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Fish-farming Value Chain Analysis: Policy Implications for Transformations and Robust Growth in Tanzania

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Abstract

This article sets out data and issues in relation to fish-farming in Tanzania with the objective of generating information to inform policy decisions required for the transformations in the fish-farming into a viable commercial activity. It identifies challenges within the sector that should be addressed through policy reform. Fish farming in Tanzania is governed by the Fishery Act 2003 No. 22 and the National Fisheries Sector Policy of 1997. The guiding research problem statement was despite the National policy objective to develop a robust, competitive and efficient fishery sub-sector, fish farming in Tanzania is underdeveloped at subsistence production that contributes to only 1.2% of GDP.

A survey design was used for collecting primary data from 293 respondents randomly sampled from 8 regions of Dar Es Salaam, Coastal, Morogoro, Njombe, Mbeya, Ruvuma, Kagera and Kilimanjaro. This data was collected using questionnaire and interviews. These were triangulated with secondary data obtained from desk top review. Descriptive statistics and content analysis method were used to report findings. The study found that the major constraints were lack of value chain in the fish farming.

We examined the value chain in terms of sources of production, inputs, extension services, technology, and marketing and found that 60% of fish farmers obtain fingerlings from local sources such as friendship network. These sources have no scientific production of fingerlings suitable for commercial fish-farming. In the overall, farmers don't have good and reliable sources for fingerlings. It was also found that 76% of fish farmers make their own feeds using the locally obtained materials like maize and paddy husks, remains of vegetables from garden, cocoyam leaves, and cattle dung. However, it was found that the home made feeds lack quality due to inadequate basic knowledge of producing right fish feeds

Lack of appropriate technology application in the fish-farming was a critical constraint that minimizes the chance of transforming the sub-sector into a commercial entity. Technology in fish farming industry include proper pond size, species, sex selection fingerlings, improved fish feeds, hatchery and storage facilities. Furthermore, the study found high demand for extension services in the

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fish-farming agribusiness, but there is insufficient or non-availability of the extension services, to impart knowledge, proper use of medicines, fish farm management practices and appropriate technology application.

For the fish-farming sub-sector to grow from the current 1.2% to the targeted 5% contribution to GDP, it is recommended that policy actions should be undertaken for providing capacity building for small farmers in terms of skills for best practice of fish-farming, credit and or subsidy facility for fish farming infrastructure and inputs, extension services for knowledge and technology transfer to small farmers and encouraging public-private partnership along fish-farming value chain for ensuring availability of quality fingerlings, fish feeds, transportation, and marketing.

Keywords: fish farming, small farmers, constraints, latent potential, policy implications making.

1.0 Introduction

Tanzania has the greatest fish farming potential in Africa with suitable land and water sources. Food and Agriculture Organization (FAO) estimates that Tanzania has a total of 14,100 freshwater fish ponds (FAO, 2013), however it is not yet tapped. According to the FAO (2013) there is viability of expanding fish farming through diversifying production and developing the export market in the Tanzanian rural economy, however this is largely untapped. This is also noted by Chenyambuga, Madalla. and Mnembuka, (2012), who argue that aquaculture in Tanzania is still a subsistence activity practiced by small-scale farmers who have low social, cultural and economic status and are limited by access to technology, markets and capital. They observed that aquaculture is dominated by freshwater fish farming in which small-scale farmers usually hold small fish ponds of an average size of 10 m x 15 m (150 m2). These are integrated with other agricultural activities such as gardening, crop production, livestock keeping and poultry on small pieces of land.

Fish farming, as identified in the Tanzania Five Year Development Plan (United Republic of Tanzania, 2012), has the potential for transformation to commercial orientation that can be a very profitable activity and wealth generating activity for poverty reduction (Wijkstrom and MacPherson, 1990), but the fish farming sub-sector is constrained by multiple factors. The objective of this paper is therefore to identify the challenges and constraints of fish farming which affect the latent potential for growth in Tanzania.

Fish farming as an approach to economic transformation and poverty reduction must involve addressing the major constraints faced by fish-farmers, processors, traders and other related actors in the value chain. This inevitably includes a wide range of activities such as ensuring access to the full range of necessary resources, inputs and technology. The identified challenges should be addressed through policy reform such as facilitating access to cheaper but better inputs, strengthening the delivery of financial services, enabling flow of market information and market access. The incentive of fish farmers to produce is when consumers are linked to the needs of fish farmers, processors, traders, and transporters. This is likely to happen when the policy environment enables the public-private partnership to operate in the fish farming sub-sector.

2.0 Problem Statement

Fish farming is among the described latent growth potentials in the Tanzania Five Year Development Plan. Guided by the Fishery Act 2003 No. 22 and the National Fisheries Sector Policy of 1997 with the associated regulations that aim at transformation of the fisheries sub-sector into sustainable commercial fishing, fish-pond farming, and processing for both domestic and foreign markets (URT, 1997); the policy objective is to develop a robust, competitive and efficient fisheries sub-sector that contributes to food and nutrition security, growth of the national economy and improvement of the well-being of fish farmers. Despite the policy objective, the fish farming (aquaculture) sub-sector is underdeveloped at subsistence production that contributes to only 1.2 of GDP (URT, 2012).

3.0 Research Questions

- What are the major constraints of fish-farming transformations in Tanzania?
- What is the incentive for scaling up fish farming transformations in Tanzania?
- How can fish-farmers increase efficiency?
- What are the necessary conditions for fish-farming transformations?

4.0 Previous Literature

There is a paucity of empirical and academic literature on fish-farming in Tanzania. However, the available studies in Africa and some countries in East Africa indicate fish farming has the untapped potential for economic growth and rural poverty alleviation. Maurice, Knútsson, and Gestsson,(2010) conducted a study in Uganda on the value chain of farmed African catfish and Kariuki (2013) studied fish farming implementation in Kenya. The study discusses the existing catfish farming industry and its value chains. The study responds to questions on the industry structure, value chains, value distribution and how relationships among actors have an influence on profitability. The study suggests value creation as a means for improving profitability in catfish farming.

Fish farming potential is limited by constraints. Ike and Onuegbu, (2007) attempted to improve the aquaculture technology package for Nigerian farmers. The results of intervention showed that the level of adoption of the technology was low. Farmers found it difficult to adopt the developed technology because they did not have adequate funds to maintain the technology.

Though not much literature is known about fish farming in Tanzania, the viability of implementing fish farming in Tanzania is similarly constrained. Chenyambuga et al. (2012) argues that aquaculture in Tanzania is still a subsistence activity practiced by small-scale farmers who have low social, cultural and economic status and limited access to technology, markets and credit. Despite the paucity of literature, the cross-examined, empirical evidence shows fish farming as a potential enterprise for economic growth and poverty eradication for the poor. However, the sub-sector is constrained by multiple factors that require policy interventions.

5.0 Methodology

A survey design was used for collecting primary data from 293 respondents randomly sampled in Dar Es Salaam, Coastal, Morogoro, Njombe, Mbeya, Ruvuma, Kagera and Kilimanjaro regions in 2013 regarding the socio-economic profiles, constraints, and technologies. In addition, interviews and focus group discussions (FGDs) were used to triangulate the information obtained on the mentioned constraints. A desk top review was conducted for secondary data on fish-farming, necessary skills, knowledge and technology as well as policy and institutional contexts including; research reports from Tanzania Fisheries Research Institute and Ministry of Livestock and Fisheries Development.

Data analysis was computed using the Statistical Package for Social Sciences version 17 (SPSS) for descriptive analysis to obtain frequencies, means, standard deviations, minimum and maximum values of individual variables in view of the described constraints and opportunities faced by pond fishing stakeholders and the Stochastic Frontier Version 4.1 computer software for estimating productivity of fish farmers by estimating mean efficiency.

The stochastic frontier model was used to compute productivity of fish farmers by estimating mean efficiency. The stochastic frontier model is derived from production function. It was first proposed by Aigner, (1977) and Meeusen and Van den Broeck (1977). The original specification involved a production function specified for cross-sectional data which had an error term which had two components, one for random effect and another for technical inefficiency. The production frontier model without random component can be written as:

$$y_i = f(x_i; \beta).TE$$

whereby:

- y_i is the observed scalar output of the producer i, $i=1,..I$,
- x_i is a vector of N inputs used by the producer i, $f(x_i, \beta)$ is the production frontier,
- β is a vector of technology parameters to be estimated TE_i denotes the technical efficiency defined as the ratio of observed output to maximum feasible output. $TE_i = 1$ shows that the *i-th* firm obtains the maximum feasible output, while $TE_i < 1$ provides a measure of the shortfall of the observed output from maximum feasible output.

A stochastic component that describes random shocks affecting the production process was added. These shocks are not directly attributable to the producer or the underlying technology. These shocks may come from weather changes, economic adversities or plain luck. We denote these effects with $exp\{v_i\}$. Each producer is facing a different shock, but we assume the shocks are random and they are described by a common distribution. The stochastic production frontier will become:

$$y_i = f(x_i; \beta).TE.\exp\{v_i\}$$

We also make assumption that TE_i is also a stochastic variable, with a specific distribution function, common to all producers. We can also write it as an exponential; $TE_i=exp\{-u_i\}$, where $u_i \geq 0$, since we required $TE_i \leq 1$. Thus, we obtain the following equation

$$y_i = f(x_i; \beta).\exp\{-u_i\}.\exp\{v_i\}$$

Assuming that *f* (x_i, β) takes the log-linear translog production function form, the model can be written as:

$$y_i = \beta_0 + \sum \beta_n lnx_{ni} + \sum \beta_n \, lnx_{nij} + v_i - u_i$$

Data from interviews were analyzed through content analysis and summarized broad categories. These were triangulated with the descriptive statistics.

6.0 Results and Discussion

6.1 Socio-Economic Profile of Fish-Farmers

In order to provide a better description of fish-farming in Tanzania, the characterizing fish-farming communities and the applied technologies aimed at describing individual socio-economic characteristics from 293 fish farmers in the sampled regions. It also aimed at obtaining information on species, and sex of farmed fish as well as types of feeds, size and number of ponds. The distribution of the study respondents by region was 49, 59 and 60 for Kagera, Kilimanjaro and Morogoro regions respectively. Other respondents were from Ruvuma, Njombe and Mbeya regions composed of 34, 32 and 59 respondents respectively.

The study results show that the fish-farming sub-sector is dominated by males who formed 82 % of the randomly selected respondents. Chenyambuga et al (2011) also observed that in Morogoro region, very few women owned fish ponds and most of them were widowed, divorced or unmarried. This shows fish-farming is dominated by men due to the fact that local customs and cultural practices in many farming systems in Tanzania discriminate against women in the ownership of assets including land. However, the trading of fried fish is predominantly a women's business.

Nevertheless, Table 1 shows that Mbeya and Njombe regions have higher proportions of female fish farmers, respectively, of 25.4% and 21.9%.

According to the information provided in the Table 1, age, experience and education variables do not vary with variation of regions. It shows that more than 70% of respondents had attained primary education and very few of them (0.7%) were university graduates. Furthermore, cross tabulation shows that respondents engaged in fish farming who had attained a higher degree were aged above fifty years.

From the question that asked farmers to indicate their experience, the results showed that the majority of fish farmers had a farming experience of one to five years (74%). However, the fish farming experience among respondents ranged from one year (20%) to 35 years (0.3%), meaning that fish-farming is a relatively underdeveloped or not common farm activity. This experience has potential for growth of fish-farming because the most (69%) of interviewed fish farmers were within the range of active age from 18 to 50 years (Figure 3). This finding agrees with the finding by Chenyambuga et al (2011) who reported that the majority of fish farmers belong in an active working group of age between 25 to 50 years. This was an interesting observation because many youth shy away from crop farming activities, but fish-farming has attracted their interests because this type of farming is less labour intensive.

The results of the study indicate that fish-farming in Tanzania is constrained by lack of inputs, supply, technologies, capacity of fish-farmers, policy related issues and the fish value chain.

Table 1: *Social Economic Characteristics of Fish Farmers Regional Wise (n = 293)*

Variable		Kagera (n= 49)	KLM (n= 59)	Mbeya (n= 59)	Morogoro (n= 60)	Njombe (n= 32)	Ruvuma (n= 34)	**Total**
Age	18 to 50	35(71.4)	33(55.9)	40(67.8)	45(75)	26(81.2)	24(70.6)	203(69.3)
	51+	14(28.6)	26(44.1)	19(32.2)	15(25)	6(18.8)	10(29.4)	90(30.7)
Education	Degree				1(1.7)		1(2.9)	2(0.7)
	Diploma	2(4.1)	2(3.4)	-	2(3.3)	1(3.1)	1(2.9)	8(2.7)
	A level	3(6.1)	1(1.7)	1(1.7)	-	1(3.1)	1(2.9)	7(2.4)
	O level	19(38.8)	18(30.5)	8(13.6)	11(18.3)	3(9.4)	6(17.6)	65(22)
	Certificate	1(2.0)						3(1.0)
	Primary	24(49)	38(64.4)	49(83)	44(73.3)	26(81.2)	23(67.6)	204(69.6)
	Informal			1(1.7)	1(1.7)		2(5.9)	4(1.4)
Experience	<= 5 yrs	38(77.6)	44(74.6)	45(76.3)	40(66.7)	23(71.9)	27(79.4)	217(74.1)
	5 years	11(22.4)	15(25.4)	14(23.7)	20(33.3)	09(28.1)	07(20.6)	076(25.9)
Sex	Male	45(91.8)	44(74.6)	56(94.9)	47(78.3)	25(75.1)	27(79.4)	241(82.3)
	Female	4(8.2)	15(25.4)	03(5.1)	13(21.7)	07(21.9)	07(20.6)	052(17.7)

Source: Authors' analysis. Note: Figures in brackets are expressed in percent.

6.2 Factors Hindering Fish-farming Value Chain—Empirical Evidence

Some of the constraints affecting the farmed fish value chain as identified by different researchers are classified into three groups; input, production and post-harvest and marketing factors (MacFadyen et al., 2011). Critical input factors include non-availability of quality fish feeds; poor quality of fish breeding; poor water quality of water; feeds; and technology. Limited best management practice for growing tilapia; farm layout and design; about feed use and fish health management. In addition,poor post-harvest of fish, sanitary and phytosanitory are other critical factors for unleashing the potential of fish-farming in Tanzania.

6.3 Fish-farming value Chain Analysis

The concept of value chain as first described by Porter (1985) is a process from producers to final consumers of products or services. He defined value as the amount buyers are willing to pay for what a firm provides, and he conceived the "value chain" as the combination of nine generic value added activities operating within a firm – activities that work together to provide value to customers (Porter 1996). Porter (ibid) linked up the value chains between firms to form what he called a value system. However, in the present era of greater outsourcing and collaboration the linkage between multiple firms' value creating processes has more commonly become the so called value chain. As the name implies, the primary focus in value chain is on interdependent processes that generate value, and the resulting demand and funds flows that are created (Feller, Shunk, and Callarman, 2006).

Therefore the concept of value chain describes the full range of activities which are required to bring fish-farming product through the different phases of production to final consumers (Knorringa and Pegler, 2006). The concept of Value Chain Analysis (VCA) for policy analysis (Lorenzo, 2013) allows the examination of multiple dimensions in the VCA framework of fish-farming value chain in achieving specific policy objectives, such as poverty alleviation by applying different policy options and scenarios and their socio-economic impacts (Bellù and Pansini, 2009). The value chain analysis is therefore an important step to understanding the fish-farming sector in Tanzania. It helps to understand the nature of the activities involved, opportunities and constraints for development.

Fish-farming value chain starts at the inputs supplier including fingerlings to the fish market. However, we have taken the view that fish fingerlings represent a very important input to the farming operations along with other key inputs such as fish feed, labour, capital because it has impact on quality of fish. Therefore, hatchery or breeding sites for fingerlings, input suppliers, agrovets, and harvest equipment are all considered to be in the first stage of the fish farming value chain. They have the roles of providing inputs to the fish farmers for production (Macfadyen et al., 2011). Fish farmers are in the second stage of the value chain, their main role is to perform all the activities necessary for production of fish products.

The third stage in the value chain is the fish marketers who constitute the role of bringing products to consumers. This stage is comprised of wholesalers, retailers, traders and processors. The processors play the roles of freezing, cleaning, cutting into pieces, packaging and then selling the products. Both wholesalers and retailers have the role of selling products to final consumers; whereas, traders may export the product or sell to industries. This segment of the fish farming value chain is relatively undeveloped and limits the incentive of farmers to engage in the sub-sector.

6.4 Assessment of Fish-farming Technologies

In order to gain insight into the available and employed technology in fish farming, the study collected information on the type and source of fingerlings, fish feeds, water, tools, and labour force. In addition, information on rotation of pond water change, technology application, and schedules of fish harvesting were also gathered. As far as the use of improved farming equipment is concerned, the study found that a very small proportion of respondents were using water pumps (5%), weight balances (4%), and generators (3%). Other technologies such as fish nets and scooping nets were reported to be used by 17% and 1% of respondents respectively.

Furthermore, technology in the fish farming industry includes pond structure and size, species and sex of fingerlings, fish feeds, fishing gear, hatchery and storage facilities. The study inquired into the species, sex, and number of fingerlings. The majority of farmers (97%) were found to farm tilapia (*perege/ sato in Swahili*) and very few raised catfish (*Kambale in Swahili*). With respect to sex of farmed fishes, a significant proportion (21.8%) of respondents did not know the sex of fish they raised, while majority of them (76.5%) raise both male and female fish. Keeping both sexes increases reproduction, but creates high competition for space, air and food. According to extension services and best practice management, mono-sex fish-farming is more profitable as fish can be harvested at 1.5kg in 6 months. Mono-sex fish farming technology has been used for the purpose of increasing the productivity of fish farmers in many places. Some of the empirical reviews from different places suggest that the technology can increase productivity and reduce the problems of food security and poverty within the fish farmers' communities.

According to WorldFish *(2012)* an improved breed (mono-sex) of Nile Tilapia, which grows 30% faster than non-improved strains, is helping to increase aquaculture productivity and food security in Ghana. The Water Research Institute (WRI) in partnership with WorldFish, has developed Nile Tilapia (*Oreochromis niloticus*) that grows 30% faster than its wild ancestors. This could be translated into greater income for farmers as they can produce more fish per year and have both labour and cost savings. An increase in productivity also has an effect on food security and nutrition available. The above described technologies had limited application amongst the sampled farmers in Tanzania, This is a challenge that requires policy action for the sub-sector to make significant contributions to the desired socio-economic transformation in the country by the 2025 target of becoming a Middle Income Country.

The sampled respondents from Kilimanjaro region reported that their ponds had the average size of 200-400m^2, whereas more than half of respondents from Kagera, Njombe and Morogoro regions had fish ponds of less than 200-400m. According to the national fisheries extension services, the recommended pond size is 200m x 400m, sufficient for introducing 900 fingerlings in commercial fish farming. It was further observed that 86% of respondents were underutilizing the fish ponds by planting smaller number of fingerlings, whereas 33% of respondents were planting fingerlings which were more than the recommended number of fingerlings per pond size for commercial farming. This means there is low or inadequate knowledge on the best practices for fish-farming.

One of the best practices in fish-farming is the requirement for rotational change of water. A significant proportion of respondents (37%) reported that they do not change pond water; whereas, 82% of respondents were found not using any type of energy for pumping water. With respect to fish harvesting schedules and the weight of fish at harvest, the proportions of respondents who reported that the harvest was after exactly six months was the smallest (19%). More than half of respondents reported the weight of fish on harvest to be either below half a kilogram (37%) or unknown (26%). According to the Ministry of Fisheries, the recommended harvest schedule and fish weight for commercial fish farming takes 6 months and the harvest weight should be between 0.5 and 1kg. Therefore, this finding connotes that majority of respondents were at a subsistence level.

The study asked farmers their main motives for engaging in fish-farming. Four main reasons mentioned by farmers as their motives in order of importance include; fish as household staple food accompaniment (65.2%), source of income (24.6%), leisure activity (5.5%) and just induced by friends (4.8%). This has implications for the targeting of farm groups who can undertake fish-farming as a business for transforming their socio-economic status.

6.5 Skills and Knowledge Gap

Fish-farming requires basic as well as specialised training such as, pond management, feed production, fingerling selection and water management (Adinya, Offem, and Ikpi, 2011). The study asked farmers whether they received any relevant training and the type and source of training. It was interesting to note that the majority (82%) of respondents had some training in general fish farming; however only 12% had attended entrepreneurship courses. This is an area with limited knowledge that calls for capacity building as a fundamental intervention for transforming the sub-sector into commercial fish-farming.

6.6 Economic Opportunities Through the Fish-farming Value Chain

Value chain analysis (VCA) can be a tool for unleashing the potential economic opportunities for the fish-farming sub-sector economy. This is because VCA seeks to understand the nature of the activities involved, opportunities and constraints in relationships and their implications for development from inception to final consumption of the product or service. The description of the fish-farming value chain is comprised of input supply, processors, traders, and markets. The vertical participants within input suppliers include input suppliers of fish feeds (24.2%), input suppliers of medicine (2.5%), input suppliers of machinery (0.6%), extension officers who provide extension services (6.5%) and breeder of fish fingerlings (10.4%). Producers or fish farmers (80.1%) made up the second and the largest part of key players in the fish farming value chain. However, producers do not have vertical participants. Processors made up the third part of the value chain and consist of vertical participants within the node. These participants include processors dealing with packaging (0.6%), filleting (5.9%), smoking (1.4%), drying (0.8%), salting (0.6%), canning (0.8%) and freezing (0.8%). The last part of fish farming value chain consists of traders. Within traders there are vertical participants which include buyers on farm site (7.9%), retailers (22.2%) and whole sellers (2.3%).

The study results show that there are many fish farmers, but few processors, traders and input suppliers in the value chain. This implies that the fish farming value chain of Tanzania is weak, limiting the growth and transformation of fish-farming into a commercial activity. Learning from the respondents, most of fish farmers (60.4%) obtain fingerlings from each other. Only a few fish farmers obtain their fingerling from government (23.5%), and 11.9% obtain fingerlings from rivers. About 2.7% of the respondents obtain from private breeders. Overall, farmers don’t have good and reliable sources for fingerlings. This implies that there is weak supply but creates an opportunity for private sector to invest in fish hatchery. This shall require policy reforms for unleashing the potential of the sub-sector. In addition, there is a need for the government and agricultural research institutions to support the required transformations in the fish-farming sub-sector by enhancing the entire value chain.

Again, transformations in fish-farming require quality and reliable sources of feeds. The needs assessment found that 76% of fish farmers produce fish feeds themselves while only 17% obtain their feeds from fish local feed manufacturers who produce fish feeds using locally obtained materials like maize and paddy husks, remains of vegetables from garden, cocoyam leaves, and cattle dung. However, it was found that many of them don’t have basic knowledge of producing the right fish feeds. This implies firstly, that there is an opportunity for the private sector to invest in the production of fish feeds and the government to encourage and prepare. Secondly, there is a need also for the government and research institutions to support them by introducing capacity building programs for fish farmers to be able to produce required fish feeds as per required fish feed ratio.

Regarding markets, most (71.3%) of fish farmers sell their product to their neighbours while other fish farmers sell their fish products to the village market

(36.9%). Some traders (retailers and wholesalers) buy fish from the farming site (22.9%). Very few (3.1%) export their fish product. None of fish farmers respondents claim to sell his/her fish product to the fish processing industry. This implies that they have not utilized other markets like the export market, processing industries, supermarkets and regional markets. This may be contributed to by the poor quality of the produced fish and products and low capacity to meet the required market demand.

Findings from the study (Table 2) indicate that there is significant higher price margin between producers and traders of Nile tilapia and tilapia at the 1kg weight when brought to market. This indicates that there is an opportunity for traders and processors to maximize revenue through trading farmed fish with weight greater than 1kg.

Table 2: *Average Price between Producer and Traders*

Fish type	t	Sig. (2-tailed)	Average Producer Price (TZS)	Average Trader Price(TZS)	Mean Margin(TZS)	95% Confidence Interval of the Difference	
						Lower	Upper
Sato (>1Kg)	47.03	.000	2470.58	7670.73	5200.14	4980.5	5419.82
Perege (>1kg)	6.81	.000	2132.78	3462.19	1329.41	944.9	1713.90
Sato (>0.5Kg)	7.49	.000	1626.47	2563.41	936.94	688.7	1185.22
Perege (=< 0.5kg)	13.16	.000	423.97	1093.90	669.93	569.7	770.15
Perege (>0.5kg)	4.69	.000	1303.28	1943.90	640.62	372.3	908.95
Sato (=<0.5Kg)	6.20	.000	702.00	1052.68	350.68	238.4	462.97
Kambale(>0.5kg)	0.06	.951	2250.00	2287.31	37.32	-1170.7	1245.36
Kambale(>1kg)	-0.01	.993	3041.67	3036.58	-5.08	-1170.1	1159.90
Kambale(=<0.5kg)	-0.72	.473	1200.00	990.97	-209.02	-789.9	371.81

Source: Authors' analysis.

As evidenced in Table 2, the capacity of fish farmers to produce fish at optimum supply weight (>1kg) is limited. Therefore capacity building for fish-farming along with advocacy of fish farmers to produce at the required weight and supply could be a necessary action.

Unleashing the potential opportunities along the value chain of fish farming sub-sector is necessary measure for the efficiency of fish farmers in production. This is important because if the production process is not efficient first of all it is very difficult for other nodes within the chain to grow and it also shows that there is more room for production opportunities. Therefore this justifies the analysis of efficiency of fish farmers in this study. Analysis of production efficiency has been done in many empirical studies using translog production function estimation, we use stochastic frontier version 4.1 software to estimate technical efficiency.

The translog production function is a generalization of the Cobb–Douglas production function. The name translog stands for 'transcendental logarithmic. It is the function which is used to estimate the efficiency in the use of input in relation to the output obtained. Inputs such as ponds, fish feed, fingerlings planted and education were considered as independent variables; while the dependent variable was the number of fish caught for the last season.

The analysis shows that fish farmers were efficient by 43.8% which means that they are inefficient by 62.2%. This implies that, there is more room for increasing production through adding more inputs by increasing pond size in the area suitable for fish farming, planting appropriate fingerlings according to the pond size and supplying more appropriate fish feed. Also the comparisons of efficiency across regions show that the Ruvuma region has the highest (53.6%) mean efficiency followed by the Mbeya and the Morogoro regions respectively. Njombe region has the lowest (33.8%) mean efficiency.

In the overall, fish farmers in Tanzania are not efficient due to un-addressed constraints and this finding is supported by the available literature. The Board of External Trade (2003) reports that, "despite of the big aquaculture potential the fish harvests may continue to be low in Tanzania if the constraints facing fish farmers are not addressed properly". The constraints include; little information regarding aquaculture in the country and quality of data; ineffective extension services; lack of co-ordinated policies across sectors; farm management and accessibility to credit facilities. Interviews with extension officers showed that if the constraints are well addressed, a pond size of 200m x 400m is sufficient for 900 fingerlings in commercial fish farming. This could be translated into US$2,500 earning in six months when 1kg of farmed fish is sold at 5,000 Tanzania shillings; implying that the sub-sector has a potential of transforming smallholders income poverty.

7.0 Constraints Facing Fish-farming in Tanzania

The study objective was to identify constraints facing fish-farming in Tanzania. In other words, the study explored the question; *why the fish-farming subsector is underdeveloped in Tanzania?* The constraints facing fish-farming in Tanzania are many (Board of External Trade, 2003), however little research has been conducted in the academic literature focusing on Tanzania. Wetengere (2011) identified marketing constraints facing the sub-sector. The respondents identified lack of necessary inputs (88%), lack of bank loans (81%) and fishing education (62%). The relative critical challenges include lack of preservation cold rooms (45%), thieves and wild animals (44%) and extension services (43%). The overall observation is that there are multiple problems facing the fish-farming sub-sector that contributes to its underdevelopment in the country.

It was important to know how farmers address these challenges. Fish-farmers find coping strategies for the identified problems (Table 3). It was noted that farmers had some innovative ways for addressing the challenges. For example, to overcome the inadequate feed supply, about 90% of farmers make their own feeds which were found to be of low quality affecting fish growth and body weight. The recommended feeding is 8% of body weight for the first 2 months, followed by 5% of body weight for the next 2 months, and 3% of body weight for the last 2 months (Ministry of Livestock and Fisheries, 2013). Some farmers reduce the required amount for feeding to minimize costs that in the end affects the quality of the farmed fish. Table

3 summarizes the compounded constraints of fish farming in Tanzania and the coping strategies adopted by farmers.

Table 3: *Ways Used to Overcome Fish-farming Challenges (n=293)*

Strategy to overcome shortage of feeds	**Percentage**	**Confidence Interval (95%)**	
		Lower	Upper
Make own feeds	90.0	85.3	94.0
Purchase	5.3	2.0	8.7
Reduce required feeds	.7	.0	2.6
Substitute with garden vegetables	1.3	.7	2.7
Do nothing	2.7	.7	5.3
Strategy for medication			
Do not use	91.3	88.0	94.7
Unaware	7.3	4.0	10.7
Follows best practices	.7	.0	2.0
Strategy to overcome shortage of fingerlings			
From own pond	28.0	21.3	35.3
Purchase from others	15.3	10.0	20.7
Friendship hospitality	26.0	20.0	32.7
From local ponds/ rivers	30.0	22.7	37.3
Strategy to overcome shortage of extension services			
Learn from peers	12.7	8.0	18.6
From government and private extension services	20.7	15.3	26.0
Do not seek extension services	64.0	58.0	70.7
Self-learning	2.0	.0	5.9
Strategy to overcome loans			
No strategy	63.3	56.7	70.0
Personal savings	21.3	15.3	27.3
Never sourced	9.3	5.3	14.0
Sourced but failed access	5.3	2.0	8.7
Strategy for fish preservations			
Nothing	83.3	78.0	88.0
Sun drying	4.7	2.0	8.0
Cold containers	8.0	4.7	12.0
Smoking	1.3	.0	3.3
Freezer / fridge	1.3	.0	3.3

Source: Authors' analysis.

Obtaining quality fingerlings is another critical problem facing fish-farming in Tanzania. About 30% of the surveyed farmers obtain fingerlings from rivers or ponds and 28% farmers raise their own fingerlings. This situation has no quality assurance of the fingerlings.

Other constraints of fish-farming value chain are the lack of marketing and access to capital. Most fish-farmers sell their farm outputs to neighbourhood and local markets at the farm gates. This implies that the fish-farming is undertaken as subsistence activity. Farmers' access to credit facilities for developing fish-farming is another serious constraint as it was found that about 49% of the surveyed fish-farmers did not have any access to credit or loans; whereas 29% get finance for starting fish-farming from their own sources and social networks.

The analysis showed a multitude of constraints that explain why fish-farming is underdeveloped in Tanzania. Since there is government will for transforming fish-farming into sustainable commercial ventures, interventions such as policy framework to support the transformations are very much necessary for the development of the sub-sector in the country. The way forward for increasing the economic potential contribution of the sub-sector is to address the above constraints including increasing fingerlings production at the fingerling production centres of Kingolwira (Morogoro region) and Mbarali (Mbeya region). More fingerling production centres should be established in designated regions to reduce the distance covered in the fingerling distribution chains. Semi-intensive and intensive aquaculture should be encouraged in order to commercialize aquaculture fish production.

In addition, extension services for aquaculture farmers should be improved to enable farmers to improve farm management skills. The country has 7,974 extension officers which represents 53% of the demand (Kayandabila, 2013). Although the draft of National Aquaculture Research and Development Strategic Plan (2012) identifies similar constraints, the major challenge has remained in the weak implementation framework. The government's capacity to produce the required inputs at Kingolwira public institution has deteriorated. Fingerling production at the time of this research had stopped despite the demand for fingerlings still being high. This is an area where public-private partnership is required from the policy environment for unleashing potentials in fish-farming.

Extension services are epistemologically designed to "extend research based knowledge to rural sector" in order to improve farm productivity, technology transfer and farm management practices. The demand for extension services in the transformation of fish-farming as agribusiness is enormous. The evidence gathered from this study indicates insufficient or non-availability of the extension services, has tremendous effect on famers' knowledge, proper use of medicines, fish farm management practices and appropriate technology application. The National Fisheries Sector Development acknowledge that aquaculture extension services are required for information and experience sharing with farmers in order to increase sustainable fish production and productivity (URT, 2010). However, there are critical constraints in the delivery of extension services to fish farmers including; inadequate extension capacity, weak research-training-extension, and inadequate infrastructure and facilities. It is recommended that the policy framework must be able to put in place the required technology through a supportive extension services.

Another important policy option for increasing fish farming is establishing subsidy for fish-farming. The policy can be considered within the public-private partnerships by way of providing incentives for the private-sector to engage in the feed production and processing industries since fish farming is an important subsector that can increasingly contribute to food security and nutrition as well as create employment. This realization can be made operational by the policy of putting in place an investment plan for small, medium and large-scale commercial aquaculture. For example, the Kenyan Government has translated its policy into action by establishing and supporting programmes including the Fish Farming Enterprise Productivity Program with a purpose of stimulating economic opportunities in rural areas for employment creation, improving nutrition and and income opportunities.This has been done by increasing production of farmed fish from 4000 MT to over 20,000 mega tons in the medium term and over 100,000 mega tons in the long term by constructing 28,000 fish ponds in the country (Kariuki, 2013). Similarly, the Tanzania fish farming constraints could be addressed through a policy promoting incentives for investment in fish farming. The interventions require a practical policy agenda for the investment implementations in the responsible ministry and other stakeholders.

8.0 Conclusion and Policy Recommendations

This study examined the constraints that limit transformation of fish farming from subsistence to commercial farming in Tanzania. The sub sector is guided by the Fisheries Act, 2003, the National Fisheries Sector Policy, 1997 and the Fisheries Sector Development Programme, 2010. Despite of the existence of policy instruments, fish-farming hasn’t effectively been harnessed to the full potential for it to contribute to smallholder poverty alleviation.

The paper observed multiple constraints facing the fish farming sub-sector including insufficient inputs supply, technology application, lack of processing plants, trading and weak government policy support.. For the fish-farming subsector transformations from subsistence to commercial fish farming to happen in Tanzania, the following policy actions are recommended to be undertaken;

- Strengthen Public-Private Partnerships in the value chain for increasing smallholder access to quality fingerlings, feeds, medicines, processing, and markets.
- Providing capacity building programmes for small farmers focusing on knowledge and skills development for small and medium fish-farmers.
- Extension services be provided to accelerate technology adoption to small farmers. This is important at the moment because farmers are not able to access the necessary technologies such as raising mono-sex fish that have a potential of reducing labour and time costs while maximizing profit.
- Establish fish-farming subsidy programme for promoting pond construction and inputs.

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