Value Chain Development for Tilapia and Catfish Products: Opportunities for Women Participation

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ABSTRACT

This investigation consisted of two parts: 1) consumer preference study and 2) value chain analysis. Analyses of the preferences of consumers in urban Kenya for farmed tilapia and catfish suggest that consumers have issues with farmed tilapia and catfish relating to availability and healthiness. Consumption is significantly dependent on the gender, marital status, age, family size, residential status and education of consumers; price of catfish and tilapia; and importance of the color, taste, smell and nutritional value to consumers. Regarding the value chain, the major actors included input suppliers, fish farmers, fish farmers/input suppliers and fish marketers. Input suppliers supplied farm inputs, greenhouse construction equipment suppliers and harvest equipment suppliers. Fish farmers are mainly grow-out farmers and fish farmers/input suppliers sold fingerlings and fry and thereby acted as hatcheries in addition to producing fish for the food market. Fish marketers included wholesalers, traders/processors. The preliminary findings suggest that high initial costs of fish farming in terms of land, training and construction needs to be addressed, despite government assistance through the ESP. This is one of the major constraints to increased female participation in the fish production stage. The SWOT analysis of all supply chain actors indicates a need for more information sharing. Nairobi fish marketers had the highest benefit-cost ratio suggesting that close proximity to urban markets could improve farm revenues.

INTRODUCTION

Aquaculture development in Kenya was identified as a core activity for funding in the New Partnership for Africa's Development (NEPAD) Action Plan in 2000. Since then Kenya's aquaculture production has risen from about 1,000 tons to almost 1,500 tons in 2006. Production in real terms has doubled and is set to grow by over 1,000% by 2010-2012. In 2003 total production of the three main fish species farmed in Kenya (Nile tilapia, rainbow trout and North African catfish) amounted to 948 tons. The value of production for 2003 came to US$ 2,153,000 (FAO, 2010).

The most important fish are tilapia and catfish. Tilapia species form about 90% of farmed fish in Kenya. Polyculture of tilapia with the African catfish (*Clarias gariepinus*) is often practiced. Semi-intensive systems form the bulk of aquaculture production in Kenya, contributing more than 70% of the total production from aquaculture. There are only a few intensive systems and hyper-intensive systems in Kenya. The latter are projected to contribute as much as 90% of all farmed fish in Kenya by both volume and value. Approximately 35% of tilapia produced in Kenya is produced in semi intensive systems, while 65% is produced in extensive systems. Approximately a third of Kenya's 5,900 fish farmers are commercial farmers although only four are large scale commercial enterprises. The remainder is rural, commercial small-scale fish farmers.

A review of past CRSP research studies in Africa suggests a strong production focus, leaving many fish consumer and marketing questions unanswered. The need to place some emphasis on consumer preference research and value chain development derives from the strategic challenges that the Kenyan aquaculture industry faces. A value chain is defined as the different stages of the fish production process, e.g. input supply, production, marketing, consumption, which are linked through different relationships.

There is limited distinction in the marketing of wild caught fish and farmed fish and the two often share the same marketing chain. Previous literature purports a very short marketing channel for aquaculture products in which producers link directly to consumers or retailers. Middlemen have a minimal or no role in the marketing channel. Farmed fish is usually produced at the village or farm level and individual farmers sell directly to individual consumers, fish retailers or nearby small establishments such as restaurants, schools, and hotels. Quantities sold are generally small and supply is inconsistent (Quagrainie et al., 2009). Schuurhuizen, et al., (2006) assert that the increase in international fish supply chains has led to disruptions in traditional arrangements and the traditional female roles are disappearing. Women participate at the peripheral parts of the value chain, such as fish processing and trading. However, as men enter the processing business they appear to displace women from those activities and women may also be required to work as laborers in male-managed agricultural activities. Wangila et al., (2007) reported that women operated almost exclusively as small-scale traders or fishmongers who bought and processed mostly small fish and sold locally. Traders usually had a specialty in which they traded; men traded mainly in medium and large fish while women traded mainly in small and medium fish. Women generally play a major role in the production, processing and marketing of agricultural products in many African countries. Their enhanced integration into the fish value chain could lead to improved economic wellbeing and help overcome inequalities and poverty for women thereby ensuring food security in Africa. Analyzing specific value-chain activities and integration of women would create some competitive advantage.

The purpose of this study was to understand consumer preferences and trends in the demand for tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*) products in Kenya and to develop value chain involving women that could lead to economic growth and to help overcome underemployment and poverty among women. This study was structured around five main objectives:

1. **Identify the factors that influence consumer decision-making and purchase behavior regarding tilapia and catfish product options;**
2. **Examine consumers' preference structure and decision criteria for tilapia and catfish products that are farmed and wild caught;**
3. **Assess the state of women participation in fish value chain, identifying opportunities and constraints to improving their welfare;**
4. **Train women in fish value participation to identify points of intervention;**
5. **Develop a Farmed Fish Marketing Information System (FFMIS) based on consumer information and existing national fish farming inventory.**

OBJECTIVES 1 AND 2

Methodology

The data necessary to accomplish the objectives was collected from Nairobi, Kisumu, Nyeri, Eldoret and Nakuru in Kenya. The questionnaire solicited for information on the socio-demographic features, general fish consumption of consumers, information specific to the consumption of tilapia and catfish. The questionnaires were administered to randomly selected households; a total of 623 questionnaires were administered; 230 in Nairobi, 213 in Kisumu, 67 in Nakuru, 60 in Eldoret, and 53 in Nyeri. After excluding incomplete responses, the sample size reduced to 415.

Consumer preference for farmed tilapia and catfish was assessed on a likert scale of 0 to 3 (0 = not preferred; 1 = least preferred; 2 = preferred; 3 = most preferred). We analyzed the effects of the importance of sensory (taste, color and smell), functional (nutritional value) and symbolic (social status) attributes and the socio-demographic features of consumers (gender, marital status, income level, family size, household income and educational level) on the preferences of consumers for farmed tilapia and catfish. Taste, color, smell and nutritional value of farmed fish, and the social status of consumers were measured on a likert scale of 1 to 4; 1 being not important, and 4 being very important. Consumers were made to indicate how important these factors are to them when purchasing tilapia or catfish. A description of selected variables used to model preferences is reported in table 1. The prices of tilapia and catfish were estimated as the ratio of tilapia (catfish) expenditure to the quantity of tilapia (catfish) purchased per fish shopping. The data described was analyzed with an Ordered Logit model.

Since about 90% of farmed fish is tilapia, a second model for consumer preferences specific to farmed tilapia was estimated using a separate data set from a choice experiment that consisted of various levels of attributes. This included four levels of fish form (fresh, fried, dried and smoked), three levels of fish size (small, medium and large), and four levels of price - KSH 150, KSH 250, KSH 300 and KSH 400 for Kenya. The levels of size were described as 150-400g for small, 400-600g for medium and >600g for large, based on findings reported by Quagrainie et al. (2010). Having specified the attributes and their respective levels, the full factorial main effects experimental design was used to generate hypothetical tilapia profiles in SPSS 11. Because full factorial experimental design was used, all the possible treatment combinations were generated (Hensher, Rose and Greene, 2005). In all, 96 ($2^1x3^1x4^2$) hypothetical tilapia profiles were generated from which 48 questions were formed. Each question had three alternatives: A, B and C from which respondents were to make a choice. Alternatives A and B were two different hypothetical tilapia profiles, and alternative C was a "choose-neither-A-nor-B" (*status quo*) option. The random parameters logit was adopted to assess consumer choice for farmed tilapia.

Results

Majority of the consumers were females (about 54%); and their average age was 33years. The high proportion of females and high average age of the respondents are consistent with the culture in most parts of Africa where the principal shoppers of households are predominantly matured females. About 73% were married and the average household size was 3.8. Over 60% of the consumers live in urban areas while the rest live in semi-urban areas of the cities. All of the respondents had either primary (grade 1 to 6) or higher level of formal education, with majority of them (58%) being graduates of second cycle institutions and a few (3%) holding post graduate degrees. The average Kenyan household earned about $342 per month and spent $114 on food. On average, households in Kenya consume about 2.10kg (4.24lb) of fish per week. The most consumed fish species included tilapia, Nile perch, catfish, silver cyprinid, lungfish, haplochromis, kingfish and common carp in that other. Tilapia is the most frequently purchased fish by 78% of household in Kenya; and Nile perch and catfish are respectively among the three most frequently purchased fish by 48% and 40% of Kenyan households. Over 70% of Kenyan consumers purchase fish mainly from open markets. Supermarkets and landing sites are also important places for fish purchases. Supermarkets and landing sites are more important locations for fish purchases.

Ordered Logit model

The analyses utilized an ordered logit models for the tilapia and catfish response data (Table 2). For farmed tilapia, the residential status of consumers appears to have a positive and significant effect on the preference of consumers, revealing that consumers living in urban areas have a higher preference for farmed tilapia compared to those living in semi-urban areas. Also, the price of catfish has a positive and significant effect on farmed tilapia preference, suggesting that farmed tilapia and farmed catfish are substitutes, i.e., the higher the price of farmed catfish, the higher the preference of consumers for farmed tilapia. Regarding the sensory and functional attributes of farmed tilapia, the importance of the color, smell, nutritional value and social status have positive and significant effects (Table 2).

In the farmed catfish model female shoppers showed a negative and statistically significant effect indicating that female consumers have less preference for farmed catfish than male consumers. Age of consumers is positive and significant. Education showed significant effect on preferences. For example, tertiary and post graduate education had positive effects on preferences of consumers for farmed catfish suggesting that consumers with tertiary and post graduate education prefer farmed catfish compared to consumers with only primary education.

The effect of price of catfish is negative and significant as demand theory suggests; the higher the price of catfish, the lower the preference of consumers for farmed catfish. The taste, color, and smell of farmed catfish have positive and significant effects on the preference of consumers for farmed catfish indicating that the more important these factors are to consumers, the more likely they would purchase farmed catfish. The social status coefficient is positive and significant suggesting that the higher consumes view their social status, the more likely they would purchase farmed catfish.

The taste of farmed tilapia and catfish can be improved by feeding them with commercially formulated feed instead of household food wastes and just food generated in the pond. In some instances, pond algae eaten by fish impart unpleasant tastes to farmed fish. Although the use of commercially formulated feed can help improve the taste of tilapia, it may be unaffordable to small-scale farmers who are the majority of fish farmers in Kenya. However, the benefits to be realized by feeding formulated feed would outweigh the cost. The use of formulated fish feed should be encouraged.

Random Parameters Logit (RPL) model

In order to avoid dummy variable trap, one level of each attribute was omitted. The omitted attribute levels were “wild-caught”, “small size” and “dried form”. The attribute levels maintained in the model were effects coded relative to the omitted levels. Effects coding is used in order to avoid confounding the *opt-out* coefficient (Ouma, Abdulai and Drucker, 2007; Tonsor, Olynk and Wolf, 2009). All the non-price attributes of tilapia were assumed to be normally distributed in the population with the standard deviation. However, price was fixed in order to ensure a negative price coefficient over the entire sample. Fixing price also means that the willingness to pay (WTP) values will be normally distributed (Layton and Brown, 2000).

The RPL estimates are presented in table 3. The model has a McFadden-R^2 of 29.07% suggesting that the model has adequate fitness. The price coefficient is negative and strongly significant suggesting that consumers have a preference for lower tilapia prices, which is consistent with demand theory. The negative sign on the price coefficient corroborates with the result that over 70% of the consumers indicated that price is very important to them when buying tilapia on a scale of 1 to 4 (1=very important and 4=not important).

The “farmed” attribute has a negative and statistically significant coefficient suggesting a lower preference compared to wild caught tilapia. Although a proportion of the consumers (23%) indicated

indifference between farmed and wild tilapia, most consumers generally do not ask about the mode of production (wild or farmed) of the tilapia they purchase. Consumers who do not prefer farmed fish gave health reasons and had the perception that cultured fish in general are produced with genetically modified feed or that chemicals like growth hormones, pesticides were used on farms.

The coefficient on "medium size" is negative but the coefficient on "large size" has a positive coefficient and is strongly significant, suggesting a preference for large size tilapia. The preferences of consumers for large size tilapia could be because large fish is relatively more fleshy and easy to fillet. Others consider big size as big enough for the entire household to share. Some consumers believe large fish are more attractive and tastier, healthier, and less bony compared to the medium and small ones.

Kenyan consumers have a strong preference for fresh tilapia. Kenyans are traditionally used to the consumption of fresh tilapia, and fresh fish in general, because of the frequent supply of fresh fish from especially Lake Victoria to open markets. Fresh tilapia sellers in Kenya usually offer to dress (remove scales and fins) their products for consumers at the points of sale in order to reduce the difficulty and time commitment involved in preparing fresh tilapia. These, among other things, are probably why Kenyan consumers strongly prefer fresh tilapia. "Fried" and "smoked" forms are statistically significant, but opposite in sign. This shows that consumers in Kenyan prefer fried tilapia but not smoked tilapia. Fried tilapia is highly preferred in Kenya probably because it is not only a delicacy, but it is also the main form of tilapia consumed with *ugali (made from maize)*, a local dish widely consumed throughout Kenya.

Table 3 also reports the standard deviations of the coefficients of the various farmed tilapia attributes. A statistically significant standard deviation of a coefficient indicates that the coefficient varies in the population, i.e. there is preference heterogeneity for that attribute. The results suggest that Kenyan consumers are heterogeneous in their preferences for farmed tilapia regarding the attributes of being farmed, medium size and fried.

OBJECTIVES 3 AND 4

Methodology

The primary focus of this study was female participation in the fish channel structure and economic and technical performance, which will be evaluated using value chain analysis (VCA) and cost-benefit analysis (CBA). The data and information used was collected from published literature, personal interviews with industry stakeholders and focus group discussions. Different questionnaires were used for the interviews of the different actors in the chain. The interviews determined industry stakeholders' perceptions of the current state and future outlook of increased female participation; and the focus group discussions provided a basis for the analysis for qualitative data (Humphrey, 2005).

The three survey areas visited were the Central region- Nairobi, Western region- Kisumu and the Rift Valley- Eldoret. Personal interviews were conducted for all respondents. Respondents included 6 input suppliers, 10 input supplier/fish farmers, 75 female fish farmers and 98 fish marketers.

The study used an integrated and interdisciplinary conceptual framework and scientific methodology in attempt to fully understand the intricate linkages between chain structure, performance and value added distribution and thereby determined optimal institutional arrangements of the different proposed models of female participation (Epstein, 1992; Taylor & Bogdan, 1998). VCA was used to map the different chains in terms of cost distribution (value addition), supply chain efficiency and income redistribution. The case studies and interviews with key aquaculture industry stakeholders determine the overall structure (technical and economic and performance of the various value chains. The study performed a CBA to assess financial efficiency and equity in order to determine profitability. However, due to data limitations, the CBA was only conducted on the fish farmers and fish marketers (wholesalers, retailers and traders). This assisted in identifying key economically viable opportunities for increased female participation in the catfish and tilapia value chains in Kenya. The field data that was gathered from

June to July 2011 form the basis for the results reported here. Much more detailed quantitative analysis is ongoing.

A workshop was conducted from 24th through 26th November 2010 in Mumias, Kenya. Participants at the workshop included 4 fish farmers who have been growing and marketing fish for over 5 years in Western Kenya and 15 fish traders from the Lake Victoria region. During their introduction, women traders narrated cases where their income has reduced over the years and that they were afraid there would be no fish to sell from Lake Victoria hence their need to find alternative livelihood. They mentioned aquaculture and expressed desire to begin farming fish as well as trading in farmed fish. All the four fish farmers talked of how successful they have been since they began to farm fish. They challenged women traders to venture into fish farming and that with time they would find farming fish has a better income that trading in capture fisheries.

Findings

The linkages between chain actors in the fish value chain structure in Kenya are examined. A flow chart of the relevant aspects of fish value chain is given in figure 1. The major actors included input suppliers, fish farmers, fish farmers/input suppliers and fish marketers. Input suppliers supplied farm inputs, greenhouse construction equipment suppliers and harvest equipment suppliers; fish farmers are mainly grow-out farmers; fish farmers/input suppliers sold fingerlings and fry and thereby acted as hatcheries in addition to producing fish for the food market; fish marketers, which included wholesalers, traders/processors. A SWOT analyses was conducted on all supply chain actors (Tables 4 - 6).

The key survey findings were

- Most fish farmers are small scale and/or only just starting and did not have previous harvest information or financial information and sell directly to consumers at the farm-gate. Most of the information gathered on fish marketing is based on wild caught fish but provided insights on farmed fish.
- Nairobi had the most diversity in terms of fish products- fresh, fried, dried, smoked, etc. Eldoret markets had mostly processed fish products.
- Markets in the Kisumu region had the most fish farmers and the best fish market in terms of facilities.
- The input suppliers for construction and harvest equipment were not exclusively aquaculture suppliers and only supplied these inputs because they were inputs that had other functions. This includes the recently established aquashops.
- Women form the majority of fish marketers and labor suppliers, and their numbers are increasing as farmers.
- The government Economic Stimulus Program (ESP) is the major program that has attributed to the increase in the number of ponds constructed
- There are 6 government accredited aquaculture equipment suppliers and 6 recently established aquashops.
- The main opportunities for women are as fish farmers which can also act as a hatchery and provide fingerlings and fry for additional income.
- Although access to larger markets is recommended in the long run, at their current small scale, sale to neighbors and the local community is advisable as it eliminates transport costs and the transaction costs of marketing.
- Additional women could also increase their welfare by entering the chain as fish marketers but this is not yet viable for farmed fish as they are not yet entering the formal markets

The main problems were

- Although the government ESP was a success, only 22 of the 75 fish farmers interviewed had as yet harvested.
- The microfinance providers were unwilling to be interviewed due to protocol, i.e. they are large corporations and permission was needed from head office. Others cited intellectual property rights for refusing to be interviewed.
- A few supply chain actors also expressed an unwillingness to provide financial data as they felt this was proprietary information. This makes it difficult to perform the benefit-cost and NPV analysis for these actors.

Participants at the workshop identified a wide range of constraints which limited the ability as women to engage in aquaculture value chain. These constraints were encountered in the different provinces and districts. The following were mentioned as constraints:

- Lack of training on business and management skills
- Lack of information on market demand, prices etc.
- Lack of saving and credit facilities including small and medium enterprise facilities
- Lack of a central marketing organization on the beach to bargain for better prices.

Cost-Benefit Analysis (CBA)

Ideally, CBA should be conducted for all the chain actors but many female were unwilling to share financial information, though some costs and revenues were calculated for some actors. A simple cost-benefit ratio that divides profit levels by the associated costs from each business type provides an indication of profitability. A cost-benefit ratio is therefore a profitability index. A ratio above one indicates that the business type is profitable while a ratio below one means that it is not. However, a detailed CBA would also include valuing benefits which are not directly expressed in monetary terms. For this report however, a simple cost-benefit ratio is calculated for selected fish farmers and fish marketers who shared information on actual costs and revenues. A more detailed CBA of all actors is ongoing.

Data used for the benefit-cost analysis for fish marketers excluded questionnaires completed by employees as they had insufficient knowledge of all the business costs and revenues. Data from commission sales agents was also excluded as these had no cost for fish stocks and could not verify their actual weekly turnover. The calculated cost-benefit ratios show that only 29 of the 86 respondents had a ratio higher than 1. Of these 29, 20 were females operators; 5 had been fish marketers 5 years or less (the average years of experience were 16 years); 2 had other income sources; and all 29 marketers obtained some of their fish from Lake Victoria. Only 5 obtained a small amount of fish from fish farms and 1 obtained fish exclusively from Lake Turkana.

Eighteen respondents with a benefit-cost ratio higher than 1 were from Nairobi (6 from City Market and 12 from Gikomba market), 7 from Kisumu and 4 from Eldoret. All 29 traded in tilapia, 21 also traded in Nile Perch and 14 traded in catfish. Eighteen performed only one business function (wholesale, retail, process) and 11 performed more than one function. Ongoing analysis will investigate whether location, gender, selection of single or multi- business functions, choice of fish to trade and choice of the source affect the ratios / profitability index. The exclusion of the commission based traders also raises the question of whether these excluded traders have a better benefit cost ratio. Further analysis will determine these issues.

Data used for the benefit-cost analysis for fish farmers came from 22 of the 75 fish farmers interviewed because they had harvested fish and kept records. Record keeping is still a challenge for many fish farmers. The overall benefit-cost ratio for the 22 dataset is 2.65 which is significantly higher than one and

indicates that fish farming is indeed profitable. There were a few large operations included in the dataset and could have skewed the profitability index up. On individual basis, only 5 of the sample of 22 had benefit-cost ratios above 1. The others provided revenues for their first harvest so they still had large sunk costs, such as construction costs. It should be noted that although the cost-benefit ratio is based on factors value in monetary terms, a ratio below 1 but close to 1 do not necessarily suggest that the venture is not viable. There are other indirect societal benefits identified that would improve economic welfare. These include improved finances, improved food security, ready protein source, and enhanced community relations resulting from farm gate sales and employment opportunities for the community.

Conclusions

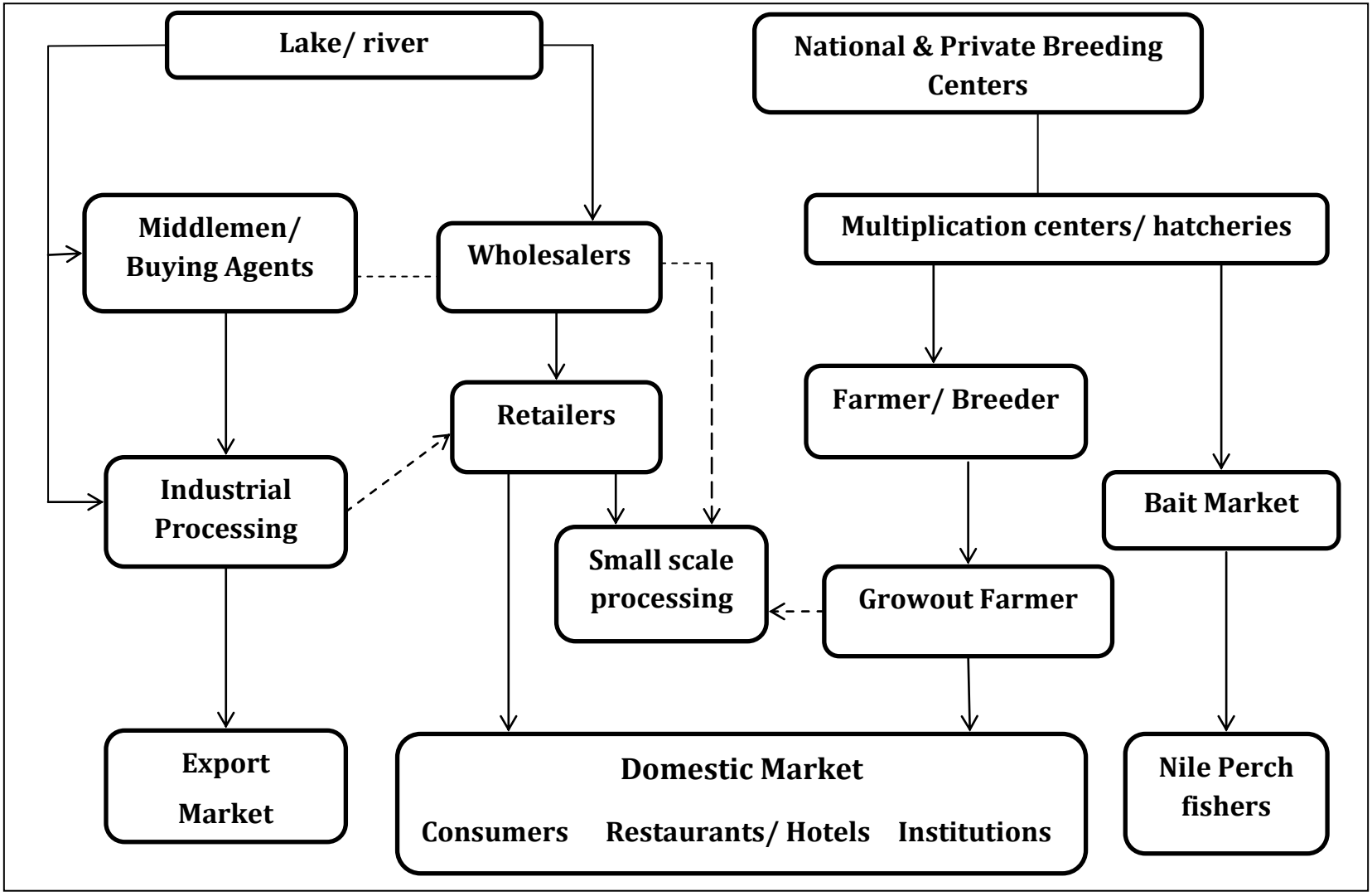
The initial findings have yielded some interesting results and more analysis is ongoing to account for indirect benefits. The high initial costs of fish farming in terms of land, training and construction needs to be addressed, despite government assistance through the ESP. This acts as one of the major constraints to increased female participation in the fish production stage.. The SWOT analysis of all supply chain actors indicates a need for more information sharing. The high ratios for Nairobi fish marketers suggest that close proximity to urban markets could improve farm revenues.

OBJECTIVE 5

The Fish Marketing Information System (FFMIS) was planned to tap into the existing Enhanced Fish Marketing Information System (EFMIS) operated by the Kenya Marine and Fisheries Research Institute (KMFRI). This EFMIS is a joint effort by KMFRI and the International Labour Organization (ILO). Initial cost estimates from KMFRI to develop a database for farmed fish as part of EFMIS was $100,000, which was unaffordable under this project's budget. Therefore, we piloted EFMIS with a select group of fish farmers. Fish farmers who were trained to query the EFMIS database to enable them become familiar with how the system works. The workshop was held at KMFRI offices in Kisumu where EFMIS is hosted and managed.

EFMIS was designed for providing market information to major landing beaches and has been expanded to cover over 140 landing beaches and urban markets. EFMIS releases market information principally on demand by text messages through a short code 5565. The system also disseminates synthesized market information through various media, including radio and the internet. The variables required for the system include fish quantities and prices at landing sites and inland markets, which is kept as a large database of market information, and updated on a daily basis. We have leveraged with the Fisheries extension network to set up similar structures that is capable of collecting daily data for farmed fish. With enough funding, it can be incorporated into EFMIS.

Figure 1: Flow Chart for Tilapia and African Catfish Products in Kenya



Adapted from Quagrainie, et al (2007), Charo-Karisa, et al (2007) and from survey findings

Table 1: Distribution and Descriptive Statistics of Respondents [a]

Variable		Mean	Std Dev
Gender			
	Female (1 = Yes)	0.542 (54.17%)	0.498
	Male (1 = Yes)	0.458 (45.83%)	0.498
Age (Years)		33.108	9.529
Married (1 = Yes)		0.725 (72.54%)	0.446
Household Size		3.826	2.247
Residential Status			
	Urban resident (1= Yes)	0.623 (62.34%)	0.485
	Sub-urban resident (1 = Yes)	0.377 (37.66%)	0.485
Highest Level of Education			
	Primary Education (1 = Yes)	0.260 (25.97%)	0.439
	Secondary Education (1 = Yes)	0.584 (58.434%)	0.493
	Tertiary Education (1 = Yes)	0.126 (12.62%)	0.332
	Post Graduate Education (1 = Yes)	0.030 (2.97%)	0.170
Monthly Household income ($)		342.209	185.504
Monthly Household Food Expenditure ($)		114.077	51.133

[a] Values in parenthesis are percentage of respondents.

Table 2: Results of the Ordered Logit Models [a]

	Tilapia Model	**Catfish Model**
Constant	-1.573 (1.134)	-7.581*** (2.161)
Female	-0.265 (0.427)	-0.845*** (0.060)
Married	0.040 (0.296)	0.005 (0.322)
Age	-0.004 (0.006)	0.007** (0.003)
Family size	0.065 (0.097)	0.0334 (0.042)
Urban residence	0.538*** (0.011)	-0.071 (0.138)
Household income	0.0005 (0.001)	-0.0002 (0.0002)
Secondary education	-0.069 (0.132)	-0.003 (0.219)
Tertiary education	0.657 (0.601)	1.262*** (0.309)
Post graduate education	-0.358 (1.037)	1.476*** (0.121)
Price of tilapia	-0.094 (0.119)	0.061 (0.091)
Price of catfish	0.063*** (0.019)	-0.237*** (0.086)
Taste	0.265 (0.230)	1.782*** (0.506)
Color	0.484*** (0.015)	0.766*** (0.184)
Smell	0.424*** (0.008)	1.007*** (0.011)
Nutritional value	0.272** (0.133)	0.100 (0.771)
Social status	0.308*** (0.083)	1.489*** (0.233)
Log likelihood function	-374.889	-262.903
Chi-squared	52.980***	318.867***
Pseudo R-squared	0.066	0.378

[a] Values in parenthesis are standard errors.
'***', '**', and '*', indicate statistical significance at 1%, 5%, and 10% respectively.

Table 3: Estimates of Random Parameters Logit Model [a]

Attribute	Coefficient	Standard Deviation of Coefficient
Price	-0.401***	
	(0.069)	
Farmed	-0.809***	1.273***
	(0.129)	(0.319)
Medium	-0.255***	0.863**
	(0.086)	(0.439)
Large	0.571***	0.240
	(0.118)	(1.115)
Fresh	2.934***	0.028
	(0.462)	(0.516)
Fried	1.183***	3.303***
	(0.206)	(0.701)
Smoked	-1.420***	0.118
	(0.222)	(0.363)
Log Likelihood Fn.	-3359.92	
Chi-squared stat	2754.59***	
McFadden R^2	29.07%	
N	4312 = (539x8)	

[a] Values in parenthesis are standard errors.
'***', '**', and '*', indicate statistical significance at 1%, 5%, and 10% respectively.

Table 4: SWOT Analysis of Fish Farming

Strengths	**Weaknesses**
1. Improved food security- ready protein source **2. Source of water used for irrigation & livestock** **3. Pond bottom mud used to fertilize gardens/fields** **4. Source of water for household use** **5. less labor intensive than other agriculture** **6. Enhanced community relations- farm gate sales** **7. Improved finances after harvest**	**1. High initial cost for training, pond construction & inputs** **2. Expensive to construction and operation costs** **3. Require expert evaluation of location/site/water** **4. Require training on fish rearing and pond management** **5. Need expert for choice of fish species and appropriate culture** **6. Require continuous access to expert for problem diagnosis & solutions** **7. Supply of operating inputs** **8. High labor demand for construction and harvesting** **9. Scarce marketing information/access** **10. Access to inputs for operating culture unit** **11. Access to means of acquiring technical know-how**
Opportunities	**Threats**
1. Successful 2008 ESP government pond initiative **2. Increased local government financial support** **3. Ready market due to government undersize fish ban** **4. Branching into input supply &/or value addition** **5. Change source of inputs-purchase, rent, or hire** **6. Can diversify into ornamental or bait fish**	**1. Access to capital** **2. Seasonal patronage** **3. Distance from farm to market** **4. Low land availability** **5. Need close proximity to water** **6. High labor costs** **7. Poaching** **8. Unauthorized harvesting** **9. Shortage of fingerling/fry to stock ponds** **10. Lack of trained extension officers**

Table 5: SWOT Analysis of Input Suppliers

Strengths	**Weaknesses**
1. Low price **2. Convenient bulk sales** **3. One stop shop** **4. Only available option** **5. Quality** **6. Modern techniques** **7. After sale services/free consultation** **8. Sex reversal and genetic selection** **9. Training & Consultation on aquaculture** **10. Great service-personal touch** **11. Good marketing-flyers & demonstrations** **12. Liaisons with government -DOF referrals** **13. Connects supply chain actors** **14. Maintain specialization-cutting edge tech**	**1. Temperature control** **2. Expensive transportation** **3. Customer defaults on payment**
Opportunities	**Threats**
1. Only 6 government accredited aquaculture input suppliers **2. Well defined market with access to capital** **3. High entrepreneurial spirit** **4. More fish farmers- more customers** **5. Successful 2008 ESP government pond initiative** **6. Increased local government financial support** **7. Older fish farmers-retired from services** **8. Referrals from government for tech assistance** **9. Newcomer fish farmers in 30-50 age group** **10. More female fish famers-encouragement**	**1. More crime- higher incidence of con men, thefts and burglaries** **2. Strong US$ makes import expensive** **3. US$ fluctuations** **4. Increase in gas prices** **5. Customs and port delays** **6. Transport delays** **7. High nylon price-poor synthetic fiber** **8. Slow delivery of liners**

Table 6: SWOT Analysis for Fish Marketers

Strengths	**Weaknesses**
1. Can partake in wholesaling, trading and processing concurrently **2. Low start up and operating costs** **3. Convenient bulk sales delivered to market** **4. Can process (dry, smoke or fry) leftover fish** **5. No construction or training required** **6. Can assess quality and only sell good quality** **7. Low switching costs in terms of products of location** **8. Flexibility in terms of products sold** **9. Flexible working hours** **10. Can provide credit**	**1. Fish perishability-leftover & due to transport delays** **2. High volatility in demand** **3. Crime & Theft by middlemen & employees** **4. Access to capital/finance** **5. Transportation for fish supply, to market** **6. No ice or electricity** **7. Low profits-high buying and low selling prices** **8. Expensive storage and refrigeration costs** **9. Water shortage-increased costs** **10. Storage problems** **11. Poor shelter- rains in** **12. Poor facilities including poor drainage**
Opportunities	**Threats**
1. More Income- Nairobi markets **2. More female traders** **3. More youth economic participation in market** **4. More Consumers especially in City Market (Nairobi)** **5. More female consumers** **6. Better market conditions from government** **7. Consolidation into one market facility** **8. Constituency Development Fund made sheds** **9. Improved sanitation (slight) including drainage** **10. New farmed fish market**	**1. Less/no government assistance resulting in less customers due to filth** **2. Poor roads-delayed delivery & accidents and having to no longer export to Tanzania** **3. Fish shortage especially due to undersize fish policy and underdeveloped aquaculture sector** **4. High cost of living-high inflation and income fluctuations** **5. Poor economy, e.g. less income-less customers-low sales** **6. Reduced Income- Western and Rift Valley regions** **7. More crime & corruption- thefts and cheating customers and bribe requests by city councilmen** **8. Supply fluctuations-Jun/Jul fish shortage crisis & Jan-Mar oversupply** **9. Rainy season-fish doesn't dry well-bad business** **10. Increased competition even from other markets** **11. Poor hygiene in the market & transportation** **12. High government taxes reduce profits** **13. Low facility security**

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