Vol. 10(11), pp. 129-139, November 2018
DOI: 10.5897/IJFA2018.0703
Article Number: BAECC2959461
ISSN: 2006-9839

http://www.academicjournals.org/IJFA

ACADEMIC JOURNALS
expand your knowledge

International Journal of Fisheries and Aquaculture

Full Length Research Paper

Is the culture of exotic fish species the answer to low fish productivity? A case study on the use of *Oreochromis niloticus* in Zambia

Alexander Shula Kefi* and John Mwango

Department of Fisheries, Ministry of Fisheries and Livestock, Chilanga, Zambia.

Received 8 September 2018; Accepted 30 October, 2018

The study was conducted in the Copperbelt and North-Western Provinces of Zambia which represented the urban and rural strata respectively. A total of two hundred and forty farmers were randomly sampled from the farmer registers kept by the Department of Fisheries (DOF) in the Ministry of Fisheries and Livestock (MFL), Zambia. The main objective of the survey was to determine the productivity of the exotic fish species *Oreochromis niloticus* in comparison to closely related indigenous fish species (*Oreochromis andersonii*, *O. machrochir* and *Tilapia rendalli*) at farm level. Correlation analysis showed that stocking density was positively, though weakly, correlated (r = 0.31, N = 292, *P*< 0.05) with yield, with a higher stocking density associated with higher yield. Since the correlation coefficient was lower than 0.5, regression analysis was not performed. Sex reversed fingerlings gave almost double the yield (5.5 tons/ha/year) compared to mixed sex fish (3.8 tons/ha/year). Productivity was highest in those farmers using commercial feed (6.4 tons/ha/year) compared to those using single ingredients or fertilization or a combination of the two. There was no evidence to show that farmers who were using *O. niloticus* were performing better than those farmers using *O. andersonii* since the productivity of the farmers culturing the non-indigenous *O. niloticus* (4.7 tons/ha/year) did not differ significantly from those farmers using *O. andersonii* (4.6 tons/ha/farmer). There should be deliberate efforts to promote *O. andersonii* both at production and consumption levels in order to create demand for the fish species. Genetic studies should be conducted to establish the genetic variability and strains of the indigenous fish species in Zambia. Furthermore, there is an urgent need to establish gene banks for most indigenous fish species to conserve the genetic resources for aquaculture and capture fisheries.

Key words: Exotic, indigenous, production, productivity, genetics.

INTRODUCTION

Aquaculture in Zambia dates back to the 1950s when the first attempts were made to culture indigenous species of the Cichlidae family, mainly Tilapias, in dams and earthen fish ponds at Chilanga (Utsugi and Mazingaliwa, 2002). The country is estimated to have produced 32,888 tons of fish from aquaculture in 2017 (DOF, 2018). The native

*Corresponding author. E-mail: askefi@yahoo.com.

Oreochromis andersonii (three spotted bream) found in most of the country's river systems has been the preferred species for culture in Zambia since the 1950s (Schwanck, 2004). Despite the country having more than 400 indigenous fish species (Fish Base, 2018), she has seen a lot of introductions of the exotic fish species including *Oreochromis niloticus* (Nile tilapia) which has been introduced in 85 countries, with establishment reported in 58% of these countries while 14% of the countries have reported adverse ecological impacts (Casal, 2006). Globally, 8% of the total fish production from aquaculture is contributed by *O. niloticus* (FAO, 2018). In Zambia, the first introduction for fish farming is said to have occurred in 1982 from the University of Stirling since at that time Zambia had a liberal policy with respect to fish translocations and introductions (Schwanck, 2004). However, the reasons for importation are unclear since the first importers never indicated any biological reasons for importing live specimen of *O. niloticus*. From that time, the Department of Fisheries (DOF, 2018, 2016), a Directorate in the Ministry of Fisheries and Livestock (MFL) mandated to monitor the fish species used in aquaculture has been receiving requests for importation of exotic fish species. The argument being advanced by the importers is that *O. niloticus*' growth rate is superior to the indigenous fish species and there is need to reduce the fish deficit estimated at 87,000 metric tons due to sustainable fish catches from capture fisheries despite an annual increase in human population of 3% (DOF, 2016). This *O. niloticus* species was cultured on a large scale by 1990 due to its perceived superiority in resisting stress compared to the indigenous fish species (Schwanck, 2004). In fact, 50% of the fish produced from aquaculture in Zambia in 2015 was *O. niloticus* (DOF, 2016).

Several studies have revealed that *O. niloticus* has spread to various parts of the country threatening the indigenous fish species. For instance, the aquaculture baseline survey conducted in 2016 in North-Western and Copperbelt Provinces revealed that the majority of fish farmers cultured the non-indigenous *O. niloticus* at 40% followed by the indigenous *O. andersonii* at 35.5% (DOF, 2016). However, it is evident that *O. niloticus* is impacting negatively on the diversity of aquatic genetic resources in the water bodies where it has been established (Deines et al., 2014; Bbole et al., 2014). In other countries, the same fish species has been destructive. For example, in China, there is evidence that the Catch Per Unit effort (CPUE) and incomes of the fishers have considerably reduced where *O. niloticus* has stabled itself suggesting suitable control methods to reduce the spread of this fish species (En Gu et al., 2015). Zambia, however, has other exotic fish species. In October 1980, 200 pieces of Mirror Carp (*Cyprinus carpio carpio*) were introduced from Malawi (Soma et al., 1997). At around the same time, Scaled Carp (*C. carpio*) from Czechoslovakia (now Czech Republic) was imported into the country. In 2001, Australian Red Claw Crayfish (*Chelax quadricarinatus*) was introduced in Zambia (Welz, 2017) and this species has spread to many water bodies in the country. This shows that the country has a lot of exotic aquatic genetic resources that can easily influence the biodiversity of the fish in the natural water bodies. The negative ecological impacts of the exotic fish species have been profiled elsewhere (Lowe-McConnell, 1987; Welz, 2017).

Although *O. niloticus* has received much attention of researchers globally and of fish farmers in Zambia, there has been very little scientifically structured on-farm evaluation of the performance of *O. niloticus* relative to the indigenous fish species in order to validate the use of *O. niloticus* at farm level. The authors, however, are aware of the only study carried out at Kalimba Farms in Zambia which compared the growth of *O. niloticus* and *O. andersonii* in which the former performed much better at lower temperature compared to the later fish species (The Fish Site Editor, 2011). This survey was conducted to compare the productivity of a cultured exotic and closely related indigenous fish species. Results of the study provide evidence which could inform policy on whether the *O. niloticus* is indeed superior to closely related indigenous fish species and whether it should be the fish species of choice in the Zambian aquaculture sector. Furthermore, the results may provide evidence which will make farmers have confidence in the indigenous fish species in Zambia. The emergence of Tilapia Lake Virus (TiLV) which is affecting 'Tilapia' species in some countries is a wake-up call on the risks of importation of live exotic species for aquaculture.

MATERIALS AND METHODS

The baseline survey was conducted in the Copperbelt and North–Western Provinces of Zambia covering eight (8) districts. The districts were Ikelenge, Kasempa, Mwinilunga and Solwezi in North–Western Province while Chililabombwe, Chingola, Kitwe and Ndola were the study districts for Copperbelt Province. The provinces and districts were purposively selected as they were project sites for the Smallholder Agriculture Promotion Programme (SAPP), the funders of this study. The project (SAPP) which was funded by the International Fund for Agriculture Development (IFAD) and the Government of Republic of Zambia (GRZ) ran from 2010 to 2017. In order to guide the data collection, a field baseline survey manual was developed summarizing the objectives of the survey, approach and methodology, and definitions and explanation of the terms used in the baseline survey. Furthermore, a structured questionnaire (Appendix) was to capture information from the fish farmers developed. Prior to data collection, the enumerators were given a three day extensive residential training at the National Aquaculture Research and Development Centre (NARDC) in Kitwe, the largest Aquaculture Research Station in Zambia. The training covered objectives of the survey, interview techniques, sampling, data collection instruments, monitoring procedures and field data collection using the final questionnaire developed by the core team. Later, they were given a one day supervised practical test (pretesting) on data collection among actual beneficiaries of the project using the final questionnaire in a non-sample area which was Luanshya district in this case. This was done to make sure that the questionnaire was clear to both the respondents and the enumerators themselves. Field data for this survey were collected by 8 enumerators who were the District Fisheries Officers.

A combination of both the stratified and systematic sampling methods was used to come up with the list of the respondents. A systematic sampling was employed to pick the fish farmers from the farmer's register, a list that shows the farmers in each district and is kept by the District Fisheries Officers. Stratification was used because it minimizes sample selection bias and ensures that certain segments of the population are not over-represented or under-represented (Cochran, 1977). A representative sample of thirty (30) farmers was then drawn using systematic sampling for the survey with each district being a stratum. Therefore, a total of two hundred and forty (240) farmers where sampled in all the eight (8) districts of the two provinces. To determine the farmers to be sampled, the following formula was employed:

$$K = N/30$$

where K is the constant (interval) and N is the population of the fish farmers indicated in the farm register. Therefore, the farmer sampled was the first on the list and every K^{th} member. The type of data collected from each farmer included the fish species cultured, stocking rate, harvest size, production period and feeding frequency.

Data analysis

T-test on type of fingerlings and Analysis of Variance (ANOVA) on fish species and feed types were used to test parametric data (productivity/yield, stocking rate, harvest size, production period, feeding frequency and absolute growth). Before analysis, parametric data were tested for normality using Shapiro-Wilk test (ANOVA) and the homogeneity of variance using Levene's test for Equality of Variances (T-test) and appropriate transformations made with the help of gladder function in Stata 12.0 once these assumptions were violated. Significant differences were deemed at $P < 0.5$ and separated using Duncan's Multiple Range Test (DMRT) (Duncan, 1955) for parametric tests. Partial correlation analysis was performed to describe the strength and direction of yield of fish species and stocking rate, age and education level of fish farmer, feeding frequency and length of production. If r was found strong ($r \leq -0.5$ or $r \geq 0.5$) and significant ($P < 0.05$) regression analysis was performed too.

$$\prod = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + \mathcal{E}$$

where $\prod$ = Dependent variable (Yield), X_1 to X_5 = Independent variables, X_1 = Stocking rate, X_2 = Feeding frequency, X_3 = Length of production, X_4 = Age of the farmer, X_5 = Education level of the farmer, $\mathcal{E}$ = Interaction effect, b_1 to b_5 = regression coefficients, and a = Constant

Statistical Package for Social Scientist (SPSS) 20.0 (SPSS Inc) software was used in analysing the data. Untransformed data are presented to facilitate interpretation.

RESULTS

Correlation analysis showed that stocking density was the only positively, though weakly, correlated ($r = 0.31$, $N = 292$, $P < 0.05$) parameter with yield with a higher stocking density associated with higher yield. Since the correlation coefficient was lower than 0.5, the regression analysis was not performed. The average age of the farmers farming different fish species did not differ significantly ($P > 0.05$). This means that all the fish species were cultured by the same people in terms of age. The productivity of fish varied among fish species with the farmers culturing the exotic *O. niloticus* yielding the highest amount of fish at 4.7 tons/ha/year. However, this yield was not significantly different ($P > 0.05$) from that of the indigenous *O. andersonii* (4.6 tons/ha/farmer). The survey revealed that farmers were stocking more *O. niloticus* per given area compared to other fish species since its stocking rate was at 3 fish/m^2 followed by *O. andersonii* 2.6 fish/m^2. There were no significant differences ($P > 0.05$) in the production period of all the fish species reared. *O. niloticus* grew to 217 g in 7.7 months while *O. andersonii* reached 211 g in 8.1 months. *Tilapia rendalli* grew to 196 g in 6.8 months. *Oreochromis machrochir* was excluded from analysis as it had few entries (Table 1).

Of the farmers sampled, only 8.8% were using sex reversed fingerlings of *O. andersonii* and *O. niloticus*. Sex reversed fingerlings were stocked at a higher rate than mixed fingerlings although the production period was shorter for the later type. However, harvest size and productivity favoured the sex reversed fingerlings significantly. Farmers who cultured sex reversed fingerlings produced more than double (0.7 tons) compared to those who stocked mixed fingerlings (0.3 tons). Consequently, sex reversed fingerlings were more productive than the mixed sex fingerlings (Table 2).

The survey also revealed that the use of commercial feed improved productivity since farmers who were using the same product had a productivity of 6.38±6.06 tons/ha/year which was significantly higher than those using any single ingredients or a combination. Surprisingly, those farmers using a combination of single ingredient and fertilization only had a higher productivity compared to those using a combination of commercial feed and fertilization (Table 3).

DISCUSSION

Although farmers that used *O. niloticus* reported the highest productivity among all the fish species found, its productivity did not differ significantly ($P > 0.05$) from that of *O. andersonii*. Other production parameters too did not differ significantly ($P > 0.05$) between the two fish species. In fact, the higher productivity observed in *O. niloticus* may be attributed to higher stocking density. This is because the yield was found to be positively correlated with stocking density. Therefore, there is no evidence to suggest that *O. niloticus* is superior to the indigenous *O. andersonii* at farm level which has been subjected to numerous genetic improvement programmes. If genetic improvements are directed at *O. andersonii*, there is a possibility that the indigenous *O. andersonii* can even outperform the non-indigenous *O. niloticus*. This will discourage the utilization of the exotic

Table 1. Production parameters according to fish species.

Production parameter	Fish species	Mean±SD
Age of the fish farmer growing the fish species (years)	*O. andersonii*	54.8±8.3
	T. rendalli	48.6±10.1
	O. niloticus	53.4±10.8
Productivity (kg/farmer/year)	*O. andersonii*	$422.9±312.1^b$
	T. rendalli	$156.9±220^a$
	O. niloticus	$463.2±307.5^b$
Stocking rate (fish/m^2)	*O. andersonii*	$2.6±1.7^b$
	T. rendalli	$1.4±1.3^a$
	O. niloticus	$3.0±2.0^b$
Productivity (tons/ha/year)	*O. andersonii*	$4.6±5.4^b$
	T. rendalli	$2.1±3.7^a$
	O. niloticus	$4.7±7.7^b$
Harvest size (grams)	*O. andersonii*	$211.7±113.7^b$
	T. rendalli	$196.0±380.2^a$
	O. niloticus	$217.2±173.3^b$
Production period (months)	*O. andersonii*	8.13±2.5
	T. rendalli	6.83±2.9
	O. niloticus	7.76±2.0

Values with different superscripts within the parameter are significantly different ($P< 0.05$).

Table 2. Production parameters of sex reversed and mixed sex fingerlings.

Production parameter	Type of fish seed used	Mean ± SD
Stocking rate (fish/m^2)	Sex reversed	$4.6±1.8^b$
	Mixed	$2.0±1.5^a$
Production period (months)	Sex reversed	$8.7±1.8^b$
	Mixed	$7.4±2.5^a$
Harvest size (grams)	Sex reversed	$264.3±37.8^b$
	Mixed	$207.2±251.7^a$
Productivity (tons/ha/year)	Sex reversed	5.5±7.6
	Mixed	3.8±5.8
Fish production/farmer/year (kg)	Sex reversed	$698.9±213.7^b$
	Mixed	$302.1±288.1^a$

Values with different superscripts within the parameter are significant different ($P< 0.05$).

fish species and consequently reduce the importation of live *O. niloticus*. This is an interesting finding on the ground since there are perceived reports that *O. niloticus* performs better than the closely related indigenous fish species probably due to large number of publications the fish *O. niloticus* has received compared to other related

Table 3. Quality of feed and production parameters.

Type of feed	Productivity (tons/ha/year)	Harvest size (grams)	Production period (months)
Single ingredient	2.65±4.26[a]	144.63±58.5[a]	7.4±2.3[b]
Fertilization only	1.96±1.98[a]	191.25±41.90[b]	9.7±2.5[c]
Commercial feed	6.38±6.06[c]	237.33±75.54[c]	7.3±1.6[b]
Single ingredient and fertilization	4.27±6.76[b]	237.83±118.43[c]	9.9±1.6[c]
Fertilization and commercial feed	2.37±1.05[a]	135.0±80.47[a]	6.6±1.9[a]

Values with different superscripts within the parameter are significantly different ($P < 0.05$).

species. In fact, we did not find any literature giving reasons of fast growth of *O.* niloticus over the native Tilapia fish species in Zambia. The perceived fast growth of *O. niloticus* has led to the importation of this species at a huge risk of bringing in fish diseases such as Tilapia Lake Virus Disease (TiLVD) (Dog et al., 2017). Furthermore, ecologically, *O. niloticus* has been found to be hybridizing with other native Tilapia fish species in Kafue River impacting negatively on the diversity of the genetic resources for aquaculture and capture fisheries in Zambia (Deines et al., 2014; Bbole et al., 2014; Kour et al., 2014). The negative impacts of *O. niloticus* have also been catalogued elsewhere (Vicente and Fonseca-Alves, 2013).

O. andersonii and *O. niloticus* are the only fish species that were sex reversed. It was observed that those farmers that used reversed fingerlings had achieved a significantly ($P < 0.05$) higher productivity (5.5 tons/ha/year) than those that used mixed fingerlings (3.8 tons/ha/year) representing 31% superiority. Popma and Green (1990) discussed how the presence of 3 to 5% females in tilapia production ponds can result in excessive reproduction and reduced growth. Therefore, the higher productivity may have resulted from the low reproduction that might have been exhibited by the sex reversed fingerlings. This is because breeding allows excess biomass in the aquaculture facility thereby imposing resources limitations. It is therefore imperative that farmers that grow tilapia species are introduced to sex reversed fingerlings that assures them of higher productivity.

The productivity of farmers using single ingredients and fertilization in combination achieved higher productivity than even those that combined fertilization and commercial feeds. It is postulated that single ingredients are cheaper and readily available and are applied more frequently than the expensive commercial feeds thereby resulting into poorer growth and consequently low productivity. It is, therefore, important that farmers access the commercial feeds and use it as prescribed for the improvement of productivity. Small scale farmers complained of costly feed but they never justified from a financial point of view rather it was on the face value. Costly inputs may not mean low profitability since costly inputs may be of high quality resulting in higher productivity.

CONCLUSION AND RECOMMENDATIONS

The growth parameters estimated for the fish species being cultured in the provinces revealed that *O. andersonii* did not differ significantly from the exotic *O. niloticus*. The Government of the Republic of Zambia should demonstrate the growth potential of indigenous fish species especially *O. andersonii* in order to convince the farmers from insisting on using *O. niloticus*. Promotion of indigenous fish species at consumption level is recommended to create demand for the native fish species. This should be augmented by the continuous programmes of improving the growth potentials of the indigenous fish species through genetic improvement programmes. Control of *O. niloticus* should continue since there is every evidence of its hybridization with closely related native fish species. Since *O. niloticus* has been established in some water bodies in Zambia, there is an urgent need of establishing the gene banks (both *in vivo* and *in vitro*) for the most fish species especially *O. andersonii* and *O. machrochir* so that the genetic purity of the fish is maintained creating fall back genetic resources. There is also an urgent need to develop a species map for Zambia to guide objective fish introductions. The correct use of commercial feeds has been found to improve productivity and thus should be promoted at farm level.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Bbole I, Katongo C, Deines AM, Shumba O, Lodge DM (2014). Hybridisation between non – indigenous *Oreochromis niloticus* and native *Oreochromis* species in the lower Kafue River and its potential impacts on fishery. Journal of Ecology and Natural Environment 6:215-225.

Casal CMV (2006). Global documentation of fish introductions: The growing crisis and recommendations for action. Biological Invasions 8:3-11.

Cochran WG (1977). Sampling techniques (3rd ed.). New York: Wiley

Deines AM, Bbole I, Katongo C, Feder JL, Lodge DM (2014). Hybridisation between native *Oreochromis* species and introduced Nile tilapia *O. niloticus* in the Kafue River, Zambia. African Journal of Aquatic Science 39(1):23-34.

Department of Fisheries (DOF) (2018). Annual report for 2017. Department of Fisheries, Chilanga, Zambia.

Department of Fisheries (DOF) (2016). Status of aquaculture in the Copperbelt and North-Western Provinces of Zambia. Department of Fisheries, Chilanga, Zambia.

Duncan DB (1955). Multiple range and multiple F tests. Biometrics 11:1-42.

Food and Agriculture Organisation (FAO) (2018). State of the World fisheries and aquaculture (SOFIA). FAO Corporate Repository Document. Rome, Italy.

FishBase (2018). *Oreochromis andersonii*, Three Spotted Bream. Available at http://www.ksuaquaculture.org.html. [Accessed on 8thJuly, 2018].

Fish Site (2011). Using *Oreochromis andersonii* (Kafue Bream) in Zambia. https://thefishsite.com/articles/using-emoreochromis-andersonii-em-kafue-bream-in-zambia. [Accessed on 7th October 2018].

Kour R, Bhatia S, Sharma KK (2014). Nile Tilapia (*Oreochromis niloticus*) as a successful biological invader in Jammu (J and K) and its impacts on native ecosystem. International Journal of Interdisciplinary and Multidisciplinary 1(10):1-5.

Lowe-McConnell RH (1987). Ecological studies in tropical fish communities. Cambridge University Press, New York, USA.

Popma TJ, Green BW (1990). Sex reversal of tilapia in earthen ponds. Research and Development Series No. 35. International Center for Aquaculture, Alabama Agricultural Experiment Station, Auburn University, AL, USA.

Schwanck EJ (2004). The introduced *Oreochromis niloticus* is spreading on Kafue floodplain, Zambia. Hydrobiologia 315:143-147.

Soma K, Kuma C, Muyunda M, Nambala S (1997). Seed production of Carp in Zambia. JICA, Lusaka, Zambia.

Utsugi K, Mazingaliwa K (2002). Field guide to Zambian fishes, plankton and aquaculture. JICA, Lusaka, Zambia.

Welz A (2017). How Aquaculture is threatening the native fish species. Yale Environment 360. Yale School of Forestry and Environmental Studies, New Haven, CT 06511.

Appendix: Questionnaire

REPUBLIC OF ZAMBIA

Questionnaire for Aquaculture Baseline Survey for Copperbelt and North – Western Provinces

Name of enumerator:		**Date of data collection:**	

SECTION A: PERSONAL DETAILS
Please tick wherever applicable in this section

The objectives of the study are:

- *Demand and supply for aquaculture inputs in the target areas.*
- *Current production and productivity levels in the target areas.*
- *Income levels for the fish farmers in the target areas*
- *Market demand for fish in the target areas.*
- *Participation of women and youths in aquaculture*

<table>
<tr>
<td>1. Province: _________ [1] Copperbelt [2] North – Western
2. District : ___________________
3. Constituency: ___________________
4. Block: ________________________</td>
<td>5. Camp name: ________________________
6. GPS Readings:
Easting: ______________Northing: _________________</td>
</tr>
<tr>
<td>7. Name of respondent (Optional):_______________________________

8. Name of the fish farmer or organization if different from the respondent (Optional):________________________________

9. Type of enterprise (if both tick all):
[1]Fingerling production [2] Table size fish,
10. Gender of the fish farmer (if organization, provide membership composition): [1] M ____ [2] F ____
11. Tribe of the fish farmer (if organization provide composition according to tribe: ____
12. Marital status: [1] single [2] married [3] Divorced [4] widowed [5] others (specify):________________</td>
<td>13. Membership of the owner to the fish farmer organization
[1] Yes [2] No
14. If yes in 13, the type of the organization [1] Cooperative [2] Club [3] Associations
15. What is the education level of the owner/chairperson of the fish farm (last grade attended/qualification): _________________________________</td>
</tr>
</table>

16. People living in fish farmer's household and their roles in fish farming **(This does not apply for associations)**

Gender (1= Male, 2=Female)	Relationship to the owner of the farm 1 = Head 2 = Spouse 3 = Child (own/step) 4 = Parent/Parent in law 5 = Brother/sister 6= Other relatives 7= Employee 8= Others	Age	Activity involved in fish farming (1 = feeding, 2 = management, 3 = marketing, 4 = Processing) – multiple responses are possible

SECTION B: <u>POND PRODUCTION AND PRODUCTIVITY</u> 17. Please provide the following information about your ponds																
Facility No.	Type of facility? [1] Concrete pond [2] Earthen pond [3] Semi concrete pond [4] Cage [5] Pens [6] Tank [7] Others (specify): ______	Approx. Size of facility (m^2/m^3)	Age of facility (in years: ***Enumerator, enter e.g. 0.08 if facility is one month***)	How was this facility construction financed? ***[Indicate all that apply]*** [1] Self financed [2] By a relative [3] By our association [4] Government support [5] Supported by Project/NGO [6] Other ______	How many finger-lings were stocked?	How many fingerlings died within a month after stocking?	Fish species stocked, which fish species ***(use common name)*** [1] Three spotted [2] Green headed [3] Red breasted [4] Nile tilapia [5] Carp fish [6] Cat fish [7] Other (specify): _____	Where did you obtain fingerlings from? ***[Indicate all that apply]*** [1] Supplied by DoF [2] From lake/ river [3] From another fish farmer [4] From my other ponds [5] Specialized seed private producer [5] Others ______	Type of seed? [1] Sex reversed [2] Mixed	What is the type of feed ***[Indicate all that apply]*** [1] Single ingredient feed (specify) [2] Fertilization [3] Commercial complete feed [4] None [5] Other (specify): ______	What is the source feed? [1] Farm formulated [2] Purchase [2] Others (specify): ______	Feeding frequency per Day [1] Once [2] Twice [3]Thrice [4]Others (specify: _____	Form of feed? [1] Powder [2] Crumbles [3] Pellets [4] Others (specify: _____	Length of production cycle *(please indicate number of months) Indicate both for partial and complete*	Production *(please note that the reference period is January to December, 2015,* ***include what was given away, consumed or payment in kind****)* Table size (KGS)	Fingerlings (NO.)

SECTION C: INPUTS, PRODUCTS AND PRICES

18. Inputs, product costs and price

INPUTS/ PRODUCTS	UNIT OF MEASURE	UNIT SELLING PRICE (K)	UNIT COST (K)
Fingerlings	Pieces		
Fish	kg		
Feed	kg		
Labour	monthly		
Manure (specify the type)	kg		
Inorganic fertilizer (specify the type)	kg		

19. Sources of income *(Reference period is January to December, 2015)*

S/N	ENTERPRISE	AMOUNT GENERATED	RANK THEM IN THE ORDER INCOME GENERATED (If respondent has challenges to provide amounts generated)
1	Crop farming		
2	Livestock rearing		
3	Poultry		
4	Shop		
5	Fish farming		
6	Others (specify): ____________		

SECTION D: FISH FARMING SKILLS AND KNOWLEDGE

20. Please indicate to what extent you are able to perform the following fish farming operations;

	To what extent are you able to perform these tasks [1] Very well [2] Well enough [3] Poorly [4] Not at all	Who provided the knowledge? [1] DOF [2] Peace Corps [3] NGOs (specify) [4] Farmer to farmer [5] Others (specify):	In 2015, how often were you visited? [1] Weekly [2] Bi weekly [3] Monthly [4] None [5] Others, specify:
Site selection, design and construction			
Stocking of fish			
Fertilizing fish pond			
Fish feed formulation and production			
Fish feeding			
Water quality management			
Harvesting fish			
Fingerling production			
Keeping farm records			
Business management			

21. How do you determine the amount of feed to give the fish?
[1] By weight of fish after sampling [2] prescribed amount of feed by extension staff [3] Guess work [4] Others specify

SECTION E: POST HARVEST LOSSES

22. Did you incur physical fish post-harvest losses? [1] Yes [2] No

23. Did you process your fish? [1] Yes [2] No

24. If yes, what methods did you use?
[1] Cold-chain [2] Sun drying [3] Smoking [4] Salting [5] salting and smoking [6] Salting, sun drying and smoking

SECTION F: MARKETING ARRANGEMENTS

25. What are the main outlets for fish [1] Farm [2] local markets [3] Supermarkets [4] institutions (specify e.g school, college, prison etc)

26. How do you package your fish?
27. What fish species do your buyers prefer?
28. What is your fish distribution channels [1] Processors [2] Wholesalers [3] Retailers [4] Others specify etc.):________________________
29. What is your distribution channels for fingerlings? [1] Other nurseries [2] Other fish producers [3] Others (specify): _______________

SECTION G: HOUSEHOLD PRODUCTION ASSETS/IMPLEMENTS

30. Please tell us about the type and number of current assets or implements owned by the household related to the fish farming.

List the types of assets related to fish farming	Number of assets

SECTION H: CHALLENGES

List the challenges that you face in your fish farming operations.

____
____
____

END OF INTERVIEW
I certify that, to the best of my knowledge, I have collected correct and complete information relating to the particulars of this farm

Date………/………/2016 Designation: …………………Signature:…………………