

Value Chain Analysis of Farmed Nile Tilapia (*Oreochromis niloticus*) and African Catfish (*Clarias gariepinus*) in Tanzania

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ABSTRACT

This study was conducted in four regions of Tanzania (Dar es Salaam, Coast, Mwanza, and Geita) to assess the value chain of pond-cultured Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*). The study aimed at determining and mapping actors and identifying constraints and opportunities of various actors in the value chain. The study involved 113 fish farmers, 16 input suppliers, 74 fish marketers/retailers, 16 fish distributors/wholesalers and 41 restaurant owners/managers. The value chain actors for farmed Nile tilapia included input suppliers, fish farmers, fish traders and fish consumers. The input suppliers were private individuals (12.5%), farmers' groups (25%) and government institutions (62.5%) and supplied fingerlings, concentrate feeds, information and training on fish farming to farmers. The fish farmers owned 2.3 ± 0.3 ponds (mean \pm se) with average size of 598.3 ± 56.4 m². All fish farmers cultured Nile tilapia, and a few (23%) of them also cultured African catfish. Average (\pm se) Nile tilapia yield was $4,928.4 \pm 427.4$ kg/ha/year and 68.1% of the fish produced were sold, mainly to retailers (26.5%), neighbour consumers (21.2%) and distributors (17.7%). For most farmers (85.8%), price of fish was based on market price. However, the selling price was sometimes negotiable. Fish traders included retailers, wholesalers, restaurant operators and food vendors. Fish retailers bought fresh fish, mainly Nile tilapia, not only from fish farmers but also from fishermen, and they sold to distributors/wholesalers, restaurants, food vendors and consumers. Before selling the fish, they added value by washing, dressing, frying, smoking and sun drying. Wholesalers sold fish to other traders, consumers and restaurants. Restaurants sold cooked or fried fish to consumers. For all traders, the price of fish was based on market price and cost plus pricing. Constraints for fish farmers included shortage of water for fish ponds, high costs of inputs, lack of proper knowledge on fish farming, shortage of fish feeds, low price of fish, slow growth of cultured fish and lack of reliable source of fingerlings. Problems encountered by fish traders included low capital, inadequate fish supply, lack of storage facilities and unfaithful suppliers who supply spoiled fish. Lack of contractual arrangement between input suppliers and fish farmers and fish farmers and fish traders was identified as the weakness among the various actors in the value chain. Opportunities for fish farmers included readily available markets for Nile tilapia in the villages and towns. For traders, opportunities included high demand for Nile tilapia, availability of tenders in hotels and rising income for the majority of the people and increase of the middle class group in the country.

INTRODUCTION

Aquaculture is one of the world's fastest growing food production sectors with great potential for supply of protein, income generation, poverty alleviation, and enhanced trade and economic benefits. Studies in Nepal (Bhujel et al. 2008) and Bangladesh (Jahan et al. 2010) have shown that fish farming significantly contributes toward food security and poverty alleviation in poor societies. In sub-Saharan Africa, aquaculture production has been promoted with the aim of improving food security; increasing domestic fish production and substituting imports of fish products; creating employment; promoting diversification

and reduce risk; promoting economic development; and improving efficiency use of resources, especially water (Béné and Heck 2005, Satia 2011).

In Tanzania, fish farming is currently being emphasized as an alternative to capture fisheries due to decline in wild stock from natural water bodies. Aquaculture practice in Tanzania is mainly for subsistence purposes. In recent years, commercial aquaculture has started whereby commercial prawn farming is practiced in Mafia, Nile tilapia and African catfish in Mwanza and Trout (*Onchorynchus mykiss*) farming in Arusha. At the moment, aquaculture is dominated by freshwater fish farming in which small-scale farmers practice both extensive and semi-intensive fish farming. The emphasis of the national fisheries policy (URT 1997) is on a semi-intensive integrated mode of fish culture, focusing on Nile tilapia. The Nile tilapia is given first priority due to its better characteristics that include fast growth, short food chain, efficient conversion of food, high fecundity (which provides opportunity for distribution of fingerlings from farmer to farmer), tolerance to a wide range of environmental conditions, and good product quality (Hussain et al. 2000, Neves et al. 2008). Another species that is given priority is the African catfish (*Clarias gariepinus*). The African catfish is either cultured on pure stand or in polyculture with Nile tilapia. In the polyculture system the African catfish is used as a predatory fish species that eats the surplus fry, hence, controls undesirable tilapia recruitment in ponds and permits better growth of the adult tilapia population.

Value-chain analysis is the key entry point to poverty alleviation and achieving pro-poor outcomes. It is usually aimed at increasing the total amount and value of products that the poor can sell in the value chain (Hempel 2010). This, in turn, results in higher absolute incomes for the poor as well as for the other actors in the value chain. The other objective of value-chain analysis is to sustain the share of the poor in the sector or increase the margins per product, so that the poor do not only gain more absolute income but also relative income compared to the other actors in the value chain (Berg et al 2008). Furthermore, value chain is used as an analytical tool for understanding the policy environment that enables efficient allocation of resources within the domestic economy to maximize value, prevent post-harvest losses, and ensure effective management is in place to promote sustainable utilization of the resources. Value-chain analysis is done by mapping the actors participating in the production, distribution, marketing and sales of particular product (or products). The mapping involves assessment of the characteristics of actors, profits and costs structures, flow of goods throughout the chain, employment characteristics and the destination and volumes of domestic and foreign sales. Also it involves identifying the distribution of benefits of actors in the chain, the role of upgrading and governance within the chain.

In Tanzania, little is known about the value chain of cultured Nile tilapia and African catfish due to fact that no thorough study has been conducted on the subject matter, thus making the government put little effort to promote fish farming for poverty alleviation. This study was carried out to identify and map the main actors involved in Nile tilapia and African catfish value chains and their functions and analyze marketing margins of the different subsectors of Nile tilapia and African catfish value chain as the produces move from producers downstream the value chain. Also, the study was intended to determine the key constraints and problems affecting different actors in the value chain.

MATERIALS AND METHODS

Study location. The study was carried out in four regions of Tanzania: Geita, Mwanza, Coast, and Dar es Salaam. Geita and Mwanza regions are found in the Lake zone in the western part of the country while Coast and Dar es Salaam are located in the coastal zone in the eastern part of the country. In the Geita region, the study was conducted in Geita and Chato districts, while in Mwanza it was done in Ilelemela, Nyamagana, Misungwi, and Sengerema districts. In the Coast region, the study was done in Kibaha and Bagamoyo districts. In the Dar es Salaam region, three districts were involved, namely Kinondoni, Ilala, and Temeke.

Study subjects and sampling procedure. The study involved fish farmers, input suppliers, traders and distributors/wholesalers. The districts were purposefully selected, based on accessibility and presence of large number of fish farmers. In each district, lists of fish farmers and traders were taken as sampling frames from which respondents were picked randomly using a table of random numbers. The suppliers of fish production inputs and the fish distributors were purposely selected.

Data collection procedure. Cross-sectional surveys were conducted in all districts. During the survey, structured questionnaires were administered to individual fish farmers, input suppliers, traders and distributors/wholesalers. The structured questionnaires included both closed and open-ended questions. For fish farmers, the questionnaire was designed to seek information on households' socio-economic characteristics (age, gender and education level of household head, main occupation and source of income), number and size of ponds, fish species cultured, fish production yield, inputs sources and costs, proportion of harvested fish consumed at home and the proportion sold, income obtained from fish, marketing of fish produced, main customers, production constraints. A total of 113 small-scale fish farmers were individually interviewed. Out of the 113 fish farmers, 32, 28, 30 and 23 were from the Geita, Mwanza, Coast and Dar es Salaam regions, respectively. During the household surveys, the respondents were heads of households or spouses or adult members of the family (in the very rare cases when the household head was not available at home).

For input suppliers, the questionnaire was designed to collect information on type of organization, type of input supplied, price determination and mode of payment and problems faced. A total of 16 input suppliers were involved in the study. Among the input suppliers, four were from Mwanza, two from Geita, four from Dar es Salaam and six from the Coast region. For fish traders, distributors/wholesalers and restaurants the questionnaire was designed to collect information on households' socio-economic characteristics (age, gender and education level of household head, main occupation and source of income), type of business, fish species sold, source of fish, value addition activities done, customers, price determination and mode of payment, main competitors, services received, problems faced and available opportunities. In Geita, a total of 30 fish traders/retailers were involved in the study, while in the Coast region 24 fish traders/retailers were surveyed. In the Dar es Salaam region, 20 fish retailers were involved in the survey. Thus, the sample size for fish traders was 74 respondents from the three regions. For restaurants, a total of 41 respondents were individually interviewed, of whom 14 were from the Geita region, 7 from the Mwanza region, 10 from the Coast region and 10 from the Dar es Salaam region. For distributors, six were from Mwanza, six from Dar es Salaam and four from the Coast region, making the sample size for distributors to be 16 respondents.

Data analysis. Data from questionnaires were coded and recorded into the spreadsheets for statistical analysis. The Statistical Package for Social Science version 20 (SPSS 2011) computer software was used to generate descriptive statistics (means, standard deviations, frequencies and percentages).

RESULTS

Actors in the value chain. Most farmers and fish traders were involved in production and marketing of Nile tilapia (*Oreochromis niloticus*), hence the study focused on the value chain of Nile tilapia. The value-chain actors for farmed Nile tilapia both in the Lake and Coastal zones included input suppliers, fish farmers, fish traders and fish consumers. The input suppliers supplied fingerlings, fish feeds, information and training on fish production to fish farmers. The fish farmers cultured fish in ponds. All fish farmers (100%) cultured Nile tilapia (*Oreochromis niloticus*) and a few of them (23.0%) cultured African catfish (*Clarias gariepinus*) in addition to Nile tilapia (Table 1). The fish traders included retailers, wholesalers, restaurant operators and food vendors. Fish retailers bought fresh fish, mainly Nile tilapia, not only from fish farmers but also from fishermen and sold to distributors/wholesalers, restaurants, food vendors and consumers. Before selling the fish, they added value by washing, dressing, frying, smoking and sun drying. Wholesalers sold fish to other traders, consumers and restaurants.

Restaurants sold cooked or fried fish to consumers. Our findings concur with the observation made by Macfadyen et al. (2012) that the value chain of farmed fish in Egypt include input suppliers, retailers and food service providers. However, unlike the findings in this study the value chain in Egypt also includes supermarket retailers as well as export market (Macfadyen et al. 2012).

In the present study, African catfish were sold directly to consumers and were not sold in restaurants as consumers preferred Nile tilapia to African catfish. This is contrary to what has been reported in Uganda (Maurice et al. 2010) whereby the value chain of African catfish includes input suppliers (feed producers, seed producers, and equipment suppliers), farmers, middlemen and retailers. Similarly in Nigeria farmed catfish are sold by farmers to primary wholesalers who transport catfish to secondary wholesalers who, in turn, sell to retailers, restaurants, or consumers (Hempel 2010).

Input suppliers. Input suppliers included private individuals (12.5%), farmers' groups (25%) and government institutions (62.5%). All input suppliers supplied fingerlings to fish farmers, and in addition some supplied concentrate feeds (62.5%), information on fish production (37.5%) and training on fish farming (87.5%). The cost of inputs supplied was based on cost plus pricing method and the mode of payment was cash for all input suppliers. The study found that there were no formal contract between the input suppliers and the farmers and the inputs or services were supplied on demand basis.

Fish farmers. Most of the fish farmers were males (90.3%) and only a few were females (9.7%) with a mean age of 40.7 ± 0.9 years. The majority of the farmers were married (92.0%) and had primary school educations (62.8%). These farmers on average owned two ponds with mean size of 598 m^2 (Table 1). All farmers cultured Nile tilapia mainly under monoculture system. The majority of the farmers said that fish farming contributed either less than 25% (20.6% of farmers) or between 25 and 50% (46.4% of farmers) of the household income. Most fish farmers (77.9%) got knowledge for fish farming from other fish farmers and only few got the knowledge from fisheries extension officers (19.5%) or by reading extension materials (23.9%) and working on fish farms (25.7%) (Table 2). The majority of the farmers did not get financial assistance, but used their own money to start fish farming. The main sources of fingerlings for these farmers were other fish farmers (51.3%) and government institutions (31.9%). The government institutions included Kingolwira Fish Farming Centre and Fisheries Training Institutes. All farmers used manure to fertilize fish ponds and they obtained the manure from their own households (71.8%) and neighbours (24.7%). Similarly the source of fish feeds was their own households and neighbour farmers. The majority of the farmers used family labour to do all fish farming activities from pond making to fish harvesting.

Mean fish yield (Nile tilapia) per household was $4,928.4 \pm 427.4 \text{ kg/ha/year}$, and it was estimated that 68.1% of the fish produced were sold and the remaining were consumed at home (31.9%). Most of the fish were sold to fish vendors/retailers and neighbor consumers, and only small amount of fish were sold to wholesalers/distributors and restaurants (Table 3). For the majority of farmers, the fish were sold at the fish farm (65.5%) and at distribution points (45.1%). The mode of payment was via cash transaction, and the price of fish was based on the market price for most of the farmers (85.8%). However, the price was sometimes negotiable for all farmers. There were no formal contracts between the farmers and the buyers. On average fish farmers realized a gross margin of TZS $1,172,189.2 \pm 38,679.7$ per year.

Fish traders (retailers). The majority of fish retailers were males (89.2%), married and had a primary school level of education (73%). Most of these retailers sold Nile tilapia, and only a few sold African catfish. This is due to the fact the Nile tilapia is popular among consumers because of its good carcass characteristics. The results in Table 4 show that the fish retailers obtained fish mainly from fishermen and only few got fish from farmers. The retailers sold fish to consumers and wholesalers/processors. For most fish traders, the income from fish business accounted for about 81% to 100% of household income, implying that they mainly depend on fish trading for their livelihoods. The majority of fish traders

reported that they do not provide financial assistance to fish farmers and themselves rarely get financial assistance from financial institution (Table 4). The financial institutions which provided short term loan to fish traders were mainly microfinance institutions and nongovernmental organizations (NGOs). The retailers added value by cleaning and dressing the fish before selling to customers (Table 5). According to the retailers the fish quality and low price were the main factors which customers considered when buying fish. The pricing method used by the retailers was market price and cost plus pricing. There were no formal contracts between the retailers and the customers. The main competitors were other fish traders.

Wholesalers/distributors. The results for wholesalers/distributors are shown in Table 6. About 69% of the wholesalers were males, and 31% were females. The mean age of the wholesalers was 39.4 ± 3.1 years, and most of them were married. Most of the wholesalers either had a primary school level of education or had no formal education. The wholesalers obtained fish from fish traders and farmers and they sold mainly Nile tilapia to fish vendors and consumers. The price of fish was based on market price, but some (68.8%) of the wholesalers used cost plus pricing method, and the method of payment was based on cash transactions. For the majority of the wholesalers, there were no formal contracts between the wholesalers and the customers. With regard to financial assistance, only few wholesalers report that they get loan from banks (18.8%) and microfinance institutions (25%).

Restaurants. The socio-economic characteristics and marketing practice for restaurants are shown in Table 7. The majority of owners of restaurants were males (63.4%), married (70.7%) and had a mean age of 35.4 ± 1.2 years. Most of them had either primary (34.1%) or secondary school (48.8%) level of education. All restaurants sold cooked or fried Nile tilapia to consumers, and no restaurant was found selling African catfish. African catfish was even not included in the menu. The main source of fish were fish traders and only few restaurants obtained fish from fish farmers (Table 7). This indicates that most restaurants served wild Nile tilapia and very few restaurants served both wild and farmed Nile tilapia. Only few restaurants had contracts with the fish suppliers, but the majority did not have any formal contracts. The price of fish was based on the market price and cost plus pricing for most of the restaurants. Value addition in the restaurants included cleaning, dressing, frying and drying. Customers were attracted by good quality of the fish, convenience of the place and habit of the customers.

Problems and opportunities for different actors in the value chain. The main actors in the value chain were input suppliers, fish farmers, retailers, wholesalers/distributors and restaurants. The problems facing fish farmers, traders and restaurants are shown in Tables 8, 9 and 10, respectively. The main constraints affecting fish farming were shortage of water supply for fish ponds, high cost of inputs, lack of proper knowledge on fish farming, lack of fish feeds, low price of fish and slow growth of the cultured species (Table 8). Most farmers said that there is no reliable source of good quality fish feed. The problems that affected fish traders were lack of appropriate infrastructure for fish handling and storage, low capital and inadequate supply of fish (Table 9). The constraints for restaurants included fish scarcity, low capital and unfaithful suppliers who supply spoiled fish (Table 10).

The main weakness for various actors in the value chain was mainly lack of contractual arrangement between input suppliers and fish farmers and fish farmers and fish traders. This made the transactions to be unreliable and expensive. Another weakness was that fish farmers considered fish farming as a secondary economic activity and, hence, invested little in terms of time, labor and money. Furthermore, most value chain actors were highly dependent on self-financing even though they have low capital. This made the level of investment of fish farming and business to be low and, hence, low productivity. Opportunities for fish farmers included readily available markets for fish in the villages and nearby towns. For traders opportunities included high demand for Nile tilapia, availability of tenders in hotels and rising income for the majority of the people and increase of the middle class group in the country.

CONCLUSION

- Fish farming contributes significantly to household income of farmers and traders and has a great potential to contribute to food security and poverty reduction among the poor households;
- Nile tilapia (*Oreochromis niloticus*) is preferred to African catfish (*Clarias gariepinus*) by consumers in the markets, and this has resulted in more fish farmers and traders being involved in Nile tilapia business compared to African catfish business;
- Value-chain actors for farmed Nile tilapia include input suppliers (fingerlings and feeds), fish farmers, fish retailers/vendors, wholesalers/distributors, restaurants and fish consumers;
- The proportion of farmed Nile tilapia in the markets is very small, and most fish traders sell wild tilapia; and
- The market for Nile tilapia is readily available in villages, towns and cities, and this provides opportunity for increasing production.

LITERATURE CITED

- Béné, C., and S. Heck, 2005. "Fish and food security in Africa," NAGA, World fish Centre Quarterly report, 28: 8-13.
- Berg, M., M. Boomsma, I. Cucco, and N. Janssen, 2008. Making Value Chain Work better for the poor. A toolkit for practitioners of value Chain Analysis. DFID, UK. Version 2.
- Bhujel, R.C., K. Shrestha, J. Pant, and S. Buranrom, 2008. "Ethnic women in aquaculture in Nepal." Development, 51: 259-264.
- Hempel, E., 2010. Value Chain Analysis in the Fisheries sector in Africa. http://www.fao.org/fileadmin/user_upload/fisheries/docs/Value_Chain_Analysis_Report_FINAL_hempel.doc. Downloaded on 10 December 2015.
- Hussain, M.G., A.H.M. Kohinoor, M.S. Islam, S.C. Mahata, M.Z. Ali, M.B. Tanu, M.A. Hossain, and M.A. Mazid, 2000. Genetic evaluation of GIFT and existing strains of Nile Tilapia, *Oreochromis niloticus* L., under on-station and on-farm conditions in Bangladesh. Asian Fisheries Science, 13: 117-126.
- Jahan, K.M., M. Ahmed, and B. Belton, 2010. The impacts of aquaculture development on food security: lessons from Bangladesh. Aquaculture Research, 41: 481-495.
- Macfadyen, G., A.M. Nasr-Allah, and M. Dickson, 2012. The market for Egyptian farmed fish. Project report. Research program on livestock and fish, World Fish Centre.
- Maurice, S., Ö. Knútsson, and H. Gestsson, 2010. The value chain of farmed African catfish in Uganda. Final Project report. Fisheries programme, The United Nations University, Iceland.
- Neves, P.R., R.P. Ribeiro, L. Vargas, M.R.M. Natali, K.R. Maehana, and N.G. Marengoni, 2008. Evaluation of the Performance of Two Strains of Nile Tilapia (*Oreochromis Niloticus*) In Mixed Raising Systems. *Brazilian Archives of Biology and Technology* 51 (3): 531 – 538
- Satia, 2011. Regional review on status and trends in aquaculture development in Sub-Saharan Africa – 2010. FAO, Rome 214p.
- URT, 1997. National Fisheries sector policy and strategy statement. Ministry of Natural resources and Tourism, Dar es Salaam, Tanzania.

TABLES

Table 1. Socio-economic characteristics of fish farmers.

Variable	Region				
	Geita	Mwanza	Coast	Dar es Salaam	Overall
Gender of household head					
Males (%)	90.6	89.3	90.0	91.3	90.3
Females (%)	9.4	10.7	10.0	8.7	9.7
Age of household head (mean ± se)	41.7 ± 1.5	42.0 ± 1.7	39.5 ± 1.7	39.1 ± 2.1	40.7 ± 0.9
Marital Status					
Single(%)	0.0	10.7	6.7	13.0	7.1
Married(%)	100	85.7	93.3	87.0	92.0
Divorced(%)	0.0	3.6	0.0	0.0	0.9
Education level					
Adult education(%)	3.1	0.0	13.3	17.4	8.0
Primary school(%)	78.1	85.7	56.7	21.7	62.8
Secondary school(%)	15.6	14.3	23.3	52.2	24.8
University graduate(%)	3.1	0.0	6.7	8.6	4.4
Land ownership					
Own land with title deed (%)	34.4	35.7	76.7	95.5	58.0
Own land under customary law (%)	34.4	14.3	16.7	4.5	18.8
Squatting (%)	31.2	50.0	6.7	0.0	23.2
Fish species cultured					
Nile tilapia	100	100	100	100	100
African catfish	6.2	3.6	43.3	43.5	23.0
Number of ponds (mean ± se)	2.1 ± 0.3	1.8 ± 0.2	2.6 ± 0.5	3.0 ± 1.2	2.3 ± 0.3
Pond size (mean ± se) (m ²)	615.3 ± 114.9	556.3 ± 76.1	683.8 ± 56.5	514.4 ± 45.86	598.3 ± 56.4
Fish farming method					
Monoculture	100.0	100.00	93.3	100.00	98.2
Polyculture	0.0	0.0	6.7	0.0	1.8
Number of years in fish farming					
1 - 2	78.1	78.6	66.7	87.0	77.0
3 - 4	21.9	21.4	26.7	13.0	21.2
5 - 7	0.0	0.0	6.7	0.0	1.8
Proportion of income from fish farming					
≤ 0.25	8.3	13.0	27.6	33.3	20.6
0.26 - 0.5	75.0	56.5	31.0	23.8	46.4
> 0.5	8.3	13.0	10.3	9.5	10.3

Table 2. Sources of inputs for fish farmers.

Variable	Region				
	Geita	Mwanza	Coast	Dar es Salaam	Overall
Source of knowledge for fish farming					
Worked on a private fish farm	15.6	25.0	23.3	8.7	18.6
Worked on a government fish farm	9.4	3.6	13.3	0.0	7.1
Attended training	3.1	0.0	3.3	8.7	3.5
Learned from neighbours	81.2	75.0	70.0	87.0	77.9
Advised by Fisheries Extension Officer	25.0	21.4	20.0	8.7	19.5
Read fish farming extension materials	15.6	17.9	30.0	34.8	23.9
Source of funds for fish farming					
Own	100	96.4	90.0	91.3	94.7
Borrowed from friends	6.2	3.6	0.0	0.0	2.7
Borrowed from microfinance institutions	0.0	3.6	6.7	4.3	3.5
Sponsored by government	0.0	7.1	0.0	0.0	1.8
Sponsored by NGOs	0.0	0.0	3.1	0.0	0.9
Source of fingerlings					
Own	21.9	3.6	23.3	17.4	16.8
Government institutions	50.0	50.0	20.0	0.0	31.9
Other fish farmers	28.1	46.4	56.7	82.6	51.3
Source of fertilizers					
Own	64.7	60.9	76.0	85.0	71.8
Government	11.8	0.0	0.0	5.0	3.5
Neighbour farmers	23.5	39.1	24.0	10.0	24.7
Source of feeds					
Own	50.0	40.7	89.7	52.2	58.7
Government	20.0	14.8	0.0	0.0	9.2
Neighbour farmers	30.0	44.4	10.3	47.8	32.1
Source of labour					
Family labour	92.9	100.00	100.00	95.0	97.3
Hired labour	7.1	0.0	0.0	5.0	2.7
Source of water					
Spring	68.8	82.1	70.0	60.9	70.8
Underground	6.2	0.0	23.3	52.2	18.6
River	6.2	3.6	6.7	0.0	4.4
Reservoir/dam	6.2	0.0	16.7	17.4	9.7
Lake	18.8	17.9	0.0	0.0	0.0

Table 3. Nile tilapia yield and marketing system of fish produced by small-scale farmers.

Variable	Region				
	Geita	Mwanza	Coast	Dar es Salaam	Overall
Fish yield (mean \pm se) kg/ha/year)	4,706.5 \pm 647.1	5,006.3 \pm 756.3	4,088.8 \pm 566.7	5,750.0 \pm 1130.9	4,928.4 \pm 427.4
Proportion of fish consumed at home (%)	37.0 \pm 4.6	36.6 \pm 4.9	27.9 \pm 5.0	24.6 \pm 2.7	32.0 \pm 2.3
Proportion of fish sold (%)	63.0 \pm 7.4	63.4 \pm 8.5	72.1 \pm 7.2	75.4 \pm 6.7	68.0 \pm 3.8
Place where fish are sold					
Farm gate (%)	53.1	57.1	73.3	82.6	65.5
Market (%)	9.4	14.3	0.0	0.0	6.2
Distribution point (%)	50.0	50.0	40.0	39.1	45.1
Customer delivery (%)	34.4	25.0	33.3	34.8	31.9
Proportion of fish sold to neighbours (%)	8.0 \pm 1.6	7.1 \pm 1.8	39.2 \pm 6.4	36.1 \pm 5.2	21.8 \pm 2.5
Proportion of fish sold to distributors (%)	21.1 \pm 5.4	28.2 \pm 7.0	13.7 \pm 5.3	5.65 \pm 3.1	17.7 \pm 2.8
Proportion of fish sold to restaurants (%)	4.0 \pm 1.2	0.8 \pm 0.4	12.8 \pm 3.1	24.6 \pm 5.1	9.7 \pm 1.6
Proportion of fish sold to vendors (%)	35.7 \pm 6.6	31.8 \pm 7.1	17.7 \pm 4.1	20.7 \pm 4.4	26.9 \pm 3.0
Payment method (cash)	100	100	100	100	100
Pricing method					
Market price (%)	76.0	78.3	92.6	95.2	85.4
Cost plus (%)	64.0	43.5	26.9	42.9	44.2
Markup (%)	8.0	4.3	0.0	14.3	6.2
Targeted return (%)	4.0	0.0	0.0	4.8	2.1
Profit maximization (%)	0.0	0.0	0.0	0.0	0.0
Negotiable (%)	100	100	100	100	100
Have contract with customers					
Yes (%)	3.1	17.9	3.3	4.3	7.1
No (%)	96.9	82.1	96.7	95.7	92.9

Table 4. Socio-economic characteristics of fish traders/retailers.

Variable	Region			
	Coast	Dar es Salaam	Geita	Overall
Gender				
Males (%)	83.3	100	86.7	89.2
Females (%)	16.7	0.0	13.3	10.8
Marital status				
Single (%)	50.0	80.0	6.7	40.5
Married (%)	50.0	20.0	86.7	56.8
Widow (%)	0.0	0.0	6.7	2.7
Education level				
Primary school (%)	83.3	70.0	66.7	73.0
Secondary school (%)	16.7	30.0	26.7	24.3
Informal education (%)	0.0	0.0	6.7	2.7
Assistance provide to fish suppliers				
Short term financing (%)	0.0	0.0	26.7	10.8
Fish farming information (%)	0.0	0.0	13.3	5.4
None	100	100	60.0	83.3
Suppliers of Nile tilapia				
Fish farmers (%)	16.7	0.0	33.3	18.9
Fishermen (%)	83.3	100	66.7	81.1
Suppliers of African catfish				
Fish farmers (%)	33.3	0.0	40.0	27.0
Fishermen (%)	66.7	100	60	73.0
Contractual arrangement with suppliers				
Yes (%)	16.7	0.0	26.7	16.2
No (%)	83.3	100	73.3	83.8
Contribution of fish business to household income				
0 - 20 (%)	0.0	0.0	13.3	5.4
21 - 40 (%)	33.3	0.0	6.7	13.5
41 - 60 (%)	8.3	60.0	6.7	21.6
61 - 80 (%)	0.0	20.0	0.0	5.4
81 - 100 (%)	58.3	20.0	73.3	54.1
Customers for fish sold				
Consumers (%)	100	80.0	80.0	86.5
Wholesalers/processors (%)	58.3	60.0	86.7	70.3
Contractual arrangement with customers				
Yes (%)	0	0	33.3	13.5
No (%)	100	100	66.7	86.5
Assistance received				
Short term financing from NGOs (%)	0.0	0.0	6.7	2.7
Short term financing from Banks (%)	0.0	0.0	6.7	2.7
Short term financing from microfinance (%)	0.0	0.0	33.3	13.5

Table 5. Value addition activities and marketing practices done by fish retailers/traders.

Variable	Region			
	Coast	Dar es Salaam	Geita	Overall
What attracts customers				
Good fish quality (%)	83.3	40.0	60.0	62.2
Low price of fish (%)	25.0	0.0	66.7	35.1
Convenience of the place (%)	25.0	0.0	0.0	8.1
Habit of customer (%)	50.0	30.0	0.0	27.0
Value addition method				
Cleaning (%)	100	100	100	100
Dressing (%)	25.0	0.0	40.0	24.3
Smoking (%)	8.3	20.0	0.0	8.1
Frying (%)	8.3	0	0	2.7
Drying (%)	33.3	0	0	10.8
Packing (%)	8.3	0	13.3	8.1
Price determination mechanism				
Market price (%)	58.3	100	86.7	81.1
Cost plus (%)	33.3	40.0	73.3	51.4
Targeted return (%)	8.3	20.0	13.3	13.5
Profit maximization (%)	0.0	0.0	0.0	0.0
Break even analysis (%)	0.0	0.0	0.0	0.0
Negotiable (%)	0.0	0.0	0.0	0.0
Main competitors				
Other fish traders (%)	83.3	60.0	100	83.3
Wholesalers (%)	16.7	20.0	0.0	10.8
None (%)	0.0	20.0	0.0	5.4

Table 6. Socio-economic characteristics and marketing practices of fish distributors/wholesalers.

Variable	Region			
	Mwanza	Dar es Salaam	Coast	Overall
Gender				
Males (%)	16.7	100	100	68.8
Females (%)	83.3	0.0	0.0	31.3
Age (mean \pm se)	39.6 \pm 3.5	35.0 \pm 10.0	47.0 \pm 0.0	39.4 \pm 3.1
Marital status				
Single (%)	0.0	50.0	0.0	18.8
Married (%)	66.7	50.0	100	68.8
Divorced (%)	33.3	0.0	0.0	12.5
Highest education level				
Primary school (%)	83.3	0.0	0.0	31.3
Secondary school (%)	16.7	0.0	0.0	6.3
University (%)	0.0	0.0	0.0	0.0
Adult education (%)	0.0	100	100	62.5
Fish species sold				
Nile tilapia (%)	100	100	100	100
Source of fish sold				
Fish farmers (%)	16.7	100	0.0	43.8
Fish traders (%)	83.3	0.0	100	56.3
Customers				
Fish traders/retailers (%)	100	50.0	100	81.3
Consumers (%)	0.0	50.0	0.0	18.8
Services received				
Short term financing from microfinance institution (%)	66.7	0.0	0.0	25.0
Loan from banks (%)	0.0	50.0	0.0	18.8
None (%)	33.3	50.0	100.0	56.3
Contractual arrangement with customers				
Yes (%)	33.3	0.0	0.0	12.5
No (%)	66.7	100.0	100	87.5
Nature of payment (cash) (%)	100	100	100	100
Price determination mechanism				
Market price (%)	100	100	100	100
Cost plus (%)	16.7	100	100	68.8
Markup (%)	0.0	0.0	0.0	0.0
Targeted return (%)	0.0	0.0	0.0	0.0
Profit maximization(%)	0.0	0.0	0.0	0.0
Break even analysis (%)	0.0	0.0	0.0	0.0
Negotiable (%)	0.0	0.0	0.0	0.0

Table 7. Socio-economic characteristics and marketing practices of restaurants owners.

Variable	Region				
	Geita	Mwanza	Coast	Dar es Salaam	Overall
Gender					
Males (%)	50.0	71.4	60.0	80.0	63.4
Females (%)	50.0	26.6	40.0	20.0	36.6
Age of household head (mean ± se)	37.1 ± 1.9	35.9 ± 3.1	32.9 ± 2.8	35.3 ± 2.6	35.4 ± 1.2
Marital Status					
Single (%)	14.3	28.6	40.0	30.0	26.8
Married (%)	85.7	71.4	50.0	70.0	70.7
Divorced (%)	0.0	0.0	10.0	0.0	2.4
Education level					
Adult education (%)	14.3	0.0	10.0	30.0	14.6
Primary school (%)	35.7	28.6	40.0	30.0	34.1
Secondary school (%)	42.9	71.4	50.0	40.0	48.8
University graduate (%)	7.1	0.0	0.0	0.0	2.4
Fish species sold					
Nile tilapia (%)	100	100	100	100	100
Type of fish sold					
Wild caught fish (%)	100	85.7	90.0	100.0	95.1
Farmed fish (%)	0.0	0.0	0.0	0.0	0.0
Both	0.0	14.3	10.0	0.0	4.9
Suppliers of fish					
Fish farmers (%)	14.3	14.3	22.2	0.0	12.5
Fish traders (%)	85.7	85.7	55.6	80.0	77.5
Fish shop/cold store (%)	0.0	0.0	22.2	20.0	10.0
Contract with fish suppliers					
Yes (%)	42.9	14.3	0.0	0.0	17.9
No (%)	57.1	85.7	100	100	82.1
Type of value addition					
Cleaning (%)	78.6	85.7	60.0	60.0	70.7
Dressing (%)	42.9	28.6	30.0	20.0	31.7
Smoking (%)	0.0	0.0	10.0	10.0	4.9
Frying (%)	100	100	100	100	100
Drying (%)	28.6	14.3	10.0	40.0	24.4
Cutting (%)	35.7	0.0	0.0	30.0	19.5
Packaging (%)	21.4	14.3	0.0	0.0	9.8
Things which attract customers					
Good fish quality (%)	78.6	100	100	80.0	87.8
Low price (%)	14.3	14.3	0.0	0.0	7.3
Convenience (%)	28.6	14.3	40.0	40.0	31.7
Habit (%)	35.7	57.1	50.0	50.0	46.3
Price determination mechanism					
Market price (%)	57.1	71.1	70.0	70.0	65.9
Cost plus (%)	64.3	85.7	60.0	6.0	65.9
Markup (%)	21.4	0.0	10.0	30.0	17.1
Targeted return (%)	0.0	0.0	0.0	0.0	0.0
Profit maximization (%)	28.6	14.3	0.0	0.0	12.2
Negotiable (%)	0.0	14.3	0.0	0.0	2.4

Table 8. Problems faced by small-scale fish farmers.

Variable	Region				
	Geita	Mwanza	Coast	Dar es Salaam	Overall
Shortage of water (%)	21.9	25.0	53.3	73.9	41.6
Lack of fingerlings (%)	25.0	14.3	20.0	4.3	16.8
Lack of fertilizers (%)	15.6	10.7	13.3	13.0	13.3
Shortage of feeds (%)	31.2	25.0	26.7	21.7	26.5
High cost of inputs (%)	31.2	28.6	50.0	47.8	38.9
Low price of fish (%)	15.6	28.6	30.0	17.4	23.0
Slow growth of cultured fish (%)	15.6	39.3	13.3	21.7	22.1
Lack of knowledge on fish farming (%)	50.0	50.0	20.0	17.4	35.4
Theft (%)	9.4	0.0	23.3	8.7	10.6

Table 9. Problems faced and opportunities for fish traders.

Variable	Region			
	Coast	Dar es Salaam	Geita	Overall
Constraints for fish retailers				
Lack of transport (%)	0.0	0.0	20.0	8.1
Low capital (%)	50.0	20.0	13.3	27.0
Inappropriate policies/regulations (%)	16.7	0.0	6.7	8.1
Lack of appropriate infrastructure (%)	25.0	80.0	26.7	40.5
Inadequate fish supply (%)	8.3	0.0	26.7	13.5
Lack of knowledge on fish farming (%)	0.0	0.0	6.7	2.7
Problems faced by distributors/wholesalers				
Late delivery of fish (%)	33.3	0.0	100	37.5
Inadequate fish supply (%)	33.3	50.0	0.0	31.3
Buying spoiled fish (%)	16.7	50.0	0.0	25.0
Opportunities for fish traders				
Availability of tender in hotels (%)	41.7	40.0	20.0	32.4
Export market (%)	41.7	0.0	6.7	16.2
New traders (%)	0.0	20.0	6.7	8.1
Increase in capital (%)	58.3	50.0	13.3	37.8
Improvement in markets (%)	83.3	100	26.7	64.9

Table 10. Problems and opportunities of restaurants.

Variable	Region				
	Geita	Mwanza	Coast	Dar es Salaam	Overall
Problems					
Fish scarcity	28.6	28.6	40.0	20.0	29.3
Shortage of power	7.1	14.3	0.0	10.0	7.3
High price of fish	7.1	28.6	0.0	0.0	7.3
Buying spoiled fish	14.3	0.0	20.0	20.0	14.6
Low capital	21.4	14.3	10.0	10.0	14.6
Shortage of customers	7.1	14.3	0.0	10.0	7.3