ANALYSIS OF SOCIO-ECONOMIC AND ENVIRONMENTAL EFFECTS OF URBAN FISH FARMING IN DAR ES SALAAM, TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN ENVIRONMENTAL AND NATURAL RESOURCE ECONOMICS OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

This study was conducted to analyze socio-economic and environmental effects of urban fish farming in Dar es Salaam. Gross Margin was used to determine the profitability of urban fish farming. Results indicate that urban fish farming are operating profitably. The gross margin obtained by tilapia farmers ranges from TZS 658 000/= to 2 515 350/= per pond per production cycle. While gross margin obtained by African catfish farmers ranges from TZS 3 750 000/= to 9 590 000/=. Contribution of urban fish farming on household income was determined. Results indicated that urban fish farming had 7% contribution to total household income. Descriptive statistics were used to analyse the effect of urban fish farming on employment creation. The findings showed that 86.7% of urban fish farming household reported to use hired labour for their fish production. Effects of urban fish farming on household food security were determined. Results indicated that urban fish farming play an important role to the household food security because of its provision of high-quality food, generation of household incomes for buying other kind of foods and available food supply to markets. Effect of urban fish farming on environment was assessed and the findings showed that threats and stress of the ecosystem caused by violation of environmental rules and values together with land and water pollution resulting from lack of proper drainage system are the two major effect of urban fish farming on the environment. In conclusion, urban fish farming in general face a number of constraints that hinder the development of sustainable and profitable fish farming. This study has recommended that the constraints need to be addressed by involving government, researchers and private parties in establishing sustainable and profitable urban fish farming in Dar es Salaam.

DECLARATION

I, Anitha Kyelu, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

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Anitha Kyelu Date

(M.Sc. Candidate)

The above declaration is confirmed by:

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……..……

Dr. Lusambo L. P Date

(Supervisor)

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DEDICATION

I dedicate this work to my lovely husband (Mr. Mkani David Waziri) and my family for their sacrifice and encouragement during my academic study and all aspects of the research.

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BCR	Benefit Cost Ratio
CTA	Technical Centre for Agricultural and Rural Co-operation
FAO	Food and Agricultural Organisation
GDP	Gross Domestic Product
GM	Gross Margin
GMA	Gross Margin Analysis
HH	Household
IAA	Integrated Agriculture Aquaculture
IFE	Income from Employment
IFF	Income from Fish Farming
IFO	Income from other economic activities
IFP	Income from Petty Business
IFT	Income from Transfer Payment
IMF	International Monetary Fund
IRR	Internal Rate of Return
Kg	Kilogram
KIIs	Key Informant Interviews
LGAs	Local Government Authorities
MALF	Ministry of Agriculture Livestock and Fisheries
MEPA	Malta Environment and Planning Authority
MLFD	Ministry of Livestock and Fisheries Development
MM	Marketing Margin

NEPAD	New Partnership for African Development
NGOs	Non-Government Organisation
PCF	Percentage Contribution of Income from fish to total household income
ROI	Return on Investment
RUAF	Resource Centers on Urban Agriculture and Food Security
SGM	Simplified Gross Margin
SMEs	Small and Medium Enterprises
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
TR	Total Revenue
TVC	Total Variable Cost
TZS	Tanzania Shillings
USD	United State Dollar
WHO	World Health Organisation

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background information

Fish farming is the world's fastest growing sector of food production, currently accounting for nearly 50% of the world's food fish (FAO, 2012). Capture fisheries and fish farming supplied the world with about 148 million tons of fish in 2010 (with a total value of USD 217.5 billion), of which about 128 million tons was utilized as food for people, and preliminary data for 2011 indicate increased production of 154 million tons, of which 131 million tons was destined as food (FAO, 2012).

Millions of people around the world depend on fisheries sector as a source of income and livelihood. According to CTA (2013), in 2010 there were 54.8 million people engaged in the primary sector of capturing fisheries and fish farming worldwide. Of these people, 7 million were occasional fishers and fish farmers. In addition, more than 87% of all people employed in the fisheries sector in 2010 were in Asia, followed by Africa (i.e. more than 7%), and Latin America and the Caribbean (3.6%). Approximately about 30% of all people employed in the fisheries sector were engaged in fish farming, and they were even more concentrated in Asia (97%), followed by Latin America and the Caribbean (1.5%), and Africa (about 1%) (CTA, 2013).

In developing countries fish is an important source of both food and income to many people. According to FAO (2007), fish contribute more than 60% of the world supply

of protein, especially in the developing countries. In Africa, 5% of the population depends wholly or partly on the fisheries sector for their livelihood (FAO, 1996). New Partnership for African Development (2005) state that, in Africa the fisheries sector provides income for over 10 million people engaged in fish production, processing and trade. Fish has also become a leading export commodity for Africa with an annual export value of USD 2.7 billion (FAO, 2007). The governments of the Africa continent under the tutelage of the African Union have identified the great potential of fish farming and are determined to encourage private sector investment (NEPAD, 2005).

Fish farming sector in Africa overall is highly diverse and fragmented, ranging from smallholder ponds providing a few kilos of fish per year to international companies with annual turnover in excess of USD 1 billion (FAO, 2012). With capturing fisheries becoming increasingly unsustainable due to overfishing, fish farming is expected to overtake capture fisheries in supplying the world's protein requirements in the future (FAO, 2012). In the recent past, some developing countries in Asia and the Pacific (Myanmar and Papua New Guinea), Sub-Saharan Africa (Nigeria, Uganda, Kenya, Zambia and Ghana) and South America (Ecuador, Peru and Brazil) have made rapid progress to become significant or major fish farming producers in their regions (FAO, 2012).

In Tanzania, fisheries sector is one of the economic sectors, which provide substantial employment, income, livelihoods, recreation, foreign earnings and revenue to the country. The industry employs more than 222 741 small scale full time fishers

directly and about 4 021 000 people are engaged in other related fisheries activities such as fish processing, fish marketing, boat building and maintenance and fishing gear mending (MLFD, 2014). The highest number of fishermen and fishing vessels were found in Lake Victoria (101 250 fishermen and 28 470 fishing vessels), others are Marine (36 321 fishermen and 7664 fishing vessels), Lake Tanganyika (26 612 fishermen and 11 506 fishing vessels), Lake Nyasa (5550 fishermen and 2632 fishing vessels), Lake Rukwa (3428 fishermen and 1786 fishing vessels), Mtera dam (2369 fishermen and 1238 fishing vessels), Nyumbayamungu dam (786 fishermen and 502 fishing vessels) and Minor water (6907 fishermen and 3239 fishing vessels) (MALF, 2013). The sector contributed 1.4% (i.e. 3.45 million) to the national GDP in 2013 and according to the FAO State of Fisheries and Aquaculture 2014 report, Tanzania came in eighth position in the list of major fish producing countries from inland waters capture (Deloitte, 2015). Moreover, fisheries sector accounts for about 10% of the national exports and also provides foreign earnings through export of fish and fishery products (MLFD, 2014). In terms of animal protein, the fish contributes to about 30% of total animal protein intake (The World Fish Center, 2010).

Fish farming in Tanzania is however an infant sector although growing and practiced at two culture environments: fresh water and marine water. Fresh water fish farming involves production from waters with a consistently negligible salinity such as lakes, rivers and dams while marine fish farming involves production in coastal and offshore waters in which the salinity is maximum and not subject to significant daily and seasonal variation. Freshwater fish farming in Tanzania involves production of mainly Nile Tilapia and African Catfish while marine fish farming has the potential

for production of a variety of species such as the milk fish, flathead grey mullet, shrimps mollusks, crabs and oysters. Farming of seaweed, which was originally introduced from the Philippines, has taken root in Zanzibar and has attracted a lot of interest from fish farmers. Most popular farmed species are tilapia and African catfish (Deloitte, 2015). They are mainly produced in earthen ponds. Seaweed farming in Zanzibar has also significantly taken root and was estimated at 12 000 tons in 2013. The sector is not yet as commercially developed as much as in the neighboring countries, and it has a large but yet untapped potential (Deloitte, 2015).

In 2012 – 2013 the estimated number of farmers for freshwater were 17 726 while in marine water there were 1306 farmers for milk fish, 51 farmers for prawn, 188 farmers for crabs, 98 farmers for pearl culture and 2826 farmers for sea weed (Fisheries Annual Statistics Report, 2013). According to Deloitte (2015) annual farmed fish production in 2013 is estimated at 2998 tons, approximately 0.815% of the average annual fish production. Systems of fish farming include ponds, small tanks and raceways. Production from ponds is mainly practiced with most fish farmers owning small ponds of an average size of $150m^2$. The Ruvuma, Iringa, Mbeya and Kilimanjaro regions have been highlighted for having more pond density. According to FAO, Meru Trout Farm is the only commercial fish farm that produces the rainbow trout and is situated in Arusha. It is also the only farm in the country that uses the raceway production system (FAO, 2007).

The high demand for fish and its products in Tanzania that cannot be met by capture fisheries but by domestic production through fish farming has made urban fish

farming to attract increasing attention for its role in feeding people in many urban areas including Dar es Salaam. However, two different views concerning the development of urban fish farming still dominate the public debate. On one hand, there is the viewpoint that the positive effects of urban fish farming outweigh its negative (The WorldFish Center, 2011; MEPA, 2014). On the other hand, there is the view that the negative effects associated with expansion of urban fish farming outweigh its positive effects (FAO, 2006; Robert *et al.,* 2013).

1.2 Problem statement and justification of the study

1.2.1 Problem statement

Urban fish farming is important economic activities that create opportunities to the society through creation of employment and income generation (MLFD, 2014). Although it is seen as an important economic activity undertaking for urban dwellers in Tanzania, still there is inadequate information on whether the positive effects of urban fish farming are greater than the negative effects or negative effects are greater than positive effects even if it is properly planned. According to Adeogun *et al*. (2007), lack of a realistic knowledge base to inform policy and planning processes is a severe constraint toward development of urban fish farming. Much remains to be examined, though, for the up-and downstream effects of urban fish farming in the local economy and environment are largely unknown. Therefore, this study was conducted with the aim to address this research gap.

1.2.2 Justification of the study

1.2.2.1 Significance of the study findings

Besides filling the existing information gap, the findings of the study will be used to convince urban planners to consider urban fish farming as one of the formal income generating activity if it is properly planned. Also the findings will help policy makers and other stakeholders in the process of formulating appropriate policies and strategies to develop urban fish farming. In addition, the study findings will benefit urban fish farmers, traders, governmental and non-governmental organisations which have a stake in urban fish farming system and have plan for interventions in the future. Finally, researchers who are planning to make further investigation in urban fish farming may equally benefit from the results.

1.2.2.2 Why study in Dar-es- salaam

The study was conducted in Dar es Salaam and the choice of the study area was based on the fact that urban fish farming in Dar es Salaam has been expanded rapidly due to high population growth, which leads to increase demand of fish and fish products (IMF, 2011). Also, the 2012 Population and Housing Census results show that, Dar es Salaam has about 1788 households involved in fish farming both fresh and marine waters.

1.3 Objectives of the study

1.3.1 Overall objective

The overall objective of the study was to analyze socio-economic and environmental effects of urban fish farming in Dar es Salaam, Tanzania.

1.3.2 Specific objectives

The specific objectives of the study were to:

i. determine the profitability of urban fish farming

ii. determine the contribution of urban fish farming on household income

iii. analyze the effect of urban fish farming on employment creation

iv. determine the effect of urban fish farming on household food security

v. assess the effect of urban fish farming on environment

1.4 research questions

This study was guided by the following research questions

i. How efficient is the urban fish farming in terms of profit received by urban fish farmers?

ii. What is the contribution of urban fish farming to household income?

iii. What are the effects of urban fish farming on employment creation?

iv. What are the effects of urban fish farming on household food security?

v. What are effects of urban fish farming on environments?

1.5 Conceptual framework

Fig. 1 presents a conceptual framework for this study. Urban fish farming has positive and negative effects to the people living in urban areas. Positive effects include job creation, income generation and food security while negative effects include environmental pollution and misunderstanding between neighbors. This study explored the positive effects of urban fish farming in terms of job creation, income

generation, food security and negative effect of urban fish farming in terms of environmental pollution.

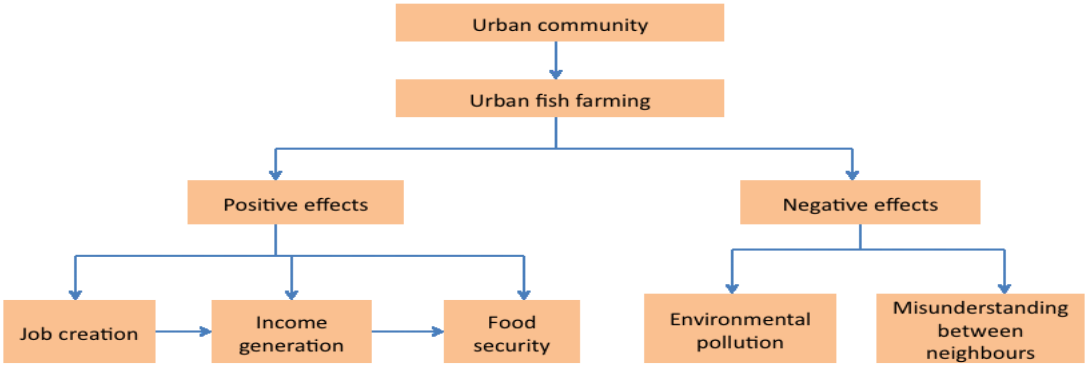

Figure 1: Conceptual framework for this study

1.6 Scope and limitation of the study

The study focused on analysis of socio-economic and environmental effects of urban fish farming, with specific freshwater fish species, Nile tilapia and African catfish. The area coverage of this study was limited to three administrative districts of Dar es Salaam City namely Ilala, Kinondoni and Temeke. However, lack of record keeping by fish farming households was a challenge during collection of relevant information. Thus, key informant interviews and secondary sources were extensively used to complement preliminary information and to understand rationality behind the status of the urban fish farming.

1.7 Organisation of the dissertation

This dissertation is organized into five chapters. The first chapter provides a general background of the study, problem statement and justification of the study, study objectives and conceptual framework. The second chapter gives a critical review of

the literatures relevant to the study while the third chapter presents a detailed description of the study area and methodology employed. The fourth chapter presents results and discussion while the last chapter presents conclusions and recommendations drawn from the study findings.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 An overview of urban fish farming

Urban fish farming involves raising fish commercially in dams, tanks or enclosures, usually for food in urban areas. According to David (2014), facility that releases juvenile fish into the wild for recreational fishing or to supplement a species' natural numbers is generally referred to as a fish hatchery. Worldwide, the most important fish species used in fish farming are carp, salmon, tilapia and catfish (Marlon, 2012).

For many years fish farming played a relatively minor role in global fish production, but its significance has increased dramatically over the past 20 years, spurred by the demand from Asia's fast-growing populations (World Ocean Review, 2013). Fish farming is not equally important in all countries and all regions. For example, central Europe in general prefers its fish to be caught in the wild (World Ocean Review, 2013). In china on the other hand, fish farming is widespread and has enjoyed a millennia long tradition, since carp were first domesticated. China is still the undisputed leader in fish farming production (World Ocean Review, 2013). Since 1970 it has recorded annual growth rates in fish farming production of an average 10%, although recently these have slowed to about 6% (Marlon, 2012).

In Tanzania, urban fish farming amongst other urban farming systems is relatively a new issue; it has occupied a unique position in the agricultural sector of the Tanzanian economy and has progressively contributed to the national fish production (MALF,

2015). Similarly, it is one of the several tools for generating income, employment and managing fresh water resources more effectively. In recent times, urban agriculture seems to have gained importance in Tanzania because among other benefits, it has been discovered to be a viable intervention strategy for the urban poor to earn extra income. As a major component of the urban foods system it provides the diversity of food needed to ensure dietary quality as well as contributes to food security by increasing the amount of food available to people living in cities (Balogun *et al.,* 2009).

2.2 Contextual analysis of fish farming in Tanzania

Tanzania is endowed with fishery resources both marine and inland. The fresh water includes the shares waters of East Africa great lakes namely Lake Victoria, Tanganyika and Nyasa which cover an area of 53 480 sq.km. The country also has other small natural lakes, manmade lakes, river systems and many wetlands with fish potential. All these water covers around 62 000 sq.km (MLFD, 2010). The marine water covers 64 000 sq. km which includes the Indian Ocean and 223 000 sq.km as offshore waters (Deloitte, 2015). The country has one of the longest coastlines in Africa, about 1424 km of the India Ocean, including Zanzibar and Pemba islands, which has not yet been exploited (MLFD, 2010).

Fish farming in Tanzania was first introduced in late 1940s when the rainbow trout (*Onchorynchus mykiss*) was introduced in the highlands, the Northern and Southern Highlands Provinces by government (MLFD, 2008). The government assisted the communities by providing fingerlings, technical and financial assistance. The system

was continued after independence. However, many of the established farms collapsed as a result of government's failure to continue providing fingerlings and extension services. However, many regions in Tanzania have good climate that can support fish farming development and have sufficient water resources, which includes rivers, lakes, natural and manmade dams (MLFD, 2010).

Most fish farmers in Tanzania prefer to produce Nile Tilapia (*Oreochromis niloticus*) and African Catfish (*Clarias gariepinus*) in fresh water but there are many other species that could be farmed successfully (Deloitte, 2015). Recently the response to fish farming has been positive and extremely high as evidenced by a large number of individual farmers and farmers' groups specialized in fish farming. According to Ministry of Agriculture Livestock and Fisheries (2015), tilapia production from fish farming in Tanzania increased from 2856 metric tons worth TZS 12.8 billion in 2010 to 3118 metric tons worth TZS 18.7 billion in 2015. The number of fishponds increased from 19 039 in 2010 to 21 300 in 2015 and number of fish farmers increased from 16 284 in 2010 to 19 395 in 2015.

Currently in Dar es Salaam, freshwater fish farming has become a great income sources and business idea for the individuals. As a result, numerous fish farms can be seen throughout the Dar es Salaam City. Some of those fish farmers are farming fish for family consumption and some are farming in large scale for high profit. According to MALF (2015) in Dar es Salaam City there are more than 50 freshwater fish farms with about 130 fish ponds.

2.3 Methodologies for impact assessment

Impact means a measure of the tangible and intangible effects (consequences) of one things or entity's action or influence upon another. It is the major means of assigning priority for dealing with incidents, problems or changes. The primary aim of an impact assessment is to measure whether a particular programme has achieved its desired outcomes. Impact assessment can be done qualitatively or quantitatively depending on the kind of data collected and kind or nature of the study conducted. In a quantitative study, data in the form of numbers are collected while in qualitative research data collected are in the form of text. The quantitative research that uses quantifiable data can use econometric models in measuring, aggregating, modeling and predicting behavior and relationship (Hentschel, 1999). Qualitative research brings important additional commitment to respect local knowledge and facilitate local ownership and control of data generation and analysis (Chamber, 2003).

Both quantitative and qualitative methods have weakness. According to Looi (2014), the major weaknesses of quantitative research approach include: fails to provide an in depth description of the experience, lack of resources for large scale research and lack of human perception and beliefs while the three major weaknesses of qualitative research approach are: (i) the inability to manipulate independent variables (ii) the risk of improper interpretation (iii) the lack of power to randomize. Thus, it is good if the combination of the two is used in assessing impact. By combining the two methods it is important to be aware of the comparative advantage of each method. While quantitative methods provide data that can be aggregated, analyzed, describing

and providing relationships, qualitative research helps to explain the relationship and its contextual differences in the quality of those relationships (Holland, 2009).

2.4 Gross margin analysis

There are various measures of profitability of the enterprises which are Gross Margin (GM), Return on Investment (ROI), Benefit-Cost Ratio (BCR or B/C), Internal Rate of Return (IRR), and Marketing Margin (MM) (Turuka, 2000). Mlulla (2003) defined gross margin as the difference between total revenue and total variable costs. It is used as a measure of enterprise profitability and means of selecting farm plans. The size of gross margin depends on the services provided, market structure, market price, perishability of the product as well as the distance between producers and consumers and may be influenced by market information especially for short-run margins. According to Eskola (2005) Gross Margin Analysis (GMA) is one of the widely used analytical techniques for planning and analysis of projects by advisors, consultants, researchers and producers.

Debertin (1993) identified some problems of using GM as a measure of profitability, which are failing to deduct the opportunity costs for the money invested in the enterprise. Furthermore, Ponte (2002) argued that GM has several disadvantages including failure to account for variation of fixed costs, and failure to make allowances of costs for depreciation and obsolescence of fixed assets.

However, Phiri (1991) argued that Gross Margin is still the most satisfactory measures of resources efficiency to Small and Medium Enterprises (SMEs). It gives a

good indication of the financial health of enterprises; and shows the deep insight into trader' management efficiency of the enterprises (Hammod, 2001). Thus, the GM is useful for urban fish farming enterprises operated by urban farmers for profit objectives. Also this study does not deal with fixed cost but variable cost thus why gross margin is more useful to find the profitability of urban fish farming.

2.5 Urban fish farming and household income

Household income is the measure of the combined incomes of all people sharing a particular household. It includes every form of income, e.g., salaries, wages, benefits received and receipts from any personal business, investments, dividends and other income. Urban fish farming compromise different activities, family members jointly and choose how to allocate their work time on these activities in order to maximize their household income (Rachel, 2013). This activity provides income to the household through selling either fish and/or fish products like fish oil (Robert *et al.,* 2013).

Fish farming can be a good income source for households in rural and urban areas, although it is not usually the main source for most farmers. In Bangladesh, Bouis (2000) found that fish farming contributed 5 to 10% of the household income. Also in Bangladesh, Jahan and Pemsi (2011) estimated the total income of Integrated Agriculture Aquaculture (IAA) project households receiving training and extension support increased annually by approximately 8% over the 3 years project period compared to just less than 1% for non project households who did not receive support. This difference was due to increased farm and fish income. It was also found

that at the end of the project fish farming contributed just over 11% to total income for project farmers compared to just less than 8% for control farmers. In Sub Saharan Africa (SSA), Dey *et al.* (2007) found that IAA adopting households had 1.5 times the income of non-adopters (USD 254 and USD 174 respectively), due to differences in farm income and larger farm size of IAA farmers. IAA farmers' average farm income was USD 185 (80% of total income), 1.8 times as much as non-IAA farmers' average of USD 115 (66% of total income). 10% of IAA farmers' income was from fish farming.

Intensification of fish farming technology can also generate higher incomes, for example Ahmed and Lorica (2002) report polyculture technology using more intensive feed and other inputs, popular in some Asian countries, provides a larger share of household income compared to traditional semi-intensive operations. Evidence from a 5 year World Fish Center fish farming project in Cameroon showed that average net profits of fish farms in peri-urban areas rose from USD 150 to USD 1500 over 5 years whereas those in rural areas rose from USD 34 to USD 213. One of the main reasons put forward by Brummett *et al.* (2011) for this difference was the positive impact of market access on the scale and intensity of fish production in peri-urban areas compared to rural areas. Combining fish farming with other activities such as rice culture has also been found to increase incomes. The Adivasi Fisheries Project in Bangladesh helped to almost double profits within a year when fish and rice farming were integrated (World Fish Center, 2009).

2.6 Urban fish farming and employment creation

Employment creation is the process by which the number of job in an economy increases or is the process of providing new jobs, especially for people who are unemployed. Through urban fish farming the urban dwellers have found employment and apart from fish production also urban fish industry can provide recreational services and care services to the communities which can help to create job opportunity to other people (RUAF foundation, 2013). According to FAO (2002) since 1994, more than three million Chinese have found employment in urban fish farming and earn generally higher income than other farmers.

Based on study by Stevenson and Irz (2009) fish farming can reduce poverty through creating low skilled jobs that are accessible to the poor and can increase people wage rates. However, compared to crop agriculture, labour use in fish farming seems low. Ahmed and Lorica (2002) indicate most studies show fish farming using very little labour, most of which is family labour. Ahmed *et al*. (1993) found less than 1% of total hired labour employed by pond owners in Bangladesh was used for fish farming. Brummett *et al*. (2008) also report large-scale fish farming production systems in SSA are not highly labour intensive requiring between 0.05 and 0.1 person-years per ton of fish produced. However, other studies suggest fish farming requires higher amounts of labour. Ahmed and Lorica (2002) report that hired labour can be common for smallholder fish farming; for example, in the Mekong Delta of Vietnam, hired labour cost account for nearly 37% of labour costs.

Hishamunda and Ridler (2006) suggest employment generation varies with the intensity of production technology estimating extensive fish farming in SSA has the same labour-land ratio as rice farming while intensive fish farming uses three times more labour per hectare. There is also some evidence suggesting labour and land productivity is higher for fish farming resulting in higher wage rates than agriculture. For example in Malawi, productivity of family labour in IAA activities was found to be higher than in off-farm activities (Dey *et al*., 2007). Direct employment generation from fish farming therefore seems to vary with technology and farm size and in some cases labour use and wage rates are higher than those generated by alternative activities and will likely vary by context.

Furthermore, fish farming generates indirect employment through backward linkages e.g. to hatcheries and feed suppliers and forward linkages e.g. harvesting, post-harvest handling, processing and marketing activities which could generate important employment opportunities for the poor depending on the degree to which fish farming is integrated into the local economy. Costa and Sampaio (2004) estimated indirect employment generation from shrimp farming in Brazil at 1.86 jobs per hectare, similar to direct employment generation. However, Stevenson (2006) estimated low off-farm employment generation by fish farming production in the Philippines, with inputs account for 11% of total labour demand and processing account for 10%.

2.7 Urban fish farming and food security

Food security exists when all people at all time have access to sufficient, safe, nutritious food to maintain a healthy and active life. It includes both physical and

economic access to food that meets people dietary needs as well as their preference. This definition consists of three pillars: availability (sufficient quantities of food available on a consistent basis), access (having sufficient resources to obtain appropriate foods for nutritious diet) and utilization (appropriate use based on knowledge of basic nutrition and care) as well as adequate water and sanitation (WHO, 1996).

Food production in the city is often a response of the urban poor to inadequate, unreliable and irregular access to food and lack of purchasing power. In urban settings, lack of income translates more directly into lack of food than in rural settings. Costs of supplying and distributing food from rural areas to the urban areas, or to import food in the cities, are rising continuously, and distribution within the cities is uneven. As a consequence, urban food insecurity will increase (Argenti, 2000). In response to this urban population is compelled to engage in fish farming.

Urban fish farming contributes to food security both qualitatively and quantitatively. The impact of urban fish farming on food security can be computed as the amount of food produced by a household as compared to total household food demand or the income a household raises for food consumption as compared to amount required to ensure the requirement of that household. Much of literature reports an increase in household consumption of fish for those who invest in pond based fish farming (Prein and Ahmed, 2000).

Evidence from Asia suggests fish farming can significantly affect direct fish consumption. Dey *et al*. (2000) found in countries where fish farming contribute a large proportion of national fish production and smallholder production dominated e.g. China, Vietnam and Bangladesh, per capital fish consumption was significant higher for fish producing households than non-producing households and the national average. In India, Kumar and Dey (2006) found the energy intake of households that own fish ponds to be nearly 11% higher than that of households with wage earners but no ponds, and that the undernourished population was 10% lower among fish pond owners than in the comparison group. Dey *et al.* (2007) found that following IAA introduction in Malawi, IAA households consumed fresh fish and other animal protein more frequently than non IAA households.

Food security can be measured by estimating the amount of income the family saves for food consumption compared to what it needs as used by Garrett (2000). He used this approach since urban dwellers must buy most of their food hence urban food security depends mostly on whether the household has adequate effective purchasing power given the prevailing prices and incomes. In Vietnam, Huong and Cuong (2012) found that freshwater tilapia fish farming play an important roles to food security of local rural poor because of its provision of high quality food, generation of cash incomes, available food supply to local markets, especially in the context of inadequate supply of livestock protein sources due to burning issues of epidemics such as bird flu, blue ear and foot and mouth diseases.

2.8 Urban fish farming and environmental pollution

Environmental pollution is the introduction of different harmful pollutants into certain environment that makes this environment unhealthy to live in. The most common pollutants are usually chemicals, garbage and waste water. Environmental pollution is happen in multifold parts of Earth usually in the form of air and water pollution. It causes great damage to ecosystem that depends upon the health of this environment to live in. Air and water pollution can cause death of myriad organisms in given ecosystem, including humans.

Urban fish farming activity is also significant contributor to environmental pollution if not properly planned to channel waste water during cleaning of ponds and dams. Usually this activity produces a lot of waste water, which affect negatively the wider environment as well as human health. According to Smit *et al.* (2001) urban fish farming may also increase the habitat of some pathogens and provide a transmission route through the fish to humans, as well as putting farmers and workers at risks. In addition, aquatic snails in fish pounds using sewage can serve as host for pathogens that cause schistosomiasis or bilharzia (World Health Organization, 2012).

According to Hall *et al*. (2011) potential negative impacts of fish farming include detrimental environmental and ecological effects. The intensification and expansion of fish farming production will mean an increased pressure on the environment, due to wastes from fish farms, in the form of nutrients (mainly ammonia and phosphorus) and suspended solids that create an oxygen demand in the receiving waters (Alvaroda, 1997).

Feeds are the main nutrient inputs in intensive fish farming operation (Alvaroda, 1997). Feed consumed by fish will in part be assimilated. The fish will excrete some of the nutrients (mainly ammonia) though the gills, and through the faeces and urine. The main products released to the natural waters are solids, and nutrients such as phosphorus and nitrogen. Most of the solids produced from uneaten feeds and faeces, settle to the sediment near the farm, and may have a strong impact in the area near the farm. However, the impact of these sediments is much localized, and it is limited to the surroundings of the farm. Generally, fish farming can have a variety of effects on the environment, through the discharge of nutrients, solid waste, medicines and antifoulants.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the study area

The City of Dar es Salaam is located in the eastern part of the Tanzania mainland at 6^0 51'S latitude and 39^0 18' E longitudes. With an area of 1393 square kilometers comprising of 210, 652 and 531 square kilometers for Ilala, Temeke and Kinondoni municipalities respectively. It occupies 0.19% of the Tanzania mainland, stretching about 100 km between the Mpiji River to the north and beyond the Mzinga River in the south.

According to the 2012 national census, the City had a population of 4 364 541 with an average annual population growth rate of 5.6%. Dar es Salaam City is divided into three administrative districts namely Ilala, Temeke and Kinondoni. Based on ecological point of view the City is divided into three ecological zones, namely the upland zone comprising hilly areas to the west and north of the City, the middle plateau, and the lowlands, which include Msimbazi Valley, Jangwani, Mtoni, Africana and Ununio areas. The main natural vegetation includes coastal shrubs, miombo woodland, coastal swamps and mangrove trees.

Dar es Salaam experiences a modified type of equatorial climate. It is generally hot and humid throughout the year with an average temperature of 29ºC. The hottest season is from October to March during which temperatures can raise up to 35ºC. It is relatively cool between May and August, with temperature of around 25ºC.

There are two main rainy seasons; a short rain season from October to December and a long rain season between March and May. The average rainfall is 1000mm (lowest 800mm and highest 1300mm). Humidity is around 96% in the mornings and 67% in the afternoons. The climate is also influenced by the southwesterly monsoon winds from April to October and northwesterly monsoon winds between November and March.

Apart from urban agriculture, other major economic activities in Dar es Salaam include internal trade, manufacturing, tourism, transport and communication, forestry and fishing, mining and quarry, utility services, construction, finance and insurance and public administration and education.

Regarding agriculture, both peri-urban and urban farmers engage in small scale farming dominated by use of hand equipment. A few use tractors and traditional upgraded technology. In 2004, about 110 850 ha of land in Dar es Salaam comprising of 52 000 ha in Kinondoni; 45 000 ha in Temeke and 13 850 ha in Ilala were potential for agriculture especially crop production (URT, 2004). Currently, the figure may be low due to rapid expansion of urban related activities. Food crops produced in Dar es Salaam are mainly cassava, sorghum, maize, rice, sweet potatoes, bananas and legumes while cash crops include cashew nut, coconuts, oranges, pineapples, mangoes and vegetables.

3.2 Research design

The design of this research was a cross-sectional survey. Under this design, data from household's respondents were collected at a single point in time without repetition from the representative population. The study design was appropriate because it is cost-effective, less time consuming and much information were obtained in a relatively short (Babbie, 1993).

3.3 Sampling unit

The sampling unit for this study included fish farming households and non-fish farming households.

3.4 Sampling techniques

This study employed three types of sampling techniques namely simple random, purposively and snowball:

3.4.1 Selection of non-fish farmers

Respondents from non-fish farming households were selected randomly from the three sampled municipalities namely Ilala, Kinondoni and Temeke from which sample of urban fish farmers were drawn.

3.4.2 Selection of urban fish farmers

Both purposively and snowball sampling techniques were employed in obtained urban fish farmers involved in this study. Purposively sampling method was used in obtaining some of the urban fish farmers based on the list obtained from fisheries

offices of Ilala, Kinondoni and Temeke. Other urban fish farmers were obtained through a snowball sampling method. In this case urban fish farmers were asked to identify their fellow fish farmers who were then selected for the survey in their fish farming areas of Ilala, Kinondoni and Temeke municipalities. A snowball sampling technique was adopted because members of these populations have not all been previously identified and were more difficult to locate or contact than known populations (Coleman, 1958; Goodman, 1961; Spreen, 1992). This sampling technique can be defined as "a non-probability sampling technique in which the researcher makes initial contact with a small group of people who are relevant to the research topic and then uses these to establish contacts with others" (Bryman, 2008). Snowball sampling is a method typically used with unknown or rare populations.

3.5 Sample size

Bailey (1994), argue that at least 30 cases seems to be the bare minimum for study in which statistical data analysis is to be done. Thus, the sample size of this study were reasonably large and consistent with Bailey argument whereby 60 households were selected, of which 30 respondents were selected from non-fish farming households and the remains 30 respondents from fish farming households.

3.6 Pre-testing of the questionnaires

Before the exercise of data collection the questionnaires were pre-tested to check if they are comprehensive enough to collect the required data to answer the stated objectives and to see their clarity to the respondents. A total of 6 questionnaires were administered one week before the general survey and the exercise was done in

Kinondoni municipality. After the pre-testing, modifications were made to the questionnaires and improved versions of the questionnaires were developed (Appendix 1 and 2).

3.7 Data collection

This study was dependent mostly on primary data collected from the sample households using two kind of semi-structured questionnaires, the questionnaire designed for fish farming households and the questionnaire designed for non-fish farming household. Also Key Informant Interviews (KIIs) by using checklists designed for MLDF, LGAs and NGOs/Project and direct observation were employed during data collection. KIIs were used to collect data on various aspects of urban fish farming in Tanzania including:

- Performance of urban fish farming in Tanzania and specific in Dar es Salaam;
- Current and future interventions in the urban fish farming;
- Constraints and opportunities of urban fish farming;
- Actors/partners in urban fish farming in Dar es Salaam.

3.8 Data processing

Data collected were coded and then entered in SPSS program and cleaned to check for the outliers and descriptive statistics were carried out for analyzing the socio-economic characteristics of the respondents. Furthermore, Microsoft Excel was used for quantitative techniques analysis and for computing the profitability of urban fish farming.

3.9 Data analysis

Various methods were employed to analyze the collected data in order to achieve the study objectives as described below:

3.9.1 Profitability of urban fish farming

Gross Margin (GM) analysis was used to determine the profitability of urban fish farming. GM was calculated using the following formula:

$$GM = TR - TVC \quad \ldots\ldots (1)$$

Where;

GM= Gross Margin

TR= Total Revenue

TVC= Total Variable Cost

3.9.2 Contribution of urban fish farming on household income

$$PCF = \frac{IFF}{\sum/(IFF,IFE,IFP,IFT,IFO)} X\ 100\% \quad \ldots\ldots (2)$$

Where;

PCF=Percentage contribution of income from fish to total household income

IFF=Income from Fish Farming

IFE=Income from employment

IFP=Income from petty business

IFT=Income from transfer payment

IFO=Income from other economic activities

The above formula was used to determine contribution of urban fish farming on household income.

3.9.3 Effect of urban fish farming on employment creation

Descriptive statistics including frequency and percentage was used to determine the effect of urban fish farming on employment creation and to make a comparison in terms of people employed in urban fish farming and nature of employment created by urban fish farming weather monthly salary employment or daily salary employment.

3.9.4 Effect of urban fish farming on household food security

Descriptive statistics such as frequency, percentage and chart were used to describe the effect of urban fish farming on household food security. Results were presented in frequency, percentages and histogram. Additionally, t – Test was used to analyse the difference in average amount of fish consumed by fish producers and non-fish producers per week to see if it was significant.

3.9.5 Effect of urban fish farming on environment

Descriptive statistics including percentage and chart was used to describe the effect of urban fish farming on environment, which include different kind of environmental pollution like land pollution and water pollution.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Socio-economic characteristics of respondents

4.1.1 Socio-economic characteristics of urban fish farmers

As shown in Table 1, approximately 53.3% of the urban fish farmers were aged between 40 and 50 years while another 36.7% aged over 50 years. The remaining 10% were less than 40 years. This implies that majority of urban fish farmers in the study area were relatively young people. The mean age of urban fish farmers was 48 years, which shows that they are at the most energetic stage of their life. The young age of the urban fish farmers have positive impacts on enterprise size, earnings, and the ability to take risks and adopt modern innovation. About 86.7% of the urban fish farmers were male while the remaining 13.3% were female. The dominance of male in urban fish farming was also reported by Fredene *et al*. (2011). The dominance of the male could be due to access to land.

Furthermore 90% of the urban fish farmers were married, 6.7% were single while 3.3% were widowed. Adewuyi *et al*. (2010) also reported married status among urban fish farmers in Ogun State, Nigeria. Clearly this state that, urban farmers could easily make use of family labour to perform critical farm tasks. About 63.3% of the urban fish farmers had attended higher education. This high level of education will enable urban fish farmers to understand the technical requirements of fish farming as well as make use of innovations and new technologies of fish management, access to credit as

well as comprehend policy measures put in place to ensure socio-economic and environmental sustainability of fish farming.

Table 1: Socio-economic characteristics of urban fish farmers

Variable	Frequency	Percentage (%)
Age (Years)		
< 40	3	10.0
40 – 50	16	53.3
> 50	11	36.7
Total	30	100
Sex		
Male	26	86.7
Female	4	13.3
Total	30	100
Marital Status		
Single	2	6.7
Married	27	90
Widowed	1	3.3
Total	30	100
Level of education		
Secondary	1	3.3
Post-secondary/certificate	3	10.0
Diploma	7	23.3
Higher education	19	63.3
Total	30	100
Primary occupation		
Permanently employed	19	63.3
Self-employment	9	30.0
Farming including fish farming	2	6.7
Total	30	100
Farming experience (Years)		
Less than five years	28	93.3
5 to 10 years	2	6.7
Total	30	100

In addition, almost all urban fish farmers had other economic activities like salaried employment and petty business which they practiced alongside fish farming. Although this enabled farmers to earn incomes from other sources which they could invest in the enterprise, it has the disadvantage of keeping fish farming at small scale.

As shown in Table 1, 93.3% of urban fish farmers have just being involved in less than five years while the remaining 6.7% have been farming for between 5 and 10 years. This experience is fairly low showing that urban fish farming is relatively new in the study area. The socio-characteristics of urban fish farming found in this study in terms of age, sex, marital status, level of education, occupation and experience are quite similar to study carried out in Nigeria (Oluwemimo and Damilalo, 2013).

The reasons for engaging in urban fish farming as shown in Table 2 were therefore: the increase demand for fish (76.7%); the high price of fish in the market (16.6%) and for subsistence (6.7%). Clearly, 93.3% of the fish farmers got involved for commercial reasons (i.e. high price and increase demand).

Table 2: Reasons for engaging in urban fish farming

Factors	**Frequency**	**Percentages (%)**
The increase demand for fish	23	76.7
The high price of fish in the market	5	16.6
For subsistence	2	6.7
Total	30	100

4.1.2 Socio-economic characteristics of urban non-fish farmers

Table 3 summarizes the socio-economic characteristics of the sampled urban non-fish farmers such as age, sex, marital status, education level and primary occupation. The results show that most of the urban non-fish farmers (46.7%) were aged between 40 and 50 years. It is also shown that 60% of the sampled non-fish farmers were female. The results in Table 3 indicate that about 93.3% of the sampled non-fish farmers were

married. A part from marital status, the results in Table 3 indicate that almost all sampled non-fish farmers' attained formal education. The results also indicates that most of the non-fish farmers interviewed were involved in permanent employment (46.6%) and self employment (40.0%), were the rest of the non-fish farmers were involved in temporarily employment and casual labourer.

Table 3: Socio-economic characteristics of urban non-fish farmers

Variable	Frequency	Percentage (%)
Age (Years)		
< 40	10	33.3
40 – 50	14	46.7
> 50	6	20.0
Total	30	100
Sex		
Male	12	40.0
Female	18	60.0
Total	30	100
Marital Status		
Single	2	6.7
Married	28	93.3
Total	30	100
Level of education		
Primary	4	13.3
Secondary	8	26.7
Post secondary/certificate	6	20.0
Diploma	4	13.3
Higher education	8	26.7
Total	30	100
Primary occupation		
Permanently employed	14	46.6
Temporarily employed	2	6.7
Self employment	12	40.0
Casual labourer	2	6.7
Total	30	100

4.2 Profitability analysis of urban fish farming

Various types and sizes of ponds ranging from earthen ponds to concrete ponds were reported among the urban fish farmers in the study area. The pond sizes range

between 20 meter squares to 800 meter squares. The most commonly employed pond type was the concrete pond (Table 4).

Table 4: Types of fishponds

Type of pond	Frequency	Percentage (%)
Concrete	27	90
Earthen	3	10
Total	30	100

Although many species of fish could be farmed successfully in the study area, currently 93.3% of urban fish farmers prefer to produce Nile Tilapia (*Oreochromis niloticus*) while the remaining 6.7% prefer to produce African catfish (*Clarias gariepinus*). Also, it was noted that both mixed sex and mono sex fish farming system are practiced in the study area. About 56.7% of urban fish farm is under mixed sex farming system while the remaining 43.3% is under mono sex farming system (Table 5).

Table 5: Kind of fish and farming systempractices by urban fish farmers

Variable	Frequency	Percentage (%)
Species of fish		
Nile Tilapia	28	93.3
African catfish	2	6.7
Total	30	100
Farming system practices		
Mixed sex	17	56.7
Mono sex	13	43.3
Total	30	100

From the findings of the study, the production of the Tilapia and the African catfish in the study area is characterized by low pond productivity mainly due to poor seeds and employment of the low pond management practices (poor quality feeds). For Tilapia farming, the major challenge is excessive reproduction and the subsequent stunting of fish due to overcrowding especially for mixed sex farming system while for African

catfish the major challenge is high mortality rates of fry resulting from starvation, cannibalism, disease and predation during the hatchery and nursery phases of production.

4.2.1 Profitability analysis of tilapia farming

The findings of this study in Table 6 below shows that the current yield is between 482 to 826 kg/pond/production cycle for a 6 to 9 months growing period. The average yield is 654kg. This reported average yield is below the recommended yield of 800 kg/pond/production cycle. Farm gate prices and corresponding simplified gross margins of tilapia in study areas vary significant from 6000 TZS/kg to 7500 TZS/kg and 22.75% to 40.60% respectively. The average simplified gross margin (SGM) is 31.68%.

The sharp variations in SGM can be due to several factors such as availability of needed inputs (i.e. fertilizers, lime, fingerlings and fish feeds), availability of suitable water, access to quality fish farming technical advice, disease/parasites, design and construction of fishpond, flooding resulting from excessive rain, and stealing. The trend of Gross profit ranges from 658 000 TZS/pond to 2 515 350 TZS/pond. Variations in gross profits depend mainly on the farmers' capacity to increase productivity (i.e. production per pound), reduce production costs and getting access to markets offering good prices.

Table 6: Profitability analysis of tilapia farming

Items	Minimum	Maximum
1.0 Revenue		
Yield per pond in Kg	482	826
Farm gate price per Kg	6 000	7 500
Revenue (TZS)	**2 892 000**	**6 195 000**
2.0 Variable costs		
Labour	360 000	420 000
Feeds	1 050 000	2 016 000
Fingerlings	800 000	1 200 000
Fertilizer/manure	-	1 000
Lime	24 000	24 000
Drugs	-	3 000
Transportation	-	15 650
Total variable costs	**2 234 000**	**3 679 650**
Gross Margin (TZS)	**658 000**	**2 515 350**
Simplified Gross Margin (%)	**22.75**	**40.60**

**Pond size: 400 meter squares

4.2.2 Profitability analysis of African catfish farming

The finding in Table 7 shows that the current yieldis between 1290 to 2860 kg/pond/production cycle for a 8 to 9 months growing period. Farm gate prices and corresponding simplified gross margins of tilapia in study areas vary significant from 5000 TZS/kg to 5500 TZS/kg and 58.14% to 60.97% respectively. The average SGM is 59.56%.

The sharp variations in SGM can be due to several factors such as availability of suitable water, access to quality of fingerlings and feeds, access to quality fish farming techniques, disease/parasites, flooding resulting from excessive rain and pilfering. The trend of Gross profit ranges from 3 750 000 TZS/pond to 9 590 000 TZS/pond. Variations in gross profits depend mainly on the farmers' capacity to increase productivity (i.e. production per pound), reduce production costs and getting access to markets offering good prices.

Table 7: Profitability analysis of african catfish farming

Items	Minimum	Maximum
1.0 Revenue		
Yield per pond in Kg	1 290	2 860
Farm gate price per Kg	5 000	5 500
Revenue (TZS)	**6 450 000**	**15 730 000**
2.0 Variable costs		
Labour	900 000	1 600 000
Feeds	1 080 000	3 150 000
Fingerlings	450 000	500 000
Drugs	-	90 000
Other variable costs	270 000	800 000
Total variable costs	**2 700 000**	**6 140 000**
Gross Margin (TZS)	**3 750 000**	**9 590 000**
Simplified Gross Margin (%)	**58.14**	**60.97**

**Pond size: 400 meter squares

4.3 Contribution of urban fish farming to household income

People in study area receive their income from different sources. In this study these sources were grouped into four major sources of income namely salaried employment, petty business, urban fish farming and transfer payment. In this study income from salaried employment were referred to income obtain from the person from being employed either by the private sector including individuals or by a government. Petty business as a source of income in this study was referring to income obtained from different business like kiosk, grocery, shops, hotels, restaurants, food venders, local brewery, transportation business and the like. Only fish farming was assessed on the part of urban agriculture without including livestock keeping and crop cultivation. This source of income for fish farming include income obtained from the sale of fish and fish products. On the side of transfer include payment like help from relatives and gifts.

The contribution of different sources of income to total household income was as shown in Table 8 and Fig.2. The urban fish farming which is represented by the income from fish farming has been ranked third in terms of its contribution to total household income. It has contribution of 7% to total household income. This small contribution may be due to fact that fish farming has been regarded as activities that is supposed to be practiced in rural areas. Due to shortage of land in urban areas this activity is normally conducted to the backyard, this together with problems like flood, access to quality fingerings, shortage of capital, inadequate technical advice and higher feed cost leads to low contribution of fish farming to total income.

Petty business has been ranked first in contributing to total household income. Higher contribution of petty business as compared to salaried employment and urban fish farming was attributed by great support from the government and the private sector. In this regard most of the households have put higher effort in petty business than fish farming which was regarded as rural activities.

Transfer payment refers to gift, help from children/relatives and pension for retired people. Its low contribution was due to the fact that most of the urban fish farmers were at active working age and therefore they were still engaging themselves in different income generating activities.

Table 8: Contribution of fish farming to household income

Source of income	Average amount earned per year (TZS)	Contribution to total income (%)
Petty business	13 403 750	53
Employment	9 670 000	38
Fish farming	1 921 175	7
Transfer payment	4 83 000	2

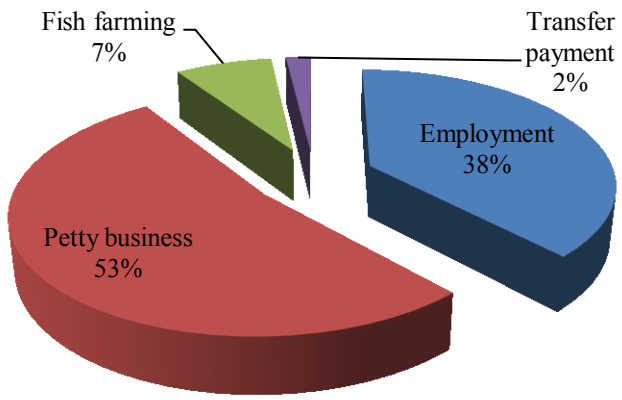

Figure 2: Contribution of different source to total income

4.4 Effect of urban fish farming on employment creation

Urban fish farming can provide more opportunities of jobs, which gives a meaningful contribution to the employment strategy in urban area. The finding in Table 9 shows that very few urban fish farming households (13.3%) reported to self-employed their own family labour. 86.7% of urban fish farming households stated that hired labours were used for their fish production. About 92.3% of fish workers have been paid on a monthly basis while the remaining 7.7% have been paid on daily basis. The monthly

salary for fish workers in the study area was from TZS 50 000/= to 420 000/= depending on the level of education of the employee/worker and scale of production. 96% of the urban fish workers were men while the remaining 4% were women. Clearly, men play asignificant role in the urban fish farming.

Table 9: Contribution of urban fish farming to employment creation

Variable	Frequency	Percentage (%)
Status of employment		
Self-employment	4	13.3
Hired labours	26	86.7
Total	30	100
Nature of employment		
Monthly salary employment	24	92.3
Daily salary employment	2	7.7
Total	26	100
Sex of the employee		
Men	25	96
Women	1	4
Total	26	100

4.5 Effect of urban fish farming on household food security

Current contributions of urban fish farming to the household food security have well depicted under aspects of food availability (quantity and quality), food access (affordability) and food utilization (nutrition and dietary habits). The finding of this study shows that urban fish farming play an important role to the household food security because of its provision of high-quality food, generation of household incomes for buying other kind of foods and available food supply to markets.

As shown in Table 10, 93.3% of the urban fish farmer households visited during this study agreed that fish farming increased fish consumption. They reported that fish

produced was consumed in the household (i.e. 0.5 kg to 12 kg per household per week depends on the family size) which gives a great contribution to their daily diet in improving the nutrients. A part from access to food by direct growing of fish, urban fish farming also generate income to purchase other kind of foods and other needs such as housing, education and medical services hence improve household livelihood.

Table 10: Effect of urban fish farming on household food security

Variable	**Frequency**	**Percentage (%)**	
HH Consumption status			
Increased	28	93.3	
Remain the same	2	6.7	
Total	30	100	
Amount consumed (in Kg)	**Minimum**	**Mean**	**Maximum**
Per week	0.5	5.1	12

From findings of this study, consumption status for fish producers in urban area is 432 g per person per week while for non-fish producer is 296 g per person per week. Thus, urban fish producers consume 1.5 times as much as non-fish producers (Fig.3). Furthermore, the finding shows that urban fish farming increases the supply of affordable fish, hence reducing the cost and increasing the availability of fish to poorer households. The difference in average amount consumed by fish producers and non-fish producers per week was analysed by t – test to see if it was significant and the finding was $t = 0.011$ at $P<0.05$. This suggests that urban fish farming has a significant positive effect on food security.

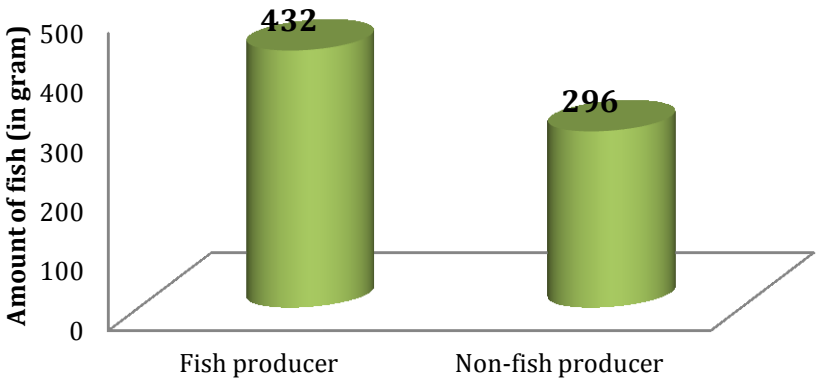

Figure 3: Fish consumption status – fish producers versus non-fish producers

4.6 Effect of urban fish farming on environment

The two major environmental effects of urban fish farming identified in the study area includes threats and stress of the ecosystems (22%) and land and water pollution (78%) as described here below and presented in Fig. 4.

- The study results show that urban fish farming has led to threats and stress of the ecosystems as some of the urban fish farmers do not observe environmental rules and values. For example some of fish pounds visited during this study are constructed close to the water sources and in the wetlands thus disrupting the hydrological regime in these areas and therefore threatening sustainability of such environmental resources.
- Although, urban fish farming produce a lot of waste water which have negative effect to environment and human health, during this study it was noted that some of ponds used by urban fish farmers still do not have proper drainage

systems. The waste water produced goes to neighbors and / or water sources which are close to ponds hence led to land and water pollution.

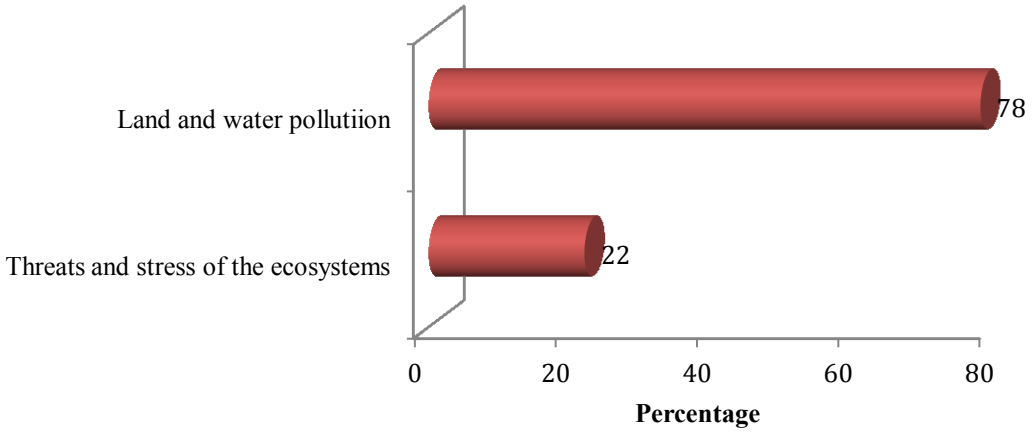

Figure 4: Effect of urban fish farming on environment

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Urban fish farming are operating profitably. The gross margin obtained by tilapia farmers in Dar es Salaam ranges from TZS 658 000/= to 2 515 350/= per pond per production cycle. While gross margin obtained by African catfish farmers ranges from TZS 3 750 000/= to 9 590 000/=. Variations in gross margins depend mainly on the farmers' capacity to increase productivity (i.e. production per pond), reduce production costs and getting access to markets offering good prices.

Urban fish farming had 7% contribution to total household income. This small contribution may be due to fact that fish farming has been regarded as activities that is supposed to be practiced in rural areas. Due to shortage of land in urban areas this activity is normally conducted to the backyard, this together with problems like flood, access to quality fingerings, shortage of capital, inadequate technical advice and higher feed cost leads to low contribution of fish farming to total income.

About 86.7% of urban fish farming household reported to use hired labors for their fish production. Of which 92.3% of these hired labors have been paid on a monthly basis. The monthly salary was ranging from TZS 50 000/= to 420 000/= depending on level of education of fish worker and scale of production. This implies that urban fish farming has a significant contribution to employment creation.

Urban fish producers consume 1.5 times as much as non-fish producers. This implies that urban fish farming play an important role to the household food security because of its provision of high-quality food, generation of household incomes for buying other kind of foods and available food supply to markets.

Threats and stress of the ecosystem caused by violation of environmental rules and values together with land and water pollution resulting from lack of proper drainage system are the two major effect of urban fish farming on the environment in urban areas.

5.2 Recommendations

Based on the findings of the study the following recommendations are put forward for the development of sustainable urban fish farming.

5.2.1 Recommendations for ensuring urban fish farming sustainability

This study identified the potential area for the development of sustainable urban fish farming in Dar es Salaam. The constraints facing urban fish farmers affect fish farming profitability and sustainability. Therefore, to ensure urban fish farming sustainability, all these constraints should be eliminated not only by the urban fish farmers but also by other stakeholders in the fish farming development like the policy makers (government) and research organisations.

5.2.2 Recommendations for urban fish farmers

For the development of profitable and sustainable urban fish farming in Dar es Salaam it is recommended that technical advice and modern technologies should be

expanded to urban fish farmers. For example, fish farmers should be provided with needed inputs (i.e. fertilizers, lime, quality fingerlings and fish feeds) at a reasonable cost as well as market information. In addition, if fish farming is a buyer driven, contract farming should be introduced and should go hand in hand with the accessibility of farm inputs, improved technologies and extension services.

Specifically, urban fish farmers are recommended to stock disease resistant varieties; put in place adequate disease preventive measures; arrange for prompt veterinary attention when ever there is outbreak of diseases and also ensure good security around their farms. Also, fish farmers should add other farm enterprises (i.e. animal keeping and vegetable garden) to fish farming in order to make overall operation more efficient and more profitable. In this way urban farmers will participate and benefit fully from urban fish farming.

5.2.3 Recommendations for government policy makers

Government is one of the institutes required to create a conducive environment for the development of sustainable urban fish farming. Thus, the government policies and interventions affect urban fish farming development potential as well as sustainability. Therefore, in order to have sustainable urban fish farming the study recommends that the government should:

i. Attract medium to large scale farmers into urban fish farming enterprises not only to increase output to bridge the supply gap but also to provide employment for the unemployed urban youths.

ii. Facilitate capacity building training and orientation programmes to steer-up sustainable fish farming. Among others, these training should focus on fish farming technologies, sustainable way to construct fishponds and the fish farming relationship to the natural environment.

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APPENDICES

Appendix 1: Questionnaire for urban fish farming households

SECTION A: FISH FARMER'S CHARACTERISTICS

A1	Age (years)	
A2	Sex	1=Male 2= Female
A3	Marital status	1= Single 2 = Married 3 = Widowed 4 = Separated
A4	Education level	1= None 2 = Primary 3 = Secondary 4 = Post-secondary certificate 5=Diploma 6=Higher education
A5	Family size – (Number of people in the household?)	
A6	Primary Occupation	1=Permanently employed 2=Temporarily employed 3= Self-employment 4=Casual labourer 5 = Farming (including fish farming) 6= Unemployed

SECTION B: INFORMATION ON PROFITABILITY OF URBAN FISH FARMING

B1:For how long have you been involved in fish farming?

1= Less than 5 years 2= 5 to 10 years 3 = More than 10 years

B2	Reason for fish farming	1 = To get income 2= To get food 3= To diversify income 4 = Hobby 5 = Inherited 6 = Tradition 7 = Lack of job 8= Others (specify).....

B3: Which kind of fish are you farming?

……...

B4: Are you using your own land or you're lending?

……..……

B5: What costs did you incur in your fish farming last season? Please use form no. 1

B6: Did you sell your fish or fish product last season? 1. Yes 2. No

B7: If yes, what was the average price of 1Kg fish in TZS

…….....……...

B8: To whom are you selling your produce? Please specify in the table below

PRODUCT	WHERE SOLD

B9: What was the amount of income obtained from your fish farming activity last year season?

……..……
……

B10: Would you say your household income has increased, remained more or less the same or decreased after getting involved in fish farming? (√ Appropriate):

1. Increased ---------- 2.Remained more or less the same (No change) ----------3.Decreased----------

SECTION C: CONTRIBUTION OF URBAN FISH FARMING ON HOUSEHOLD INCOME

C1: What are other sources of household income apart from fish farming?

S/n	Source of income	Amount earned per year (TZS)
1	Salaried employment	
2	Petty business	
3	Fish farming	
4	Transfer payments	
5	Other sources (Please specify)	
Total		

C2: Please mention household assets/properties, which were purchased using income obtained from the fish farming?

……
……
…….

SECTION D: INFORMATION ON URBAN FISH FARMING AND EMPLOYMENT
D1: Have you employed any labourer? Yes ( ) No ( )
D2: How much do you pay him/ her per month?
.....
D3: What is the nature of the employment? 1. Temporally [ ] 2. Permanently [ ]
D4: Sex of your employee? Male ( ) Female ( )
(If is more than one please specifying how many are male and how many are female?)

SECTION E: INFORMATION OF URBAN FISH FARMING ON HOUSEHOLD FOOD SECURITY

E1. What food items do you consider to be luxury or of high value? ----------

E2. How often do you consume fish? (√)
1. Very often ---------- 2.Often ---------- 3.Rarely ---------- 4. Not at all ----------

E3: Compared to the past, do the consumption of fish improved, remained the same or decrease since you started fish farming? (√)
1. Increased ---------- 2.Remained the same ---------- 3. Decreased ----------

E4: What portion of your fish production do you use for your home consumption per production cycle?
……...……...
……
.....
E5: How many times in a week your family eats fish or fish product?
……...……
…
Please specify amount in term of Kg per each time in week.
……..……
……

SECTION F: INFORMATION ON URBAN FISH FARMING AND ENVIRONMENTAL POLLUTION

F1: What are the effects of urban fish farming on environment?
.....
.....
.....
.....
.....**SECTION G: CHALLENGES FACING URBAN FISH FARMERS AND PROPOSED SOLUTIONS**

G1: What are the challenges facing you as an urban fish farmer?
……
……
……
……

G2: In order to solve these challenges what do you think should be done?
……
……
…..……
……..……

THANK YOU VERY MUCH FOR YOUR TIME AND CO-OPERATION

Appendix 2: Questionnaire for non-fish farming households

SECTION A: RESPONDENT'S CHARACTERISTICS

A1	Age(years)	
A2	Sex	1=Male 2= Female
A3	Marital status	1= Single 2 = Married 3 = Widowed 4 = Separated
A4	Education level	1= None 2 = Primary 3 = Secondary 4 = Post-secondary certificate 5=Diploma 6=Higher education
A5	Family size – (Number of people in the household?)	
A5	Primary Occupation	1=Permanently employed 2=Temporarily employed 3=Self-employment 4=Casual labourer 5 = Farming (including livestock) 6=Unemployed

SECTION B: INFORMATION OFURBAN FISH FARMING ON HOUSEHOLD FOOD SECURITY

B1. What food items do you consider to be luxury or of high value? ----------

B2. How often do you consume fish? (√)

1. Very often ---------- 2.Often ---------- 3.Rarely ---------- 4. Not at all ----------

B3: How many times in a week your family eats fish or fish product?

…….…… Please specify amount in term of Kg per each time in week.

…….

SECTION C: INFORMATION ON URBAN FISH FARMING AND ENVIRONMENTAL POLLUTION

C1: What are the effects of urban fish farming on environment?

.....
.....
.....
.....
.....
.....

C2: Do you think urban fish farming has advantage? 1. Yes 2. No

C3: If yes, please mention the advantages of urban fish farming

……
……
……
……
……

C4: If no, explain why you think so?

……
……
…….....
.....

THANK YOU VERY MUCH FOR YOUR TIME AND CO-OPERATION

Appendix 3: Checklist for Ministry of Agriculture Livestock and Fisheries (MALF)
Contact person and
title……..……..……..……
Mobile number: +255……
Email:……..……

QN 1. What are the performance of urban fish farming in Tanzania and specific in Dar es Salaam? – *Please ask for data and/or report if available to show the trends.*

QN 2. What are the current policies and planned initiations to improve or promote urban fish farming at national level?

QN 3. Describe constraints and opportunities of urban fish farming?

QN 4. What plans do you have for the future interventions?

QN 5. Do you have any suggestions in terms of strategy to promote urban fish farming? *If yes, explain your suggestions*

Appendix 4: Checklist for Municipal Councils (i.e. Ilala, Kinondoni and Temeke)
Contact person and
title……..……..……..……..……
Mobile number: +255……
Email:……..

QN 1. Who are the actors/partners in urban fish farming in your area? *Please mention them and state their roles in urban fish farming*

QN 2. How can you describe the urban fish farmers? *Please ask for a list of urban fish farmers at each municipal*

QN 3. What are your current interventions in the urban fish farming?

QN 4. What plan do you have for the future interventions?

QN 5. Do you have any suggestions in terms of strategy to promote urban fish farming? *If yes, explain your suggestions*

Appendix 5: Checklist for NGOs/Project
Contact person and
title..……..
Mobile number: +255……..……
Email:……..……..…….

QN 1. What has NGO/Project been doing to promote urban fish farming?

QN 2.What has been NGO/Project approach? And how did it work?

QN 3. How can you describe the urban fish farmers you working with?

QN 4. What plan do you have for the future interventions?

QN 5. Do you have any suggestions in terms of strategy to promote urban fish farming? *If yes, explain your suggestions*

Appendix 6: Profitability analysis of fish farming

Income/cost items	**Amount (in TZS)**
Revenue per pond	
Variable costs	
Labour	
Feeds	
Fingerlings	
Fertilizer	
Lime	
Drugs	
Transportation	
Security	
Other variable costs	
Total variable costs	
Gross Margin	

N: B
Please specify:
(a) Pond size? …….Square meter
(b) Yield per pond? ……..Kilograms