Impact of Withdrawing *Oreochromis niloticus* (Nile Tilapia) from Aquaculture Production in Zambia: A Case Study of Solwezi District

Simataa Simataa, Confred G. Musuka

1. Department of Fisheries, Box 110118, Solwezi, Zambia
2. The Copperbelt University, School of Natural Resources, P.O. Box 21692, Kitwe, Zambia

Corresponding author email: confred.musuka@cbu.ac.zm


Received: 14 Oct., 2013
Accepted: 18 Nov., 2013
Published: 07 Dec., 2013

Copyright © 2013 Simataa and Musuka., This is an open access article published under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

**Abstract** The impact of withdrawing *Oreochromis niloticus* (Nile Tilapia) from aquaculture production in Zambia was studied in five fish farming areas (Lumwana East, Shiinde, Meheba, Mutanda and Solwezi Central) of Solwezi district, where this species was highly promoted and widely distributed by the Department of Fisheries through an American Peace Corps Project called Rural Aquaculture Promotion (RAP). The study was conducted between July and August 2012, through a survey by administration of questionnaires and personal interviews. A total of 30 respondents (22 males and 8 females), thus twenty-five percent of the total population (120) of fish farmers were randomly selected for the study. Results of the study indicated that withdrawing *O. niloticus* had a negative impact on the overall aquaculture production. Withdrawal of Nile tilapia culture resulted in the decrease in average annual pond yields per 100m² and household income. The study revealed that slightly over fifty-three (53.3%) per cent of farmers annual pond yields had fallen below 15kg per 100m². Furthermore, 33.3% of annual household income dropped to below K300 (US$58). Reasons advanced for such changes were partly attributed to some farmers having their ponds not stocked and the slow growth of other cultured species compared to *O. niloticus*.

**Keywords** *Oreochromis niloticus*; Impact; Withdraw; Aquaculture production; Zambia

**Introduction**

Zambia has an expanse of natural resources ideally suited to aquaculture production (FAO, 2004). Considerable work by the Department of Fisheries (DoF) in cooperation with international assistance agencies and NGOs in promoting aquaculture practices in the country had resulted in some 6,460 small-scale farmers’ operating over 13,900 fish ponds throughout the country (Mudenda et al., 2005). Despite the overwhelming response by the small-scale fish farmers to venture into aquaculture, the challenge was that most indigenous species, *Oreochromis andersonii* inclusive, were not capable enough to boost fish production to unprecedented levels. Their performance was below par. *Oreochromis niloticus* (Nile Tilapia), an exotic species, was introduced in aquaculture to improve the value of farmed fish and enhance pond productivity (Pillay, 1990). *O. niloticus* was introduced to fish farms in Zambia in 1982 from where it escaped to enter the Kafue River, a major tributary of the Zambezi (Howard, 2004). It was also introduced for aquaculture in the Lake Kariba catchment and has now established in both the middle and lower Zambezi Basins (Howard, 2004). *O. niloticus* (Nile Tilapia) was widely distributed by the Peace Corps’ Rural Aquaculture Promotion (RAP) Project in collaboration with the Department of Fisheries among small scale fish farmers in Solwezi district and was accepted for its ability to thrive well in organic manure fertilized ponds and gave improved pond yields even under minimal pond management practices (Thomas, 2007). According to Khan (2011), Nile tilapias are not prone to disturbing the bottom of the pond as they preferred to stay in shallow waters for reproduction and feeding. They efficiently browse on benthic organisms and detritus. Other than that, in enclosed or commercial ponds, when feed is given to the Nile tilapia, they rush to the surface of the water in a vigorous manner, with some of them even jumping above the water surface in an attempt to access the feed as quickly as possible. However, they have limitations of being in deep waters due to temperature, and harmful gases such as carbon dioxide, hydrogen sulphide and ammonia (Khan, 2011). Since, Nile...
Tilapia was still viewed as an invasive and fast breeder (Khan, 2011), the Department of Fisheries in Zambia directed small scale fish farmers to discontinue its production due to some negative environmental concerns (Thomas, 2007; Nyambe, 2011). Because *O. niloticus* reproduce at such a rapid rate, they overcrowd and out-compete native species (Mahmud-ul-Ameen, 2000). This loss of biodiversity leads to genetic erosion and greater susceptibility to disease (Mahmud-ul-Ameen, 2000).

1 Materials and Methods

The study was conducted in 5 fish farming areas namely; Solwezi central, Mutanda, Meheba, Shiinde and Lumwana East which were 30km, 36km, 70km, 85km and 100km from Solwezi town, the Provincial headquarters for the North Western Province of Zambia. In this study, randomization was achieved by allocating a number to fish farmers found in the area and using simple random sampling by the lottery method. A total of 30 respondents (22 males and 8 females), thus twenty-five per cent of the total population (120) of fish farmers were randomly selected for the study. A representative sample for the study from each fish farming area was based on Boyd’s formula as follows:

\[(n/N) \times 100 = C\]

Where:

- C - Represents a figure greater or equal to five per cent (5%) of the fish farmer population.
- N - Overall Population (Total number of Fish farmers).
- n - Number of selected fish farmers (Sample size) as by Boyd et al. (1981).

Required Sample Size: \(n/N \times 100 = C\); \(n = 120 \times 25/100\) \(n = 30\)

And the following were parameters considered:

- Total number of fish farmers who cultured *O. niloticus* (Nile tilapia).
- Average annual pond yields per 100 m² before withdraw of *O. niloticus* (Nile tilapia).
- Average annual pond yields per 100 m² after withdraw of *O. niloticus* (Nile tilapia).
- Annual farmer house hold income from fish farming before withdraws of *O. niloticus* (Nile tilapia).
- Annual farmer house hold income from fish farming after withdraws of *O. niloticus* (Nile tilapia).

Data was analyzed using Statistical Package for Social Sciences (SPSS 12.0).

2 Results and Discussion

From the results obtained, it was clearly seen that 73.3% males were involved in fish farming, while the participation of females was only 26.7% (Figure 1).

![Figure 1 Gender of respondents](image1)

Reasons advanced for low participation of women in fish farming were: (1) Labour intensiveness of the venture, especially pond construction phase; and (2) Inability to own land of their own, where traditionally the land was owned by the male folks and the need for married women to seek approval from their husbands before participating in any venture.

Results on age indicated that 73.3% were over 45 years, 16.7% had ages ranging from 35 to 44 years. The age group with the lowest (10%) participation rate in fish farming was that of the youth ranging from 25 to 34 years (Figure 2).

![Figure 2 Age of respondents](image2)
From the study, it was observed that the participation rate for respondents above 45 years was very high, an indication of serious minded and focused people whose ultimate goal was to improve their livelihood, while the age groups of 25 to 34 years comprised people who were unsettled and mainly focused on short terms investment ventures than long term ones. The study further revealed that the selected fish farmers were engaged in fish farming for many years with the majority (93.3%) being involved in fish farming for more than 9 years, while 6.7% showed that they had been in the sector between 6 to 9 years (Figure 3).

![Figure 3 Numbers of years in fish farming](image)

About 80% of the farmers owned less than 5 fish ponds each (Figure 4).

![Figure 4 Total number of fish ponds owned](image)

The majority (67%) of the respondents had smaller earthen ponds of less than 500m² on average, an indication that they were subsistence fish farmers. On the other hand, only 3% of these fish farmers owned ponds of more than 500m² (Figure 5).

![Figure 5 Pond sizes for fish farmers](image)

A number of reasons were advanced why they owned fewer and small sized ponds. The major one was largely attributed to labour intensiveness in pond construction that required capital to hire extra labour. Most farmers occupied traditional land that was not on title, as such could not be used as collateral when seeking funding from financial lending institutions. Furthermore, fish farming was considered as a part-time venture by the respondents as most of them spent much of their time on maize cultivation and vegetable gardening.

Results of the study further revealed that there was no commercial fish farming taking place in Solwezi district. The study also revealed that almost all the respondents started their fish farming with *Oreochromis niloticus* (Nile tilapia) as the main species that was being promoted by both the Department of Fisheries and the American Peace Corps at the time. The results clearly indicate that the government fish farm was the major source of the *Oreochromis niloticus* (Nile tilapia) fingerlings (76.7%) stocked by fish farmers, followed by local fish farmers (20%) and lastly private seed producers (3.3%) (Figure 6).

![Figure 6 Sources of fingerlings](image)
More than half (53.3%) of the fish farmers revealed that they financed the purchase of their fingerlings through contributions made to Peace Corps Volunteers in their respective areas who in turn sourced for them in collaboration with the Department of Fisheries, while 6.7% were procured by the Department of Fisheries (Figure 7).

Figure 7 Financing of fingerlings

The study revealed that 93% of the respondents’ cultured *O. niloticus* (Nile tilapia) for 5 to 6 years, which was ample time for them to give sound opinion about the species compared with 6.7% of farmers who cultured the fish for only 1 to 2 years before its culture was discontinued (Figure 8).

Figure 8 Duration of culturing Nile Tilapia before withdraw

Slightly over Seventeen (17.3%) per cent of the respondents had annual pond yields of 46 to 60kgs, 26.7% had pond yields of 31 to 45kgs, 19.3% had pond yields of 16 to 30kgs and 36.7% produced below 15kgs per 100m$^2$ pond (Figure 9).

These pond yields were much better considering that they were based on the 100m$^2$ of pond area; partial harvests were rarely recorded or accounted for.

However, following the withdraw of *O. niloticus*, the annual average pond yields showed that 53.3% of the respondents harvested between 0 to 15kgs, 19.3% harvested 16 to 30kgs, 18.1% had pond yields of between 31 to 45kgs and a partly 9.3% harvested between 46 to 60kgs of fish per 100m$^2$ pond per annum (Figure 10).

Figure 9 Nile tilapia pond yields before withdraw

Figure 10 Pond Yield after withdraw of Nile tilapia

The annual pond yields observed in the categories 0 to 15kgs, 31 to 45kgs and 46 to 60kgs showed a decrease of 16.6, 8.6 and 8 per cent respectively Reasons advanced for such changes were partly attributed to 33% respondents’ inability to stock their ponds after withdraw of Nile tilapia (Figure 11) and the slow growth of *O. andersonii* and other cultured species compared to *O. niloticus*.

This concurs with observations made by Musuka and Musonda (2012), who stated that *O. niloticus* (Nile tilapia) was the most favoured species because of its relatively faster growth, and flexible feeding habits in crowded conditions, particularly in cages. Curtis *et al.* (1993) further observed that in developing countries where artificial feed was expensive, farmers increased the use of manure and composite feed in tilapia.
Figure 11 Pond status immediately after withdraw of Nile tilapia production. Based on these observations, it was felt beyond reasonable doubt that the majority of the respondents still preferred Oreochromis niloticus to other species for its faster growth, easy cultivation in organic manure fertilized and composite fed ponds. This was also acknowledged by Peterson (1998), who observed that to most farmers fast growth was by far the most important fish characteristic. The author further stated that O. niloticus was the fastest growing bream in Zambia, harder and more resistant than O. andersonii and because 70% of its diet was plankton it was easier and cheaper to feed, as such the fish grew faster, especially the males, which gave the farmers good returns. The study also revealed that half (50%) of the respondents earned an income of between K300 and K600 (US$58-US$115), 33.3% were earning less than K300 (US$58), while 16.7% earned between K600 and K900 (US$ 115 and US$173) from fish farming per annum before withdraw of Nile tilapia, which was quite a good income at the time, which assisted them meet their daily needs. Among the notable things they were able to do from that income was to pay for their children’s school fees, medical bills and procure bicycles for easy mobility (Figure 12).

The respondents acknowledged that the given figures did not take into account the unrecorded kilograms of fish taken for home consumption as well as fish exchanged for labour through barter system during cultivation of agriculture fields.

The results obtained from this study clearly indicate that the majority (80%) of the respondents felt that withdrawing of O. niloticus (Nile tilapia) had both affected their pond yields and household income from fish farming. Based on the aforementioned, O. niloticus was a popular fish and ideally suited for aquaculture in Zambia as it boosted production to unprecedented levels country wide. The study also revealed that O. niloticus (Nile tilapia) was the small scale fish farmers’ favorite cultured species, because the species could still do well even under their relaxed pond management practices. Withdraw of Nile tilapia from aquaculture production resulted into serious setbacks to the industry and negatively impacted aquaculture production in general. Besides, the procedure to withdraw O. niloticus (Nile tilapia) was implemented without due consideration of other factors such as the availability and accessibility of the alternative species (O. andersonii, O. Macrochir and T. rendalli) to fish farmers from whom Nile tilapia was withdrawn. Furthermore, many farmers felt that there was inadequate information on possible mitigation measures to address the concerns that led to its withdrawn. At the time there was no policy guideline on translocation of exotic species, the use of genetically enhanced aquatic species, uncertainties associated with their impact on their wild counterparts and applying science-based risk assessment, combined with an adaptive management approach (The International Bank for Reconstruction and Development/The World Bank, 2006).

However, those who recommended for its withdraw from aquaculture production felt that, as an alien species, there was a likely potential of its release into the natural environment through escapes from fish farms, hence bringing about threats to biodiversity mainly associated with transformation of the ecosystem as the case was with Nile perch in Lake Victoria, which now dominates the Lake’s aquatic fauna (The International Bank for Reconstruction and Development/The World Bank, 2006).
several impacts on natural aquatic ecosystems have been documented following the introduction of *O. niloticus*, which have included: possible risk of invasion and subsequent short and long-term damage to ecosystems upon which many millions of people and diverse biodiversity depend. The introduction of this species in an aquatic environment is considered as a potential risk in any country, because it modifies, hybridizes, cross-breeds, eradicates underwater vegetation, has occupied or destroyed feeding and breeding niches, and has promoted outbreaks of parasites among native species, presenting special threats of species extinction (Howard, 2004).

However, although official communication from government on the discontinuation of culturing *O. niloticus* (Nile tilapia) was released late around 2008, the study revealed that the majority of the fish farmers (96.7%) stopped culturing the fish 5 to 6 years before based on verbal instructions from Peace Corps volunteers in collaboration with the district fisheries office (DOF, 2007). Some respondents (3.3%) only stopped culturing the fish 3 to 4 years ago because they could not secure other culturable species in time (Figure 13).

The study revealed that 66.7% of respondents (Figure 11) continued fish farming with other culturable species with the majority (50%) of these fish farmers stocking *O. andersonii* (three spotted bream) while others (17%) stocked *Tilapia rendalli* (red breasted bream). Unfortunately, 33% of the respondents indicated that their ponds remained unstocked after they stopped culturing *O. niloticus* (Nile tilapia). Most of the fish farmers, who found themselves in such a dilemma, were those who initially bought fingerlings by either Peace Corps or the Department of Fisheries (Figure 7) and had failed to secure the other culturable species as they claimed to have had no money. As a result of that aquaculture production and household incomes were adversely affected.

Based on the results obtained from the study, 53.3% of the respondents indicated that they were not satisfied with the other cultured species. One among the reasons given for their dissatisfaction was poor growth rate of the current cultured species in composite fed ponds as compared to Nile tilapia.

From the results obtained, the majority of the respondents were not only involved in fish farming but also in other agriculture activities. About 73.3% of the respondents grew maize as their main crop, which they ground into maize meal for their staple food, which is Nshima, followed by vegetables (16.7 %) and 10% grew cassava (Figure 14). Maize bran, a by-product of maize was the most popular supplementally fish feed used by the small scale fish farmers.

More than half (53.3%) of interviewed fish farmers were also engaged in poultry farming, 26.7% in goat rearing and 20% indicated not having kept any livestock (Figure 15).
Generally, the study revealed that most small scale fish farmers were not specialized in one farming enterprise but they shared their time between different types. The majority of farmers integrated fish farming with poultry farming which provided manure for their fish ponds.

3 Conclusions
From the results obtained, there was overwhelming evidence indicating that withdrawing of Nile tilapia had a negative impact on small scale fish farmers in Solwezi district. Withdrawal of Nile tilapia culture resulted in the decrease in average annual pond yields per 100m² and house hold income. There was urgent need to immediately improve the availability and accessibility of other culturable species (although the majority of the respondents expressed dissatisfaction with them) to fish farmers as that had led to many fish farmers having their ponds not stocked and subsequently affecting aquaculture production in Solwezi district. Furthermore, the potential of aquaculture production and all the efforts made so far was being threatened with the yearly decrease in pond yields and house hold income from fish farming. If no immediate solutions were found, aquaculture adoption rates were going to be low and instead, increases in fish farming abandonment was likely to take the central stage.

Acknowledgement
The authors wish to acknowledge financial and material support rendered to the team by the Copperbelt University without which this project would not have been undertaken. Special thanks to go to all members of staff in the Department of Fisheries throughout the country and all those who helped us in one way or another.

References
Department of Fisheries (DOF), 2011, Contributions to the livestock and fisheries bulletin.
Deines A., 2005, Interactions and impact of Nile tilapia on the Kafue watershed in Zambia. University of Notre Dame, Global linkages of

http://ija.sophiapublisher.com

http://dx.doi.org/10.1023/A:1013776931706
Howard G., 2004, Invasive Species in Water-Dependent Ecosystems: In Use of Genetically Improved and Alien Species for Aquaculture and Conservation of Aquatic Biodiversity in Africa. Gupta, M.V., D.M. Bartley and B.O. Acosta (eds.) WorldFish Center Conference Proceedings 68, pp.113
Khan V., 2011, The Online Guide to the Animals of Trinidad and Tobago. Oreochromis niloticus (Nile Tilapia) [http://www.israquarium.co.il/Fish/Israel Fish/Israel Fish ABC.html-downloada 15/11/11.
PMcid:PMC3561512
Sarantokos S., 2004, Social research. Palgrave Publisher, New York, USA.
http://dx.doi.org/10.1016/j.tree.2006.07.007 PMid:16859805
Thomas E.C., 2007, Comparison of the performance of two tilapia species, Oreochromis ananderoni (Kafue bream) and O. niloticus (Nile tilapia – imported) under farm conditions in Zambia.
Vitule J.R.S., Freire C.A., and Simberloff D., 2008, Introductions of non-native freshwater fish can certainly be bad. Fish Fish., 10: 1-10