes large enough to meet producer's needs. It becomes prudent that countries evaluate the status of their facilities and available human resources against a comparative assessment of the investment and operational costs required to establish and run breeding programs for both scenarios vis-à-vis the actual and projected demand for tilapia seed. This is important because at the end of the day, the seed produced should be adequate, of high quality and affordable for table fish producers in lieu of their enterprise budgets. It should also be noted that the continuous evaluation of performance shall be necessary for both scenarios.

**Involvement of beneficiaries**

The successful uptake of aquaculture by the targeted beneficiaries (farmers) is only possible if these stakeholders have played pro-active role in the different initiative. Particularly in genetics enhancement research, involving them from the beginning is crucial as this will give them a better knowledge of the products of obtained (e.g. improved fish breed) thereby enabling them to manage and handle the stocks properly. This strategy requires development of centralized multiplication centers at the facilities of selected pioneer

farmers. These centers will act as a supply of the improved seeds aand avoids piracy multiplication from the user farmers.

**Biodiversity, Biosecurity and Biosafety**

International and regional protocols and standards advocate for the development of local strains to safeguard aquatic ecosystem integrity, productivity and health in a manner that additionally ensures equitable access and benefit sharing of genetic resources. Compliance to the NagoyaProtocol, Regional Frameworks on Environmental Management for Sustainable Aquaculture Development in Africa, Regional Aquatic Animal Disease Control frameworks as well as national policies and regulations is therefore, a prerogative.

**Reduction on the use of non-native stock or strains of Tilapia:** The predominant source of tilapia seed is directly from wild-stock or hatcheries basically using wild stock as brood-stock. The other major source, and indeed often only option, is farmer's reproduced stock which presents a high risk of in-breeding. Where tilapia hatcheries exist, levels of production typically do meet demand. There is a need to reduce the use of non-native stock or strains of Tilapia in view of the risks they pose to Tilapia biodiversity. Much aquaculture depends on wild stocks, precluding production gains by selective breeding and increasing disease risk.

**Policy and planning documents:** Related policy and planning documents should give high importance to fish genetic improvement and breeding programs. This should be a substantial change from the situation in the 1970s when such documents typically cited only needs for increased quantities of seed supply, irrespective of breeding history and genetic determinants of performance.

**Sustainable conservation of aquatic biodiversity and habitats:** Africa has a wealth of freshwater biodiversity and habitats, and adequate areas containing this natural heritage should, where possible, be kept off limits to aquaculture, whether of native or alien species, including tilapia. Such areas would contain the wild genetic resources for future breeding programs of farmed fish, and would serve as in situ gene banks for this purpose. This could be achieved by combining appropriate policies, rules, and regulations, as well as implementation, management, and administration practices for aquaculture development with long-term safeguarding and conservation of aquatic biodiversity and habitats.

**Security issues and protection of the improved strains**

*Physically protecting the strains*

The inbred lines can be protected against unauthorized reproduction by distributing only the F1 hybrids between two or more lines. Furthermore, the hybrids will be hormonally sex reversed. If the hybrids are reproduced by a "***hijacker***" the resulting F2 generation will

be less uniform and generally inferior to their parents both in form and in growth rate.

*Legal protection and registration*

The legal procedure for officially registering or patenting a new genetic variety requires a demonstration of the uniqueness, stability and uniformity of the variety. DNA markers can be used for this purpose and the number of DNA marker loci developed for tilapia is more than adequate. However, it will be necessary to collect DNA samples from every generation of breeders and store them in a safe place even if there is no immediate plan to analyze them.

*Visible and DNA markers for forensic analysis*

DNA marker data ("***fingerprint***" profiles) will also be available for forensic use if necessary, i.e. if there is suspicion that the strain has been stolen by a competitor. DNA marker data accumulated during successive generations of breed development can and have been used for this purpose. In this context it is important to accumulate DNA samples and data each generation.

*ISO certification of the genetic improvement program: GIFT tilapia must run under African locally breeding program for maintenance of the genetic merit of the strain*

The multiplication centers that will be used as African source of the dissemination of the improved tilapia nucleolus must be ISO certified. The ISO standards for documentation and repeatability are exactly what will be required when multiplication centers begins to sell genetic products (e.g. fry or fingerlings) on the basis of a proven and repeatable improvement in performance. The objective should be to make it as easy as possible for a person to exercise professional "***due diligence***" when buying genetic products for multiplication centers or calculating the value of the genetics program as a corporate asset for Africa.

## *POLICY OPTIONS AND RECOMMENDATIONS*

Policy options to resolve some of the outstanding issues and enabling environments for GIFT transfers and to get them thrive include:

- Enhance levels of awareness among policy makers and all stakeholders about the potential risks of the GIFT and on the need to develop and conserve local aquatic strains.
- Countries to determine opportunities to enhance use of underutilized aquaculture species and further assess the suitability of GIFT in the production systems they are intended for, prior to their wide-spread use; and where necessary, establish policies and legislation to control their introduction.

- Countries to make aquaculture farming profitable by solving problems associated with the appropriate aquaculture technologies to producers and inputs, particularly, feed, seed and brood-stock.
- Countries to enhance or develop local strains, with a bid to enhancing tilapia production for enhanced availability and guaranteed food security and farm incomes, while at the same time assist in policy development and management decisions taking into account sectoral and environmental sustainability. Egypt and Ghana, Africa's largest farmed tilapia producers, have set precedence by farming their own locally improved strains, respectively the Abassa and Akosombo.
- Enhance the capacity of stakeholders, including farmers and local communities, to use and develop aquaculture species by integrating traditional and modern approaches and technologies across the full range of available production systems.
- Develop and implement cost-effective monitoring and conservation measures to ensure aquatic genetic diversity is maintained to enable farmers to respond to ever changing consumer demands and environmental conditions.

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