THE DETERMINANTS OF PERFORMANCE IN SEMI INTENSIVE TILAPIA AQUACULTURE PROJECTS IN DAR ES SALAAM

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A DISSERTATION SUBMITTED IN PARTIAL FULLFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF PROJECT MANAGEMENT (MPM) OF THE OPEN UNIVERSITY OF TANZANIA

2015

CERTIFICATION

The undersigned certifies that he has read and hereby recommends for acceptance by the Open University of Tanzania a dissertation entitled: ***The Determinants of Performance in Semi Intensive Tilapia Aquaculture Projects in Dar Es Salaam*** in partial fulfilment of the requirements for the award of the degree of Master of Project Management of the Open University of Tanzania.

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Dr. Salvio Macha

(Signature)

....

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DECLARATION

I, **Niza Leonard Mwenesi**, do hereby declare that this dissertation titled ***" The determinants of performance in semi intensive tilapia aquaculture projects in Dar es Salaam"*** is my own original work and has been submitted and will not be submitted for a similar or any other degree in any other University.

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Signature

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Date

DEDICATION

The researcher has been interested in aquaculture business since 2008, he has been searching for technical and financial information regarding fish farming in order to establish his own profitable Semi Intensive Tilapia Aquaculture (SITA) business in Dar es Salaam. The search for information has been difficult as most of the fish farmers neither keep their records nor do they follow proper farming methods. The level of details therefore could not suffice as reference for starting a new business. The researcher therefore decided to undertake the research named "The determinants of performance in semi intensive Tilapia aquaculture projects in Dar es Salaam" as a dissertation topic for Master in Project Management at the Open University of Tanzania. This is the researchers` continuous effort towards establishing a sustainable and profitable SITA project in Dar es Salaam. The researcher therefore dedicates this valuable work to his beloved Sons Ivan Niza Mwenesi (four years old) and Alvin Niza Mwenesi (one year old), this is to give them courage and the will to pursue their dreams in life.

ACKNOWLEDGEMENT

The researcher would like to convey his sincere thanks to Righas Safina's Farming Aqua Company Limited Farm Manager, Mr Wilfred Obuoge Zablon, Farm Technician Mr Zacharia Wilfred and the two farm helpers Mr Paschal Godfrey and Respicious John for their positive cooperation during data collection. Secondly, the researcher would like to thank Mrs Mwanukuzi the farm manager of the Mwasonga Fish Farm and the farm technician, Miss Mariam for their good cooperation during data collection. Thirdly, the researcher would like to thank Mr Kenneth Kagombola of the Kiziza Fish Farm for his tireless contribution and provision of valuable information concerning his farm operations.

The researcher would also like to thank Dr Rashid Tamatamah of the department of aquatic sciences and fisheries at the University of Dar es Salaam, for providing his technical overview and experience of SITA activities in Dar es Salaam. Dr Tamatamah also provided the road map on technical aspects of semi intensive aquaculture projects in general.

Lastly the researcher would like to thank Dr. Salvio Macha, the supervisor of this research work for his endless encouragement, guidance, supervision and fruitful criticism that enable this research to meet the required scope within the prescribed time and budget.

ABSTRACT

Enterprise budget, breakeven and sensitivity analyses were conducted in selected fish farms in Dar es salaam to assess the determinants of performance in Semi Intensive Tilapia Aquaculture (SITA) projects. Field data was collected using structured questionnaires, checklists and face to face interviewing and analysed using the Statistical Package for Social Sciences (SPSS). The research findings revealed that the feed prices, survival rate, and farm size have a significant effect on performance of SITA projects and therefore should be optimized in order to attain a profitable and sustainable SITA projects. Higher feed prices decreases net returns and increases the breakeven price per kilogram. It was also evidenced that, the higher the survival rate the higher the net returns and the lower the breakeven prices per kilogram. Also the farmers are advised to ensure that they develop as bigger farms as possible as the farm size increases, the net returns per cubic meter increases and breakeven price above total cost decreases. The study recommends that SITA farmers should conduct a detailed financial plan prior to establishing SITA projects, farmers should establish good quality fish feeds sources with reasonable prices prior to establishment of the farm, farmers should be conversant of all the biological aspects of tilapia farming in order to increase survival rate of his/her stock and lastly farmers should locate the farm in the area where there is a potential of enlarging his/her farm in future.

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ABBREVIATIONS AND ACRONYMS

%	Percentage
FAO	Food and Agriculture Organisation
GIFT	Genetically Improved Farmed Tilapia
IGFA	International Game Fish Association
IRR	Internal Rate of Return
kg	Kilogram
km	Kilometre
m	Meter
MARR	Minimum Attractive Rate of Return
MPT	Modern Portfolio Theory
NASO	National Aquaculture Sector Overseas
NPV	Net Present Value
PI	Profitability Index
SID	Strategic Investment Decision
SITA	Semi Intensive Tilapia Aquaculture
SPSS	Statistical Package for Social Sciences
sqkm	Square Kilometre
TC	Total Cost
TFC	Total Fixed Cost
ToP	Theory of Performance
TVC	Total Variable Cost
URT	United Republic of Tanzania
USAID	United States Agency for International Development
WBG	World Bank Group

CHAPTER ONE

INTRODUCTION

1.1 Background to research problem

The Nile Tilapia (*Oreochromis niloticus*) locally known as "Sato" is popular in consumption markets all over the Tanzania, with the larger percentage sales being in Dar es Salaam. The demand for the Nile Tilapia is predicted to increase due to population growth, expected economic development and changes in eating habits. This provides opportunities for improvement in fish production and commercialization of the smallholder production system. In Tanzania-Dar es Salaam in particular, aquaculture has a vast but yet untapped potential (Chenyambuga, 2013).

Understanding whether SITA project will perform at the required performance level and make profit requires a thorough assessment of the costs and benefits. The recent entrepreneurial movements and respective trainings in Tanzania has motivated the starting up of these projects. Particularly in Dar es Salaam, there have been several projects which have been established in the recent years with the aim of tapping this opportunity. However the question comes, are these projects performing at the required level?, are these projects making any profit?, how much should one invest in order to get a particular return on Investment (RoI)?. This research aims at answering these questions particularly for the proposed projects establishment in Dar es Salaam.

The result of this research is a financial model which will assist in determining the effects of varying performance variables (feed price, farm size and survival rates) in SITA projects in Dar es Salaam. The knowledge obtained from this research will assist fish farmers and managers to sustainably plan and manage profitable aquaculture projects.

1.2 Statement of the research problem

Assessment of the determinants of performance in SITA projects in Dar es Salaam is a crucial undertaking. As described in Section 1.1, there are several basic questions which needs to be answered before one can decide to invest in this type of business. In addition, the knowledge will assist farmers to properly prepare their financial plans and acquire loans from the government or financial institutions.

Most African countries do not easily access financial assistance from government or financial institutions because of the absence of necessary economic data (Yakubu, 2014). Project investment/appraisal techniques could assist fish farmers to determine the profitability of their fish farming activities. The actual valuation of fish ponds, like the valuation of any other resource is difficult concept for most people (Wetengere, 2010). Valuation includes both direct and indirect benefits and intrinsic benefits obtained from the resource.

(Yakubu, 2014) and (Wetengere, 2010) provided a good road map in the financial assessment of aquaculture projects in Africa and Tanzania. This research aims at further analyzing the performance criteria (feed price, survival rate and farm size) and through the use of sensitivity analysis, build a model to determine the RoI in different scenarios.

1.3 Research objectives

1.3.1 General Objective

To assess the determinants of performance in semi intensive Tilapia aquaculture projects in Dar es Salaam.

1.3.2 Specific Objectives

The specific objectives are measured based on (20m * 30m =600 m^2) ponds which is typical size of most SITA farms in Dar es Salaam and the assessment is based on one year of operation. The specific objectives of the research are;

i. To undertake enterprise budget Analysis of 600 m^2 ponds (as a base case scenario) in one year of operation;

ii. To undertake Breakeven Analysis of 600 m^2 ponds (as a base case scenario) in one year of operation;

iii. To assess the effect of net returns per one cubic meter and breakeven above total cost of varying feed prices;

iv. To assess the effect of net returns per one cubic meter and breakeven above total cost of varying survival rates; and

v. To assess the effect of net returns per one cubic meter and breakeven above total cost of varying farm size.

1.4 Research questions and or hypothesis

1.4.1 Specific Research Question

i. What is the Enterprise budget of 600m^2 Tilapia farm (base case scenario) over one year of operation?;

ii. What is the breakeven price and yield of 600m^2 Tilapia farm (base case scenario) over one year of operation?;

iii. What is the effect on the net returns per one cubic meter and break even above total on varying feed prices?

iv. What is the effect of the net returns per one cubic meter and breakeven above total on varying survival rates?

v. What is the effect of the net returns per one cubic meter and breakeven above total cost of varying farm size?

1.5 Significance of the study

Efficient management of aquaculture projects can make the difference between profits and losses, even in years of unfavorable prices and costs. Farms management involves more than just taking care of the biological processes involved; it includes paying close attention to economic and financial measures of the farm business also. This research may provide a practical overview of economic and financial indicators and analyses of the performance of tilapia farm business. The research may specifically contribute the following knowledge and experience.

1.5.1 Management Improvement

The study may assist farm owners and managers to make more informed management decisions on tilapia farms. The study may provide the linkage between the determinants of performance (for this case feed prices, survival rates and farm sizes) with respect to the forecasted return on investment. The farm managers may be in a good position to negotiate feeds prices, to understand what pond sizes are suitable for a given capital, stocking density, tilapia selling prices and other management aspects in order to achieve a profitable and sustainable project. The results of this study is an operational model which will assist in achieving sustainable SITA operations.

1.5.2 Ensure Profitability

The purpose of any business is to make money, or to generate profits. This would seem to be simple and straight forward concept. Nevertheless, there are several different ways to look at the profitability of a business activity. Proper management of the determinants of performance can make the difference between profits and losses, even in years with unfavorable prices and costs. The study may assist aquaculture farm managers to integrate the biological, economical and financial measures to ensure profitability and sustainability.

1.5.3 Adoption and implementation of appropriate policies in intra-regional trade.

Africa has a the potential to develop its fisheries and aquaculture sector to play a much greater role in promoting food security, providing livelihoods and supporting economic growth (Hall, 2015), the director of World Fish stated this during the 4th March 2015, launching of the pan African project which aimed at strengthening African Governments including Tanzania on great potential to increase trade in fish as well as support adoption and implementation of appropriate policies in intra regional trade.

This study may increase knowledge to the URT fisheries policy makers, specifically for urban areas. The study may also be the source of updated information on current status of the SITA projects in Dar es Salaam.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter highlights how other researchers have approached the aquaculture management projects and their experience. The main objective is to incorporate their previous researches information in this study in order generate appropriate solution and suggestion on improving SITA projects performance in Dar es Salaam.

The conceptual definitions, theoretical and empirical literature review, policy review, research gap and conceptual and theoretical framework are described in this chapter. The conceptual definitions mainly contains concepts used in determining performance of SITA projects. Within the theoretical literature review, relevant theories relating performance indicators have been described. Empirical review worldwide in Africa and Tanzania has also been addressed.

A theoretical framework provides a rationale for predictions of the relationship between the determinants of performance in SITA projects and the projected profits. Theories are constructed in order to explain, predict and master phenomena (e.g. relationships, events, or the behavior) on the other hand conceptual framework is used in research to outline possible causes of action or to present a preferred approach to an idea or thought.

2.2 Theoretical Literature Review

2.2.1 The theory of performance

The Theory of performance (ToP) by (Elger, 2008) develops and relates six fundamental concepts to form a framework that can be used to explain performance as well as performance improvements. To perform is to produce valued results. A performer can be an individual or a group of people engaging in a collaborative effort. Developing performance is a journey, and level of performance describes location in the journey. Current level of performance depends holistically on six components I.e. context, level of knowledge, level of skills, level of identity, personal factors, and fixed factors. Three axions are proposed for effective performance improvements. These involve a performer mindset, immersion in enriching environment, and engagement in reflective practice.

Relating to this research " The determinants of performance in semi intensive tilapia aquaculture projects in Dar es Salaam" the theory of performance gives a guide on how the SITA project managers and keepers should equip themselves in order to achieve valued results. The above mentioned six components of the theory of performance are the key instruments towards achieving good performance.

2.2.2 Uncertainty theory of profits

Uncertainty Theory of profits by Frank Knight, (1921), holds that profits as a non contractual residual accruing to the entrepreneur for his non transferable function of bearing uninsurable future uncertainty, I.e. profit is the price paid for bearing uninsurable uncertainty. The uncertainty is caused by the following factors: competitors' behavior, innovations, consumers' behavior (like taste etc), government policy interventions, wage and labor policies, income of people, movement of prices, technological changes, natural disturbances, etc. This is also a residual and windfall theory of profits.

Relating to this research, SITA managers are required to consider both biological and economical factors in order to achieve good performance. Even if the biological factors have been well considered, the farmer should ensure other factors such as competitors' behavior, innovations, consumers' behavior (like taste etc), government policy interventions, wage and labor policies, income of people, movement of prices, technological changes, natural disturbances are also considered to ensure sustainable performance of the farms.

2.2.3 Oxbow Theory

This version on the origin of aquaculture by (Rabanal, 1988) relates to the beginnings of this industry to existing natural rivers and stream especially in inland areas. These rivers, in the course of time, develop curves and oxbows which, due to natural topography and physiography of the area, may further result into long, winding oxbows of varying sizes. As time went on, under varying flood levels that occurred in different years such rivers may have changed their courses behind leaving behind the formed oxbows together with the fish and other living organisms in them.

Human populations along the rivers, who by adaptation are natural fisherman discovered that a good harvest could be derived from these naturally formed oxbows. It was also found that seasonal flooding of these water areas restocked them with fish which again could be harvested during the ensuing dry season. Taking full advantage of this occurrence individuals in the surrounding communities would begin to improve the embankments enclosing such oxbow areas for aquaculture purposes.

Subsequently, in addition to the seasonal natural stock of fish that enter the modified oxbows, additional stock may be planted, thus starting aquaculture management in them. This continued on until complete aquaculture management was attained. Development of this nature is exemplified by extensive low lying areas with a network of rivers and a distinct annual rainy and dry season period.

In relation to this research, the theory provides a historical overview on how aquaculture activities emerged and points out the opportunities and challenges which were faced. The theory equips farm managers with good experience and technical knowledge of the aquaculture activities.

2.3 Empirical Literature Review

This section is aimed at reviewing previous SITA projects which have the similar theme, particularly the ones which describe both biological and economical performances of aquaculture projects. Literature reviews from around the world, Africa and Tanzania was conducted and relevance to this study has been discussed.

2.3.1 Literature review from Africa and other parts of the world

Since mid 1990s, fish production from global capture fisheries has stabilized around 90 million tons, with marine fisheries contributing around 80 million tons (WBG, 2013). This represents a substantial increase from 18.7 million tons in 1950, of which 16.8 million tons was from marine waters. Despite the overall growth of fish consumption and trade that has occurred in much of the world, a decline in per capital fish consumption has been observed in some Sub-Saharan African countries, such as Gabon, Malawi, South Africa, and Liberia (FAO, 2012), as well as in some developed countries, such as Japan and the United States.

With this global view of fish demand and supply, it is evident that there is a big room for expansion of aquaculture business in Tanzania with growth perspective within Africa and world at large.

As most countries in sub Saharan Africa have weak banking systems, some governments such as in Nigeria, Kenya and Malawi provides soft credit loans for agriculture projects in some agriculture development commercial banks (FAO, 2012). In Malawi the initiative is in framework of a USAID funded programme to support lending to the so called "Malawi Gold Standard" or to support emerging small scale commercial farmers. 12 percent of fish farmers in Ghana are able to obtain loans from both agriculture development and commercial banks. However, it is evident from the National Aquaculture Sector Overseas (NASOs), that access to finance by small farmers (non commercial and commercial) is one of the major constraints to expand and intensify production.

It was however noted that, there are several banks in Tanzania which have started to offer agricultural loans, for example the Equity Bank of Tanzania has "Uvuvi Biashara Loan" which is granted to fish farmers and those in the fishing business to enable them to purchase fishing equipment, boats, cooling equipment, construction of fish ponds etc. The Bank may provide a minimum loan amount of Tshs 100,000 and a maximum of Tshs 50,000,000 with interest rates of 18% (Equity Bank Tanzania, 2015).

Tilapia is known to be an important specie for subsistence fisheries for thousands of years but have gained prominence in recent years. Tilapia, that is native to Africa and middle east, has emerged from mere obscurity to one of the most productive and internationally traded food fish in the world (Ahmed *et al*, 2015).

Tilapia fish (Figure 2.1) is well suited to fish farming because it grows quickly, able to survive in poor water conditions and eats wide range of foods. The adult Tilapia prefers vegetation diets, varying from macrophytic to phytoplanktivorous. In ponds with supplementary feeding, natural food contribute (30-50)% of tilapia growth. Sexual maturity in Tilapia depends on age, size and environmental conditions. The males grow faster than females. Nile tilapia with (75-500)g body weigh can deposit 50 to 2000 eggs per spawning and can breed easily with no need for special hatchery technology (Chhorn *et al*, 2012).

The monosex tilapia is a fast growing popular fish (Ahmed *et al*, 2015). In Bangladesh, commercial farming of tilapia has been found to develop rapidly since the introduction of Genetically Improved Farmed Tilapia (GIFT) from the Philippines in 1994. The success of using the GIFT strain of tilapia for commercial farming is due to its ability to produce millions of monosex male fry in hatcheries and this practice has been found to considerably eliminate the problems related to production of mixed sex tilapia showing slow growth as well as the production of small sized individuals in a given culture facility.

There are three commercial species of Oreochromis such as Nile tilapia (*O. niloticus*), Mozambique tilapia (*O.mossambicus*) and the blue tilapia (*O.aureus*). *O. niloticus* has been reported as the best specie for cultivation in ponds (Appendix 9). Since *O. niloticus* reaches sexual maturity after three to five months of age, they typically weigh (150-200)g more than *O.mossambiccus*. In ponds after eight months of culture. tilapia can weight 500g.Overpopulation can be controlled (by stocking one catfish per two tilapias).Doing so causes the production homogeneous weigh of individuals that can be sold at a uniform price

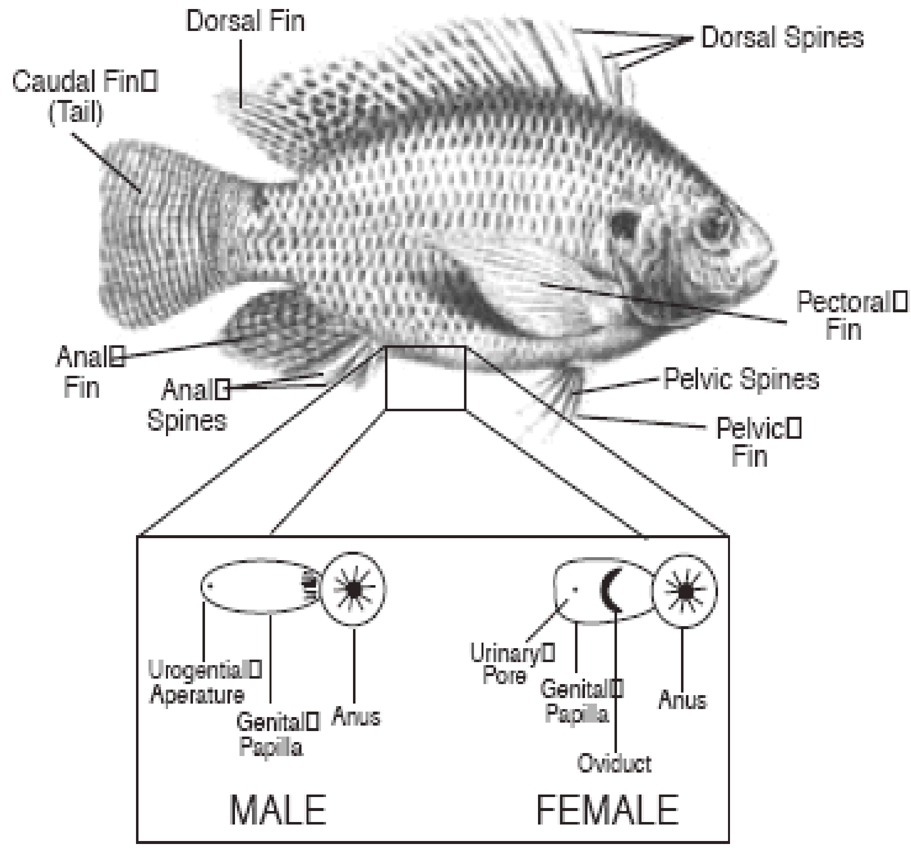

Figure2.1 : Fins and genital papilla of the Nile Tilapia

Source: [www.thefishsite.com] (2015)

The importance of proper design, construction and the need for involvement of experts during the process of setting up aquaculture production units is paramount (Infonet Biovision, 2015). Ideally, production units should be designed in such a way to allow total control of what gets in or out, when it gets in or out, how it does this, how much gets in or out and the rate of getting in and out, as indicated in (Figure 2.2). The final size of the fish farm is determined by; the amount of water available for fish culture, the technology to be employed as intensive systems require less land compared to semi intensive systems to produce the same quantity of fish and lastly the target production and capital available for investment.

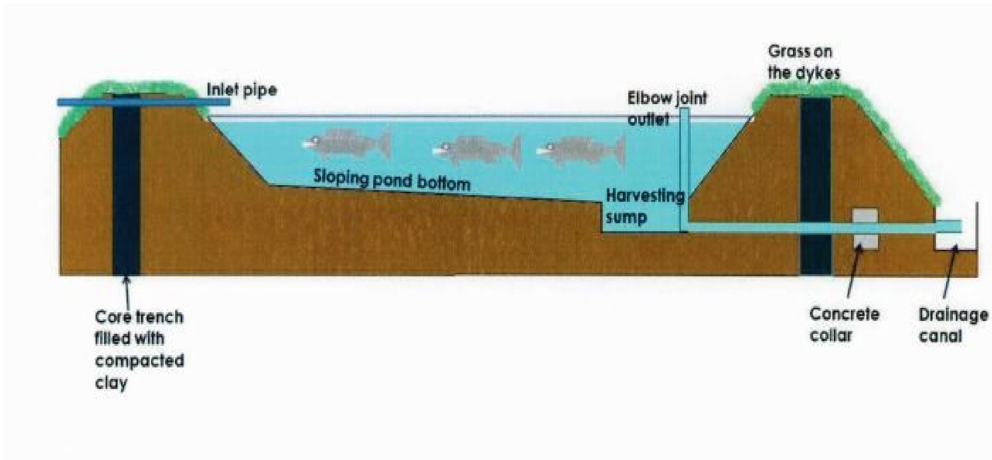

Figure 2.2 : A cross section of a completed pond showing the position of various structures

Source: Infonet Biovision (2015)

It has been established that a well treated animal manure can serve as organic fertilizer and feedstuff in fish ponds while maggots, livestock offals, bones and feather meal can form part of fish feed ingredient without affecting the taste, meat quality of the fish and even increases the profitability of fish farming Adewumi *et al* (2011).

Afolabi *et al*, (2012) From the department of Agricultural Economics and Extension in Nigeria undertook the study and revealed that tilapia can be successfully cultivated in peri-urban homestead concrete tanks. The practice can be both economically and technically viable, as revealed by the results of the Net Present Value (NPV), Internal Rate of Return (IRR) and Benefit Cost Ratio (BCR) calculations on the project. The study has also demonstrated that the culture of hybrid tilapia in outdoor concrete tanks is possible without affecting growth and water quality. There is considerable potential for achieving Nigeria's objectives in increasing fish protein production most especially in the urban centers by farming fish in family-based homestead concrete tanks. This practice will greatly enhance the current low per-capita fish protein intake, and when widely accepted and extensively practiced will probably reduce the existing deficit between fish supply and demand in Nigeria. The practice of rearing fish under small-scale intensive system in homestead tanks is still new which is probably responsible for its little recognition. There is need to introduce and encourage the practice nation-wide and it should be backed with adequate extension service and publicity with the aim of creating awareness.

Fish farming in most part of Tanzania is practiced as standalone activity, which can be a risky venture, because of economic factors such as the price instability. Aquaculture in Tanzania began in the late 1950s with the pond culture of tilapia species native to the region. To date, it has not done any better. In the early 1970s, international donor funded projects were responsible for establishing approximately 8000-10000 ponds producing about 2000tons per year Ogello *et al* (2013). The number of fish ponds fell to less than 1000 by 1985 due to poor management, inappropriate technologies, inadequate extension efforts, poor marketing and infrastructure. Despite a decline in pond tilapia aquaculture in Tanzania livestock fish culture is still viewed as a possible source of livelihood for farmers in the coastal; region that is closer to the urban markets of Dar es Salaam.

Chenyambuga *et al* (2013) undertook the study of value chain of Nile Tilapia cultured in ponds of small scale farmers in Morogoro Region Tanzania and basically came up with the following conclusion; The main factors in the value chain of cultured Nile Tilapia are fingerling producers, fish farmers and consumers. Most farmers sell fresh fish directly to neighbors and consumers in the local markets within the village. Fried and smoked fish fetch higher price than fresh fish in the local markets. The major constraints to Nile Tilapia farming under small-scale fish farming is lack of funds, stunted growth of stocked fish, inadequate knowledge on fish farming and unavailability of concentrate feeds.

Shoko *et al* (2011) undertook an experiment to demonstrate the role of vegetable fish culture integration in the growth, yields and economic benefits of fish and vegetables in Tanzania. The study concluded that the fish reared under integrated system exhibited higher growth rates and net yields thus higher income than those reared under non integrated systems.

2.4 Policy review

2.4.1 Fisheries Act, 2003

This act provides for the sustainable development, protection, conservation, aquaculture development, regulation and control of fish, fish products, and aquatic resources and its products and related matters. Section 9 of the act charges the Director of Fisheries to promote, encourage and support all initiatives leading to the development and sustainable use of the fish stock and aquatic resources.

2.4.2 The Water Resources Management Act, 2009

The Water Resources Management Act, 2009 (URT, 2009) provides a framework for the management and utilization of water, taking into account domestic, social, industrial and environmental needs. The Act provides principles and objectives of Water Resources Management, which includes among others: (a) meeting the basic human needs of present and future generation; (b) promoting equitable access to water; (c) promoting the efficient, sustainable and beneficial use of water in the public interest; (e) protecting biodiversity, especially the aquatic ecosystem and; (f) providing a system for the management of the resources and implementation of international obligations.

The Act directs the need to apply and pay all required fees for water utilization permits. It also directs the adoption of integrated water resource management approaches and the application of principles such as: (a) precautionary principle, (b) polluter pays principle and, (c) the principle of ecosystem integrity.

2.5 Research gap

Considering the theoretical and empirical literature reviews, previous researches on development of quality cost effective rations from locally available resources, and means of accessing credits to small scale fish farmers to enhance farming under small scale production systems were used as base case scenarios. This research " the determinants of performance in semi intensive Tilapia aquaculture project in Dar es Salaam" has been designed to provide the unavailable information concerning the first track performance criteria in achieving successful semi intensive aquaculture project in Dar es Salaam, Tanzania.

2.6 Conceptual Framework

Figure 2.3 describes conceptual framework of the determinants of SITA projects. The model indicates that feed prices, survival rates and farm sizes are the major independent variables whereby the total cost (the sum of total variable cost and total fixed costs) being the dependent variable. The total cost therefore determines the breakeven price per kilogram and breakeven yield per kilogram.

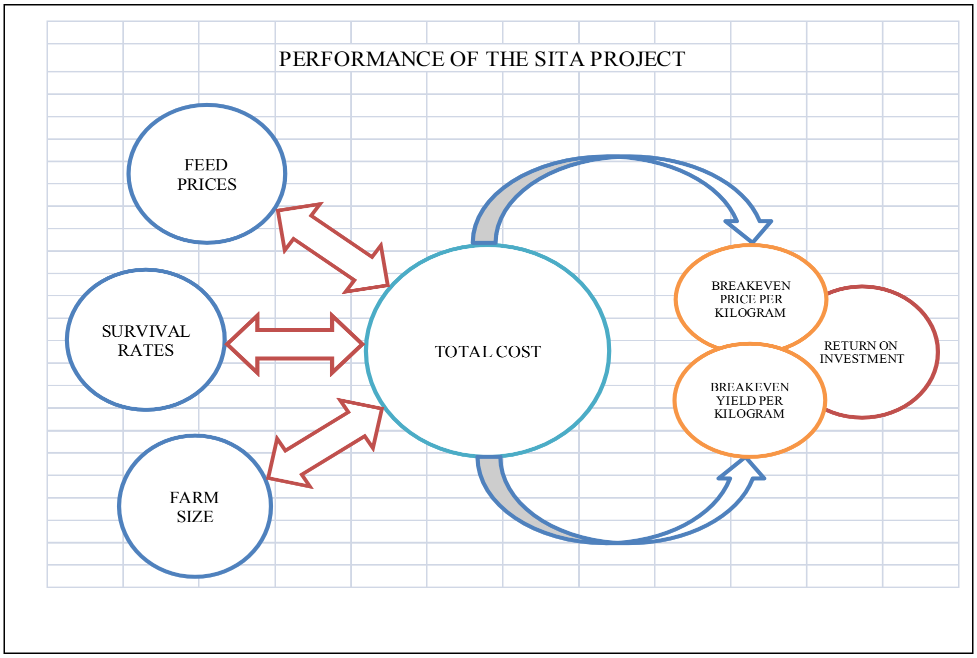

Figure 2.3 : Conceptual Framework of SITA performance determinants
Source: Research Findings (2015)

2.6.1 Conceptual definitions

- **Fishery**

Generally a fishery is defined as an entity engaged in harvesting and raiding fish which is determined by some authority to be a fishery. A fishery may involve the capture of wild fish, also referred to as capture fisheries or raising fish through fish farming or aquaculture (Tamatamah, 2009)

- **Aquaculture**

Aquaculture is defined by FAO as "the farming of aquatic organisms, including fish, mollusks, crustaceans, and aquatic plants. Farming implies some form of intervention in the process to enhance production, such as regular stocking, feeding, protection from predators etc it also implies ownership of stock being cultivated Earth Trends, (2003)

- **Semi intensive aquaculture**

In semi intensive system feeding is offered to the fish and natural productivity of the pond is harnessed and supplemental aeration is normally done. Production levels can be as high as five tons per hectare per crop. Yakubu, (2014)

- **Gross Receipts**

Are the total amounts the project receives from all sources during the annual accounting period (Investopedia, 2015), without subtracting any costs or expenses. In this particular case are the receipts obtained from selling live tilapia per kilogram.

- **Variable Costs**

Are those costs that vary depending on the production volume; they rise as production increases and fall as production decreases (Investopedia, 2015). In SITA the main variable costs considered include the costs of buying tilapia fingerlings, Pelleted diet (feeds), fertilizer, field labour etc.

- **Fixed Costs**

Are expenses that have to be paid by a company, independent of any business activity. It is one of the two components of the total cost of a good service along with the variable cost. Particularly in this study the following fixed costs were considered i.e. depreciation of equipment and ponds.

- **Return on Investment (RoI)**

Is the benefit to the investor resulting from investment of some resource. A high RoI means the investment gains compare favorably to investment cost.

- **Breakeven Price/breakeven yield**

Is the amount of money for which an asset must be sold to cover the costs of accruing and owning it/the amount of money for which a product or service must be sold to cover the costs of manufacturing or providing it. In this study, the breakeven price is the price of selling tilapia fish per kilogram in order to cover their production costs per kilogram.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This Section describes the methodology used in data collection in order to answer all the given research questions. The research design constitutes the blue print for collection, measurement and analysis of data (Kothari, 2004). The methodology has been designed specifically to suite the study " The determinants of performance in semi intensive tilapia aquaculture projects in Dar es Salaam" and to be able to address all the research specific objectives.

3.2 Research paradigms

Research paradigms address the philosophical dimensions of social sciences. A research paradigm is a set of fundamental assumptions and beliefs as to how the world is perceived which then serves as a thinking framework that guides the behavior of the researcher (Wahyuni, 2012). The four popular paradigms that shape the thinking of researchers are positivism, postpostivism, constructivism and matter-of-factness. Tashakkori and Teddlie (1998) argue that while pragmatism refuses to join the ‘paradigm war’ between the positivist and interpretive research philosophies, and instead of questioning ontology and epistemology as the first step, pragmatist supporters start off with the research question to determine their research framework. This study takes the stand of realist in reaching the object of the study.

3.3 Research Design

Three semi intensive aquaculture farms were selected on each Dar es Salaam Districts I.e. Temeke, Ilala and Kinondoni. The site locations were selected based on administrative and technological advancement of the farms compared to the other farms within the District.

3.3.1 Population size

It is estimated that, Dar es Salaam has a total of 15 Semi Intensive Tilapia Aquaculture farms (fortuneofafrica, 2015). The farms are randomly distributed within the three Districts I.e. Kinondoni, Temeke and Ilala. These 15 SITA farms were the ones considered as the population size for this study.

3.3.2 Sampling Method

This study used judgmental sampling method. The researcher employed judgmental sampling to select sample from the suitable SITA farms in Dar es Salaam. The benefit of using this method is that it gives chance for researcher to judge properly which farms are suitable to provide reliable information at right time in order for the study to be accomplished.

3.4 Sample Size

This is the number of items selected from a population to constitute the sample. It is also the act of choosing the number of observations or replicates to include in a statistical sample. The sample size is an important feature of any empirical study in which the goal is to make inferences about a population from a sample. In practice, the sample size used in a study is determined based on the expenses of data collection, and the need to have sufficient statistical power. Three SITA farms were selected from the three Dar es Salaam Districts, making a total of 9 sample size from the population of 15 SITA farms in Dar es Salaam.

3.5 Data collection methods

Both qualitative and quantitative data were collected. The information on determinants of performance at individual semi intensive farms were then collected with the following objectives;

i. To cover the sample of semi intensive farms in Dar es Salaam to be able to estimate the Return on Investment (RoI) of a 600m^2 farm over one year of operation;
ii. To cover the sample to be able to determine the factors affecting performance such as feed prices, survival rates and farm sizes.

It was decided to interview farm managers and keepers to provide useful data for this survey, an effort was made to identify individual farms with comparatively good performance. The possible impact of this choice is a sample biased in favor of the farmers who keep records of their operations.

Therefore the present survey exercise should be considered as frame survey which could be used as reference if broader performance measurements surveys are required. A more immediate use of the present survey is to assess the determinants of performance in semi intensive tilapia aquaculture projects which are comparatively in good operation.

3.5.1 Primary Data collection Methods

3.5.1.1 Questionnaires

Questionnaires were designed and used to gather specific information from the selected farms I.e. The questionnaire was designed to capture the following information;

i. General farm information (farm name, location, area)

ii. Ponds description (water source, description of the production activities)

iii. Enterprise cost and price (source of fingerlings and cost, cost of feed); and

iv. Production characteristics employed by the farm (stocking density, average survival rate, tilapia selling price).

The sample questionnaires which were used in this research are attached as Appendix 1.

3.5.1.2 Checklists

The checklist consisted of a prepared list of items pertinent to SITA activities. The presence or absence of each item may be indicated by checking 'yes' or 'no' or multipoint scale. The use of a checklist ensured a more complete consideration of all aspects of the farm, act or task. Checklists contained terms, which the respondent understands, and which more briefly and succinctly express his views than answers to open-ended question. It is a crude device, but careful pre-test made it less so. Due to the nature of the study two types of checklists were developed;

a) Checklist for enterprise cost and price in Tshs, and

b) Checklist for production characteristics.

The checklists are attached as Appendix 2 and 3.

3.5.1.3 Interviewing (face to face interviews)

Face -to -face interviews were administered to the farm managers and helpers. The interviews yielded highest response rates in the survey. They also allowed the researcher to clarify ambiguous answers and when appropriate, seek follow-up information.

3.5.2 Secondary Data collection Methods

Secondary data collection involved the review of available documents and records which mainly included guides for tilapia management and species sorting and selection techniques. Other secondary information was sourced from the internet which mainly included the published journals, this mainly included the literature on proper management of Tilapia fish. This wealth of background work means that this secondary data has a pre-determined degree of validity and reliability which need not to be re-examined by the researcher.

3.6 Variables and measurements procedures

The researcher analyzed in a general way whether or not it would be profitable to make a relatively small change in the management of the farm. The changes include to expand existing hectares by building more ponds, changing the feed price and survival rate. The research indicates how the proposed small change can be analyzed with partial budget. In this case, all the new costs, added benefits or reduced benefits that would result from the change would combine to see whether or not overall, the benefits exceed the cost.

3.6.1 Enterprise Budget Analysis

The first step in the analysis of the economics of tilapia farming is to determine if it is possible to make money generally from this type of business activity (Engle et al, 2005). The researcher performed an analysis called an "enterprise budget analysis" An enterprise budget provides a generalized summary of the costs and returns of a particular enterprise-in this case tilapia production-for one year of operation.

3.6.2 Production planning model (A one pond model)

A one pond production model was developed based on the data collected, such as harvesting cost and labor. The pond and stocking characteristics such as number of fingerlings, density of fingerlings was captured through the administered checklist. Other parameters included fertilization mode and duration. The mean body weights and percentages mortality was also determined.

After discussions with the farm managers, the survival rate of all complete cycle was assumed. This was therefore used to calculate the biomass in the pond by multiplying the total number of fish in the pond by the weight divided by 1000g kg^{-1}. That biomass multiplied by the percentage of feeding per month was used to determine the quantity of food needed per month.

$$\text{Biomass (kg)}=\text{Number of fish}*\text{Mean body weight (g)}*10^{-3}$$

$$\text{Length (cm)}=\text{Infinitive length}*(1-\text{Exp}(-K*\text{Time})$$

$$\text{Mean body weight (g)}=a*\text{Length}^{b}$$

The net revenue from this pond was therefore obtained by subtracting the cost of production during the cycle (purchase of fingerlings, fertilizer and food) by total sales. Thus it was possible to determine the net revenue of producing 1kg of fish by subtracting the total costs from the gross revenue.

3.7 Preliminary data analysis

This was associated with data editing and preparing it for further analysis. The analysis involved description of key features of the data, and provision of the summary of the results. It involved a systematically organizing raw data which was collected in a manner that facilitated analysis. For open ended questions the researcher categorized all responses given and assigned numbers to them and for closed ended questions, the researcher assigned numbers to them directly. Data coding, classification and editing was done with the purposes finding mean, variance, standard deviation and kurtosis.

3.7.1 Descriptive Data Analysis

Data from the questionnaires was coded, classified and edited followed by descriptive analysis using SPSS. The descriptive data analysis was provided with summary statistics of data in relation to mean, variance, standard deviation and kurtosis. The results have been reported in the form of tables and figures.

3.7.2 Ethical Issues

In this study the researcher observed basic ethical principles that govern all the stages that are involved in this research. This implies from the research proposal preparation, data collection procedures, data analysis and report writing .The researcher protected the respondents from any harm, and be it social or psychological or physical due to participating giving data.

The research observed the right to privacy. The information that was obtained in the study secured and used for the purpose of this study only.

The respondents were also told to participate voluntarily in such a way that they had a right to withdraw at any time without being victimized and participated willingly.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Enterprise Budget Analysis

The first step in the analysis of the determinants of performance in SITA project is to determine if it is possible to make money generally from this type of business. The researcher performed an analysis called an "enterprise budget analysis". An enterprise budget provides a generalized snapshot of the costs and returns of a particular enterprise-in this case tilapia production in a 600m^2 pond for 1 year of operation. Table 4.1 presents a summary of nine SITA farms surveyed as part of this study.

Table 4.1 : Enterprise budget of the six surveyed SITA farms in Dar es Salaam

Item	Description	Unit	Quantity	Price/Unit	Total Cost
Gross Receipts					
Tilapia	Live	kg	1800	9,000	16,200,000
Total Gross Receipts					16,200,000
Variable Costs					
Tilapia Fingerlings	Hatchery Raised	Individual	1800	300	540,000
Pelleted Diet	15% Crude Protein	kg	225	4,000	900,000
Fertilizer	Urea	kg	65	4,000	260,000
	Diammonium phosphate	kg	32	4,400	140,800
Agriculture Lime	Lime	kg	45	700	31,500
Field Labour, stock., feed, fertilizer, harvest and security		Tshs	12	100,000	1,200,000
Labour levee repairs, after draining		Tshs	1	500,000	500,000
Interest on operating capital		Tshs	3,572,300	0.12	428,676
Total Variable Costs (TVC)		Tshs			4,000,976
Net Returns Above TVC					12,199,024
Fixed Costs					
Depreciation					
Equipment		Tshs			500,000
Ponds		Tshs			1,500,000
Total Fixed Costs (TFC)		Tshs			2,000,000

Item	Description	Unit	Quantity	Price/Unit	Total Cost
Total Costs (TC)		Tshs			6,000,976
Net Returns Above TC		**Tshs/600m^2**			**10,199,024**
Breakeven price per kilogram sold					
Above TVC		**Tshs/kg**			**2,223**
Above TC		**Tshs/kg**			**3,334**
Breakeven yield per kilogram sold					
Above TVC		**kg/m^2/year**			**0.74**
Above TC		**kg/m^2/year**			**1.11**

Source: Research findings (2015)

4.2 Breakeven analysis

Breakeven prices and yields offered an insight into the overall feasibility of the operation. Breakeven price above Total Variable Cost (TVC) was calculated by dividing the total variable cost by the total quantity produced on the farm, In this budget, breakeven price above TVC was Tshs 2,223/kg of tilapia produced. This indicates that tilapia production will be profitable as long as the price is above Tshs 2,223/kg.

Breakeven yield was calculated in the similar manner. The TVC was divided by the price and divided by the $600m^2$ of the farm to obtain $0.7kg/m^2$. As long as production per cubic meter of water is above $0.7kg/m^2$, then it is profitable to raise tilapia in the short run. Breakeven yield above total cost was calculated by dividing the total costs by the price and then divide by $600m^2$ in the farm to obtain a breakeven yield of $1.11kg/m^2$. If production levels are above $1.11kg/m^2$ this operation will be profitable, even in the long run. At this level of production, there is enough production to cover both all variables and all fixed costs.

4.3 Sensitivity analysis

For this research, enterprise budgets were developed based on average expected prices, costs, quantities, and yields. Sensitivity analysis was employed because the prices and costs were observed to be highly variable between the surveyed SITA in Dar es Salaam. The sensitivity analysis considered the range of possible values for the particular price and quantity in question which was substituted for the mean value, and the respective Tables were developed. Table 4.2, 4.3 and 4.4 provide examples of sensitivity analyses done for the SITA budgets by varying feed prices, survival rate, and farm size.

4.3.1 Effect of net returns/m² and breakeven above total cost of varying feed prices

As the feed prices increased from Tshs 2000/kg to Tshs 4000/kg, the net returns/m² decreased from Tshs 10,703, 024 to Tshs 10,199,024. Breakeven prices increased from Tshs 3,054/kg to Tshs 3,334/kg Table 4.2.

Table 4.2 : Effect of net returns/m² and breakeven above total cost of varying feed prices

	Feed Price (Tshs/kg)	Net Returns (Tshs/kg)	Breakeven Price (Tshs/kg)
1	2,000	10,703,024	3,054
2	2,500	10,577,024	3,124
3	3,000	10,451,024	3,194
4	3,500	10,325,024	3,264
5	4,000	10,199,024	3,334

Source: Research findings (2015)

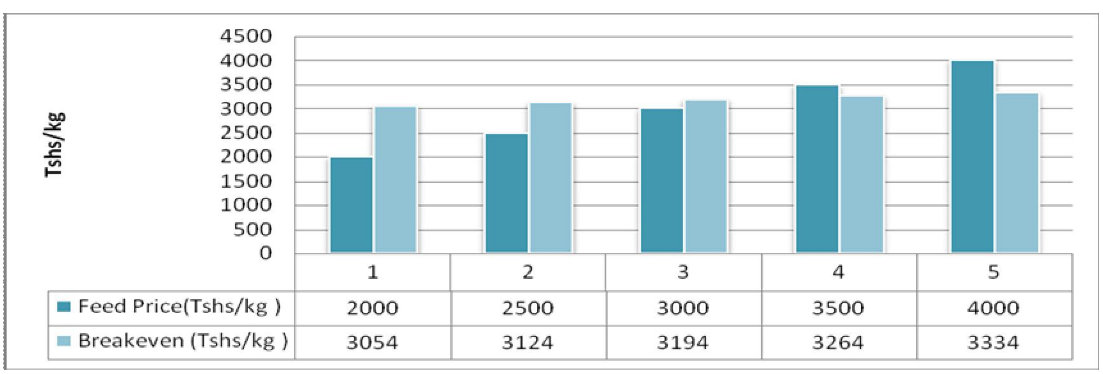

Figure 4.1 : The graph showing Feed Prices Vs Breakeven Price
Source: Research findings (2015)

4.3.2 Effect of net returns/m^2 and breakeven above total cost of varying survival rate

As the survival rate increased from 75% to 95%, net returns/m^2 increased from Tshs 6,149,024/kg to 9,389,024/kg and breakeven prices above total cost decreased from Tshs 4, 445/kg to Tshs 3509/kg Table 4.3 and Figure 4.2.

Table 4.3 : Effect of net returns/m^2 and breakeven above total cost of varying survival rate

	Survival Rate %	Net Returns (Tshs/kg)	Breakeven Price (Tshs/kg)
1	75	6,149,024	4,445
2	80	6,959,024	4,167
3	85	7,769,024	3,922
4	90	8,579,024	3,704
5	95	9,389,024	3,509

Source: Research findings (2015)

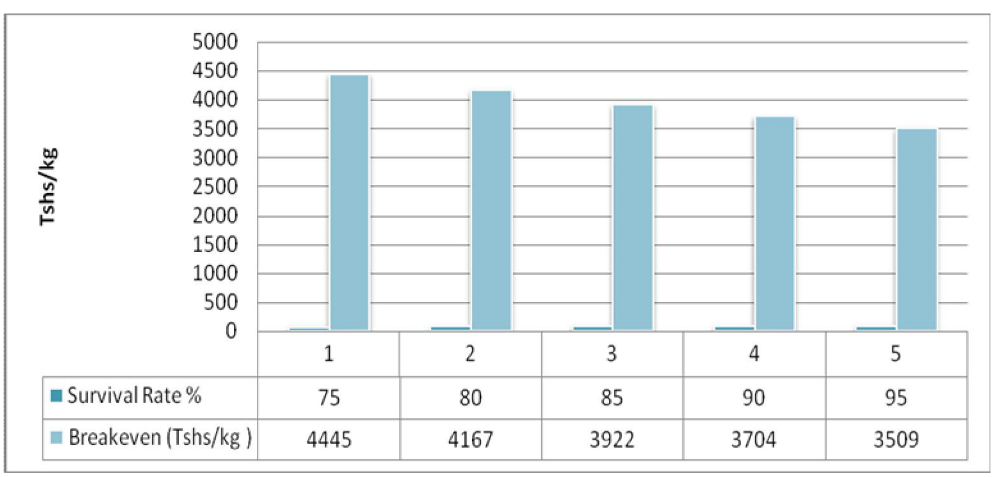

Figure 4.2 : The graph showing Feed Prices Vs Breakeven Price
Source: Research findings (2015)

4.3.3 Effect of net returns/m^2 and breakeven above total cost of varying farm size

As the farm size increased from 600m^2 to 4200m^2, net returns per m^2 increased from Tshs 10,703,024 to Tshs 102,503,024, and breakeven prices above total costs decreased from Tshs 3,054/kg to 458/kg Table 4.4 and Figure 4.3

Table 4.4 : Effect of net returns/m^2 and breakeven above total cost of farm size

			Farm size		Net Returns /ha	Breakeven Price
	Length	Width	m^2	Number of Tilapia Fingerlings	Tshs/m^2	Breakeven (Tshs/kg)
1	20	30	600	1,800	10,703,024	3,054
2	30	40	1,200	3600	26,903,024	1,527
3	40	50	2,000	6,000	48,503,024	916
4	50	60	3,000	9,000	75,503,024	611
5	60	70	4,200	12,600	102,503,024	458

Source: Research findings (2015)

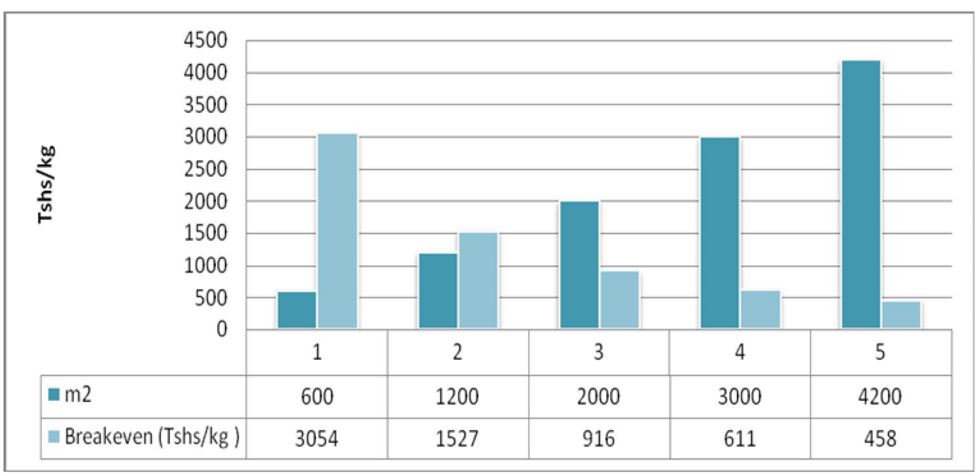

Figure 4.3 : The graph showing Farm size Vs Breakeven Price

Source: Research findings (2015)

4.4 Discussion of the findings

This Section discusses the field findings as analyzed and represented in Section 4.1 to 4.3. This Section discuses the determinants of performance in semi intensive tilapia aquaculture projects in Dar es Salaam and how they relate to the enterprise budget, breakeven price and yield, and the net returns on varying survival rate, feed prices and farm size.

4.4.1 Enterprise budget of 600m^2 Tilapia farm over one year of operation

Section 4.1 and Table 4.1, indicates that is actually possible to make profit from constructing and operating a 600m^2 fish farm over one year of operations. Table 4.1 indicates that, over one year of operation a 600m^2 is capable of generating a Net Return Above Total Cost of Tshs 10,199,024.

This is in line with Wetengere's finding which indicates that, it is actually possible to make profit from fish farming project operations (Wetengere, 2010), however the valuation should thoroughly include both direct and indirect benefits and intrinsic benefits obtained from the resource.

The base case scenario of 600m^2 farm size with Net Return Above Total Cost of Tshs 10,199,024, is a substantial amount which may improve the house hold income. The possibility of scaling up and controlling other performance determinants may further increase the profit. This finding is also inline Chenyambugas finding which states that, In Tanzania-Dar es Salaam in particular, aquaculture has a vast but yet untapped potential (Chenyambuga, 2013).

4.4.2 Net returns/m^2 and breakeven above total cost Vs varying feed prices

As indicated in Table 4.2 and Figure 4.1, controlling feed prices is a very crucial component in fish farming. As the feed prices increases it reduces the net returns. The fish farmer is therefore required to estimate the maximum feed prices he/she can afford in order to realize the profit of the operation. In this particular project it was observed that as the feed prices increased from Tshs 2000/kg to Tshs 4000/kg, the net returns/m^2 decreased from Tshs 10,703, 024 to Tshs 10,199,024. Breakeven prices increased from Tshs 3,054/kg to Tshs 3,334/kg.

These study findings are also supported by the findings from Adewumi *et al* (2011). and Afolabi *et al*, (2012), that the fish feed prices are one of the crucial components of Tilapia fish farming profitability analyses and that they should be carefully analyzed, planned and controlled in order to realize profitability of the Tilapia fish farming projects.

4.4.4 Net returns/m^2 and breakeven above total Vs varying survival rates

The survival rate of all complete cycle was assumed to be 90% as the base case scenario. This was therefore used to calculate the biomass in the pond by multiplying the total number of fish in the pond by the weight divided by 1000g kg^{-1}.

As Table 4.3 and Figure 4.2 suggests that as the survival rate increases the net returns also increases. This indicates that, in order to realize profit in SITA projects, the farmer is required to control not only the economical aspects but also the biological aspects which ensures the survival and well being of the fish. for this particular project it was observed that, as the survival rate increased from 75% to 95%, net returns/m^2 increased from Tshs 6,149,024/kg to 9,389,024/kg and breakeven prices above total cost decreased from Tshs 4, 445/kg to Tshs 3509/kg Table 4.3 and Figure 4.2.

The findings from this study confirmed argument by different authors that the realisation of profit and good performance of SITA projects depends on both the biological and economical patterns importantly the survival rate of the fish species during the farming period. Earth Trends, (2003) mentioned that SITA implies some form of intervention in the process to enhance production such as regular stocking, feeding, protection from predators etc to ensure maximum survival of the fish.

(Ahmed *et al*, 2015) also suggested that the monosex tilapia is a fast growing popular fish in the world, apart from being a fast growing specie, the specie can withstand some difficult environmental conditions. This statement also supports our findings that survival rate is very crucial aspect and therefore choosing the right specie becomes important.

4.4.5 Net returns/m^2 and breakeven above total cost Vs varying farm size?

The larger the farm size the higher the net returns per m2 and vice versa, the farmer is required to thoroughly decide on the farm size based on the initial capital and land availability as this is a crucial factor for profit realization in SITA projects.

For this particular case, as the farm size increased from 600m^2 to 4200m^2, net returns per m^2 increased from Tshs 10,703,024 to Tshs 102,503,024, and breakeven prices above total costs decreased from Tshs 3,054/kg to 458/kg Table 4.4 and Figure 4.3.

Similar findings were obtained by (FAO, 2012). In Malawi the initiative is in framework of a USAID funded programme to support lending to the so called "Malawi Gold Standard" or to support emerging small scale commercial farmers, it was stated that, start up farmers should start with at least $600m^2$ farm sizes in order to realize profit.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

The study investigated the determinants of performance in semi intensive tilapia aquaculture projects in Dar es Salaam. In light with the main objectives the study had specific objectives of examining how the feed prices, survival rates and farm sizes affects performance in Semi Intensive Aquaculture projects.

The study employed both qualitative and quantitative data analysis using SPSS package thereafter employed Enterprise Budget Analysis, Breakeven analysis, Sensitivity analysis for assessment of the variables on different scenarios.

The study findings indicated that feed prices, survival rate, and farm size have a significant effect on performance of SITA projects and therefore should be optimized in order to attain a profitable and sustainable SITA project. Higher feed prices decreases the net returns and increases the breakeven price per kilogram. It was also evidenced that, the higher the survival rate the higher the net returns and the lower the breakeven prices per kilogram. The farmer should ensure that he develops as bigger farm as possible as the farm size increases, the net returns per cubic meter of water increases and breakeven price above total cost decreases.

5.2 Recommendations

Based on results obtained from this study, the researcher recommends the following;

- Semi Intensive Tilapia Aquaculture farmers should prepare a detailed financial plan prior to establishing their farms. Financial planning will assist the farmer on cash flow management, investment management, training planning, tax planning, farms expansion planning, and risk management. Implementation of the above mentioned activities will ensure sustainable and profitable SITA projects.

- The farmer should establish good quality fish feeds sources with reasonable prices prior to establishment of the farm. As it is a compromise between good quality fish feeds and their respective costs, the farmers are advised to source their fish feeds from reputable suppliers and if possible have enough stock in order to have the control of feeds buying price fluctuations.

- The farmer should be conversant of all the biological aspects of tilapia farming in order to increase survival rate of his/her stock. The farmers should not only concentrate of economical aspects of the farm as biological factors are of equal importance as they ensure survival rate of the stocked Tilapia.

- The farmer should locate the farm in the area where there is a potential of enlarging his/her farm in future. As it has been observed, the bigger the farm the higher the net returns therefore SITA projects should be located in areas with potential for scaling up the operations in future to ensure sustainable and profitable aquaculture business.

5.3 Potential Future research topics

From this research "The determinants of performance in semi intensive tilapia aquaculture projects in Dar es Salaam", It has been observed that is actually possible to generate profit by maximizing the utilization of the main determinants of performance I.e. controlling feed prices, farm size and survival of the fish.

This research therefore calls for another investigation to assess how to optimize technical operations of SITA projects in Dar es Salaam in order to obtain optimum yields I.e. what are the technical aspects to insure good survival rates, what are the technical innovations to reduce feed prices etc

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APPENDICES

Appendix 1 : Questionnaire on aquaculture performance indicators

GENERAL FACILITY INFORMATION

1. Farm

   Name:...

2. Farm

   location:...

3. Farm Manager

   Name:...

4. Which of the following statements best describes this facility? (check one box)

   - ☐ Aquatic animal production is the only agricultural activity
   - ☐ Aquatic animal production is one of several agricultural activities, but aquatic animal production is the primary industry
   - ☐ Aquatic animal production is one of several agricultural activities, and other agriculture -not aquatic animal production-is the primary industry

5. Which of the following statements best describes your aquatic animal production activity? (check one box)

   - ☐ I am an independent grower
   - ☐ I am a grower that contracts another company for quantity and price prior to sale
   - ☐ I am part of a production cooperative

6. What is the total area (land and water) of this facility? ....ha
7. How much of your land is in aqua cultural or other agriculture use? ....ha

POND DESCRIPTION

8. Please describe your water source.

   a. What is the water source filling your ponds? (please check all that apply.)

   ☐ overland runoff or stream flow into the pond

   ☐ water is pumped from groundwater

   ☐ water is pumped from a stream, river, or other surface water body

   ☐ Water level is maintained due to high groundwater table

   ☐ water is reused from water drained from pond

   ☐ water is pumped or flows from a public supply (municipal or irrigation)

   ☐ other, please describe...

ENTERPRISE COST AND PRICE

9. Where do you source your Tilapia fingerlings..?
10. If your facility does not have a hatchery (9) please indicate price per one fingerling ....?
11. What type of feed do you provide to your fish ....?
12. What is the cost of the feed per kilogram ....?
13. What type of fertilizer do you use to fertilize your pond water? (check one box)

   ☐ Urea

   ☐ Diammonium phosphate

   ☐ Cow dung

   ☐ Chicken manure

   ☐ Pig manure

   ☐ Other

14. How many workers do you have for stocking, feeding, fertilizing and harvesting ....people
15. How much do you use to pay your labour force per annum?.................Tshs
16. How much do you use for labour levee, repairs after draining the ponds?..........Tshs
17. How much is your interest on operating capital...................................Tshs
18. How much is your depreciation cost for;
    a. Equipment...Tshs/annum
    b. Ponds..Tshs/annum
19. How much is your interest on investment..Tshs

PRODUCTION CHARACTERISTICS

20. What is your stocking density per cubic meter ....tilapia/m^2
21. Based on history of your stocks, what is an average survival rate ....%
22. How much are you going to sell the Tilapia fish per kilogram.....................
23. How much is your investment cost on
    a. Machinery and equipment...Tshs
    b. Ponds..Tshs/pond
24. What is your source of capital? (check one box)
    - ☐ Loan-amount..Tshs
    - ☐ Cash available from owner-amount...Tshs
    - ☐ Other-amount...Tshs

Appendix 2 : Checklist for enterprise cost and price in Tshs

*The data collection and analysis is conducted in the already established fish farms before the selling period.

*The budgets and analyses are based on prices and cost conditions in Tanzania (Dar es Salaam) in 2015 with some assumptions

*Tilapia stocked at 3.0 tilapia/m2 on a 600 m2 fish pond

Item	Description	Unit	Quantity	Price/Unit	Total Cost
Gross Receipts					
Tilapia	Live	kg	1800	9,000	16,200,000
Total Gross Receipts					16,200,000
Variable Costs					
Tilapia Fingerlings	Hatchery Raised	Individual	1800	300	540,000
Pelleted Diet	15% Crude Protein	kg	225	4,000	900,000
Fertilizer	Urea	kg	65	4,000	260,000
	Diammonium phosphat	kg	32	4,400	140,800

Item	Description	Unit	Quantity	Price/Unit	Total Cost
	e				
Agriculture Lime	Lime	kg	45	700	31,500
Field Labour, stock., feed, fertilizer, harvest and security		Tshs	12	100,000	1,200,000
Labour levee repairs, after draining		Tshs	1	500,000	500,000
Interest on operating capital		Tshs	3,572,300	0.12	428,676
Total Variable Costs (TVC)		Tshs			4,000,976
Net Returns Above TVC					12,199,024
Fixed Costs					
Depreciation					
Equipment		Tshs			500,000
Ponds		Tshs			1,500,000
Total Fixed Costs (TFC)		Tshs			2,000,000

Item	Description	Unit	Quantity	Price/Unit	Total Cost
Total Costs (TC)		Tshs			6,000,976
Net Returns Above TC		**Tshs/600 m^2**			**10,199,024**
Breakeven price per kilogram sold					
Above TVC		**Tshs/kg**			**2,223**
Above TC		**Tshs/kg**			**3,334**
Breakeven yield per kilogram sold					
Above TVC		**kg/m^2/year**			**0.74**
Above TC		**kg/m^2/year**			**1.11**

Source: Engle, 2005 but modified for this research (2015)

Appendix 3 : Checklist for production characteristics

Production Characteristic	Unit	Value
Stocking Density	tilapia/m^2	3
Initial number of tilapia		1500
Initial weight of tilapia stocked	g	10
Initial biomass	g	15000
Tilapia fingerlings Cost	Tshs/ind	300
Survival	%	90
Cycle length	days	270
Tilapia price	Tshs/kg	7000

Production Characteristic	Unit	Value
FCR	Ratio	
Pelleted Diet	Tshs/kg	1200
1 US $	Tshs	2000
Growth rate tilapia	g/day	1.16
Final number of Tilapia	ind	1350
individual harvest weight of tilapia	g	323.2
Yield -live tilapia	kg/ha	10,464
Total amount of feed per batch	kg	1458
Interest on operating capital	%	12
Annual depreciation on ponds	yrs	20
Terms of loans for equipment and ponds	yrs	10
Proportion of capital borrowed	%	50
Investment cost of		
Machinery and equipment	Tshs	2000000
Ponds	Tshs	1200000
Total amount of loan	Tshs	7000000
Cash available from owner	Tshs	3000000
Capital available from owner	Tshs	16080000
Total investment	Tshs	
Proportion of investment capital provided by owner	%	70
Percentage of TVC that must be borrowed at the beginning of the year to operate for income statement	%	50

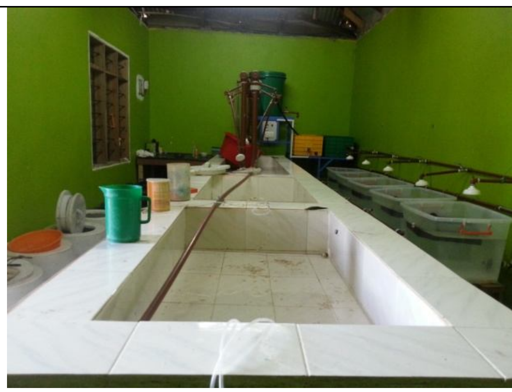
Source: Engle, 2005 but modified for this research (2015)

Appendix 4 : Assumptions parameters for the study

	Other assumptions	Unit	Value
1	Total farm area	ha	1
2	Area of individual ponds	ha	0.05
3	Cost to build ponds	Tshs/pond	600000
4	Land Cost	Tshs/ha	6080000
5	Ponds	No	20
6	Hourly wage	Tshs/hr	2400
7	Month	days	30
8	Batch cycle length	months	9
9	Average pond depth	months	0.8
10	Urea		
	Cost	Tshs/kg	400
	Quantity	Tshs/ha	880
11	Diammonium phosphate		
	Cost	Tshs/kg	440
	Quantity	Tshs/ha	420
12	Agricultural lime		
	Cost	Tshs/kg	69
	Quantity	Tshs/ha	50000

Source: Engle, 2005 but modified for this research (2015)

Appendix 5 : Preliminary site visit plates

	
Typical 600m^2 Tilapia fish pond for analysis	Integrated fish farming
	
Hatchery	Feeding the tilapia

Source: Researcher-during the preliminary site visit (2015)

Appendix 6 : Recommended Tilapia Species for Farming

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TILAPIA TAXONOMIC IDENTIFICATION KEY

1. *Tilapia zilli*

Body usually with two horizontal stripes crossed by vertical bars, caudal fin usually covered with a grey network with pale interstices, dorsal spines are 13-14.

Distinguishing characters

I. Body depth contained 2-2 ¾ times in standard length. 8-12 gill rakers on the lower part of the first gill arch. Distinctive "Tilapia-mark" persisting in adult fishes at the base of the dorsal fin.

II. Colour: Body olivacious, shot with an iridescent blue sheen; lips bright green. Chest pinkish (black surmounted by an intensely crimson flush in breeding fishes). Six or seven dark vertical bars, of variable intensely, may be visible on the body and caudal peduncle.

III. Dorsal, caudal and anal fins olivacious with yellow spots, the dorsal and anal fins often outlined by a narrow *orange band. The "Tilapia-mark" is a large, black, nearly circular spot almost completely* outlined in yellow.

IV. The colouration of breeding fishes is more intense than that of non breeders. The eggs of this species are green.

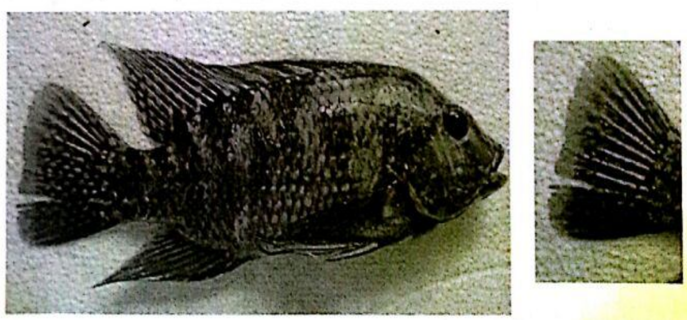

Plate 1: Tilapia zilli

2. *Tilapia rendalli*

Body usually with vertical bars only, scales with a dark basal crescent, caudal fin. With a spotted dorsal half and a red or yellow ventral half, dorsal spines 15-17

Distinguishing characters

I. Body depth contained 2 ¼ - 2 ¾ its standard length, 8-10 gill rakers below the joint of the first fill arch. Number of dorsal fin spines 16, rarely 15 or 17.

II. Colour; dorsal surface of head and body mid to dark olive green, paling over the flanks.
III. Body crossed by dark vertical bars. Scales veering a dark basal crescent. Dorsal fin olive-green with a thin red margin and white to grey dark oblique spots on the soft rays.
IV. The caudal fin has a spotted upper half and a red or yellow lower half. This red or yellow pigment may also colour the anal fin.
V. A carmine flash may be present on the lower flanks behind the pectoral fin. The eggs of this species are yellow.


Plate 2: ***Tilapia rendalli***

3. *Oreochromis esculentus*

Caudal fin weakly if at all spotted. Length/depth ratio of caudal peduncle 0.8-1.1. Lateral line with 32-35 scales; 18-21 gill rakers on the lower part of the first gill arch. Length/depth ratio of the caudal peduncle 0.9-1.1. No marked bump before the eye. Dorsal fin sometimes tipped with red, but never orange.

Distinguishing characters

I. Lateral line series with 32-35 (usually 32 or 33) scales; 18-21 (usually 19) gill rakers on the lower part of the first gill arch. Length/depth ratio of the caudal peduncle 0.9-1.1.
II. Colour; Reddish-brown; fins grayish, weakly if at all spotted; dorsal fin without coloured outline, or, if coloured, a deep red (never orange).
III. Breeding males have the ventral surface of the body sooty, and the flanks suffused with red. Young fishes are silvery-grey; the "Tilapia-mark' is a well defined black spot outlined in pale yellow.

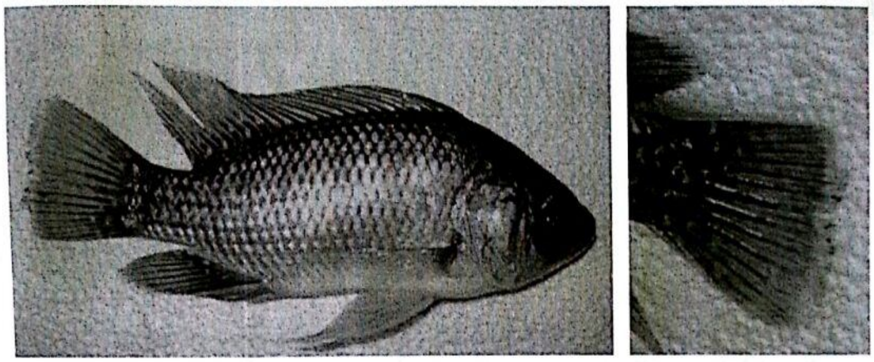

Plate 3: *Oreochromis esculentus*

4. ***Oreochromis variabilis***

Lateral line with 30-33 scales; 19-23 gill rakers on the lower part of the first gill arch. Length/depth ratio of caudal peduncle 0.8-0.9. A well developed bump in front of and partly above the eye. Dorsal fin tipped with orange.

Distinguishing characters

I. A relatively deep bodied species with a characteristic convexity immediately before the eye. A characteristic feature of breeding males is the conspicuous **genital tassel**. This is a branched structure, yellow to orange in colour and often several centimeters long, developed from the genital papilla, which lies immediately before the anus.

II. Colour; Adult but non-breeding fishes are uniformly grey or grayish-green, the flank scales somewhat darker at the center than at the edge. Fins grey, the caudal weakly if at all, spotted. Dorsal fin tipped with orange throughout life.

III. Breeding males are bluish-grey to bluish-green; the caudal fin is outlined in bright orange. The colouration of breeding females is similar to that of non-breeding individuals. A typical colour variety also occurs; the ground colour is basically a piebald black and silver, variably blotched with bright orange. Such specimens are grey-silver, with eight to ten dark, vertical stripes on the flanks and caudal peduncle.

IV. The dorsal fin is outlined in orange; the 'Tilapia-mark' is a relatively indistinct black marbling.

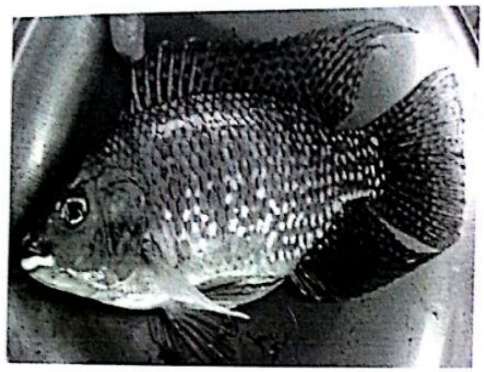


Plate 4: ***Oreochromis variabilis***

5. *Oreochromis niloticus*

Caudal fin with numerous wavy bars, lateral line with 31-33 scales, 22-28 gill rakers on the lower part of the first gill arch.

Distinguishing characters

I. Lateral line series with 31-33 (usually 31) scales; 22-28 (usually 24-26) gill rakers on the lower half of the first gill arch.

II. Colour; Silver Grayish ground coloration, darker above; faint traces of six or seven dark vertical bars on the flanks and the caudal peduncle. Dorsal and anal fins grayish somewhat irregularly spotted.

III. Caudal fin grey, covered with dark red, narrow, vertical stripes. In breeding males the ventral surface of the body and the anal.

IV. Dorsal and pelvic fins are black, and the head and flanks are flushed with red.


Plate 3: ***Oreochromis niloticus***

6. *Oreochromis leocostictus*

Caudal fin intensely spotted lateral line with 28-30 scales; 19-24 gill rakers on the lower part of the first gill arch. Length/depth ratio of caudal peduncle 0.5-0.8. Body with numerous while spots

Distinguishing characters

I. Lateral line series with 28-30 (usually 29) scales, 19-24 (usually 22) gill rakers on the lower part of the first gill arch. Length/depth ratio of the caudal peduncle 0.5-0.8.

II. Colour: Body dark olive-green to slightly-black, clearly marked with whitish spots, lower lip often bluish-white; eight to eleven dark vertical stripes sometimes visible on the flanks.

III. Dorsal, anal and caudal fins dark; the soft dorsal fin, the entire caudal fin and the anal fin with well-defined bluish-white spots.

IV. In breeding males the ground colour changes to a dark blue-black, whilst the whitish spots on the body and the fins are intensified; the eye is outstanding with its bright amber iris crossed by a black bar.