FACTORS INFLUENCING FRESH WATER FISH FARMING IN EMBU NORTH DISTRICT, KENYA

BY

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DECLARATION

This research project report is my original work and has not been submitted for a degree award in any other University.

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This research project report is submitted for examination with my approval as university supervisor.

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DEDICATION

This research project report is dedicated to my husband Fredrick Chakairu Mwangi, Daughter Isabel Wamuyu, Sons Bill David Gichuru and Prince Fortune Munene, for your love, support and encouragement during this study.

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ABBREVIATIONS AND ACRONYMS

AEA	Agricultural Extension Agents
ADB	Asian Development Bank
AMA	American Marketing Association
DFID	Department for International Development
ESP	Economic Stimulus Programme
FAO	Food and Agricultural Organization
GOK	Government of Kenya
MDGs	Millennium Development Goals
NEMA	National Environment Management Authority
SDPED	Social Development and Poverty Elimination Division
SPSS	Statistical Package for Social Sciences
WCED	World Commission on Environment and Development

ABSTRACT

Kenya Vision 2030 is the country's new development covering the period 2008 to 2030 and it aims at transforming Kenya into a newly industrialised middle-income country providing a high quality life to all its citizens by the year 2030. In a bid to realise vision 2030 strategic plan, the Kenyan government injected 70 million U.S. dollars between 2009 and 2013 financial years to invest in fish farming for food security under the social economic pillar. However, demand for fish in Kenya has been on the increase, while the supply of fresh water fish from capture fisheries has been on the decline in the first decade. As world fish catches continue to decline and population continue to increase, aquaculture has great potential for growth in Kenya to produce the critical volumes of fish to fill the growing gap between National fish supply and demand. Literature reviewed showed that fresh water fish farming brings forth to sustainable development and is a pathway towards achievement of first millennium development goal on eradication of extreme hunger and poverty. This study therefore sought to examine the factors influencing fresh water fish farming in Embu North District. The specific factors which were assessed include; ecological factors, social economic factors, training and extension services and the influence of marketing on fresh water fish farming in Embu North District. The significant of this study is to improve the fresh water fish farming in terms of revenue, efficiency and expansion hence enabling the government's economic growth for the achievement of millennium development goals and vision 2030. This will consequently improve the living standards of majority of Kenyans who are struggling to make a living. The researcher employed a descriptive research design. The target population for this study was 164 respondents .The study took a census of 164 respondents from Embu North District. Data collected using questionnaires was analysed by the use of descriptive statistics using the Statistical Package for Social Sciences and MS Excel and was presented using percentages and means. The information was written in prose and presented using tables. The study showed that majority (50.3%) of respondents stocked Tilapia. The research further showed that availability of capital was the main determinant of the number of fish ponds each farmer had according to 49.7% of respondents .The study showed that majority (55.9%) of respondents had not experienced any fish problem and diseases however,34.8% of respondents experienced fish stress due to lack of oxygen in the pond. The study also showed that 68% of respondents had the problem of pollution from farm chemicals however left over feeds and excess feeds followed .The study showed that birds were the main fish predators as indicated by 64.6% of respondents followed by snakes and otter .The study also showed that Combination of agriculture and aquaculture improved food supply in Embu North District. The study indicated that majority (86.3%) of the respondents sold their raw fish to local markets. The main conclusion of the study is that fresh water fish farming is highly influenced by the type of fish species stocked, availability of clean water, favourable environment in the pond, availability of market and farm inputs. The recommendations of the study shows that the Government should join hands with private partners to come up with quality fish species, subsidized farm inputs, come up with policies and regulations on pond pollution from farm chemicals and lastly further research and development especially on fish diseases and other innovations on fish culture and management systems which is a vehicle towards sustainable fresh water fish farming. The study will benefit Government officers, fish service providers, farmers, future researchers and other stakeholders.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Aquaculture is defined as farming of aquatic organisms, which includes fish, molluscs, crustaceans, and aquatic plants (Ahmed, 2002). Fish farming is predominantly an extensive land-based (earthen ponds) system practiced at subsistence levels in the country. Aquaculture is the fastest-growing food production system globally, with an 8.8% increase in production of animal products per year since 1985 (FAO, 2007). It fulfills a major role in feeding people today, and its potential for doing so in the future is large. Since natural fisheries rely on wild stocks, which are often overexploited, aquaculture can either exacerbate this overexploitation through damages to natural ecosystems or reduce it by alleviating pressure on wild fish stocks (Adu, 2005).

The International Food Policy Research Institute according to Budak, (2010), forecasts that the annual increase in seafood consumption will be about 1.5 kilogrammes (kg) per person in 2020, which would make the demand for seafood products considerably higher than it is now more than 10 million metric tons of additional seafood would be consumed each year (assuming no increase in the human population). Over this same time, harvest from natural fish stocks will probably remain static or decline (Dey, 2005, FAO, 2001a). Fish and fish products are the most traded food commodity. World fish trade has developed rapidly in the last three decades, increasing from a US$8 billion in 1976 to US$101.8 billion in 2008. In real terms (adjusted for inflation) fish exports increased by 104 percent between 1985 and 2008, including a 50 percent increase in the period between 1998 and 2008. Indeed, more than one-third (39 percent live weight equivalent) of total annual production enters international trade. About 50 percent (US$50.6 billion) of that international fish trade by value originates in developing countries, where it represents an important source of foreign exchange earnings and employment opportunities. Net fish exports (i.e. the total value of exports less the total value of imports) from developing countries have increased significantly in recent decades, growing from US$1.8 billion in 1976 to US$26.5 billion in 2008.

The Kenya Vision 2030 is the country's new development covering the period 2008 to 2030 and it aims at transforming Kenya into a newly industrialised middle-income country providing a high quality life to all its citizens by the year 2030 (MOFD, 2010) . In a bid to realise vision 2030 strategic plan, the Kenyan government injected 70 million U.S. dollars between 2009 and 2013 financial years to invest in fish farming for food security under the social economic pillar .Under the Kenya Economic Stimulus Programme (MOFD, 2010) whose aim was to jumpstart the Kenyan economy towards long term growth and development**,** the Ministry of Fisheries and Development launched fish farming project, themed round - Improving nutrition and creating over 120,000 jobs and income opportunities has been one of the more successful components. There are 200 fish farming ponds constructed for 140 constituencies at an estimated cost of Kshs.1.12 billion (Kshs.8 million per constituency) (GOK, 2012). The youth within the benefiting constituencies provided the labour to dig the ponds. Stocking the ponds with appropriate fingerlings was determined by the various eco-climatic zones and the needs of the beneficiaries. Over 12,000 farmers had been trained on fish ponds construction. In some river basins recreational fisheries also contribute significantly to the local economy. In Europe, for instance, the inland recreational fishing industry has been valued as high as $25 billion a year (Dey and Prein 2006). Increasing numbers of developing countries, such as Argentina, Brazil, Chile, India, and several states of the Zambezi River Basin, are also using part of their fishery resource for recreational fisheries to boost their local tourist economy.

Where small-scale inland fisheries or aquaculture has been supported and well managed, fish-related activities play a critical role in generating wealth and sustaining economic growth (DFID, 2000) For example, research in the Zambezi floodplain reveals that inland fisheries generate more cash for households than cattle rearing in most cases and more than crop production in some cases. In Sri Lanka recent economic valuations have put the value of fisheries at about 18% of total economic returns to water in irrigated paddy production (Foeken, 2008). This capacity of small-scale fisheries to generate cash, however, is still poorly recognized by both academics and decision makers. In addition, because fishers and, to a lesser extent, fish-farmers, can access cash year-round by selling fish, fisheries provide a "bank in the water" for remote rural populations

that lack access to formal financial systems. This contrasts with agriculture, where farmers have to invest and then wait for harvest before earning cash returns.

Aquaculture is a relatively new industry with significant potential for innovation. Most species that are grown are not much different from their wild counterparts, nor have they been domesticated to a great extent (Foeken and Owuour, 2008). Aquaculture innovation produces a higher capital return to the farmer than traditional farming practices do, and such innovation can also be a natural way of managing aquaculture production to become more sustainable.

In developing economies, the development of commercial aquaculture is yet to become popular or widespread (Quagrainie, 2009). This is as it is widely recognized that the persistent inherent uncertainties which result in wide variation in production yield in aquaculture, fisheries industries, are caused by adverse weather conditions and pest and disease outbreaks. In highlighting the reasons for taking into account production risk in inputs in the empirical analysis of firm behaviour and productivity change, observes that, risk-averse producers choose input levels which differ from the optimal input levels of risk-neutral producers. Secondly, risk-averse producers will be concerned about risk properties when they consider the adoption of new technologies; thus, they may not necessarily choose the technology with the highest mean output (Oladele and Olajide, 2010).

1.2 Problem Statement

According to FAO (2010), demand for fish in the world has been on the increase, while the supply of fresh water fish from capture fisheries has been on the decline in the first decade. As world fish catches continue to decline and population continue to increase, aquaculture has great potential for growth in Kenya to produce the critical volumes of fish to fill the growing gap between National fish supply, demand and food security as outlined in vision 2030. Owing to its prominence to bridge this gap, the Kenyan Government in the 2009/2010 financial year under the Economic Stimulus Programme (ESP) introduced commercial fish farming in Kenya in 140 political constituencies (MOFD, 2010). Each constituency benefited with funds for 200 fish ponds, 15 Kilogrammes of fertilizer and 1,000 fingerlings. The exercise got into the second

phase in the 2011/2012 financial year where an additional 20 constituencies were brought on board adding an extra 100 fish ponds for the first 140 constituencies and 300 fish ponds for the new constituencies making a total of 50,000 ponds costing about 15 million US dollars. The figure not with-standing the operational cost and cost for 15 kilogrammes of fertilizer per pond and 1 000 fingerlings per pond among other costs. The success of this new Government initiative brought about renewed strength on fresh water fish farming in Embu county which covers approximately 190,000m^2 area under fish farming(MOFD,2010),but there was no documentation on factors which influenced the success of this new Government initiative. However, fish production is still low despite the Government's effort due to challenges such as poor understanding of fish farming technology, poor quality feeds, poor quality seeds and inadequate information on the right species to culture in specific locations, prolific breeding of tilapia culture and cannibalism in catfish culture and inadequate capital for materials such as fish pond liners, fish harvesting nets and lack of cold storage equipment to facilitate delivery of fresh fish into the local market outlets in local hotels and supermarkets. Despite of all these challenges, fish farmers in Embu North District are increasing their production in order to satisfy the demand in the County and this will depend on the extent to which factors that influence fresh water fish farming be identified and documented in order to attain sustainable fish farming in Embu North District. What is not known is also the extent to which selected factors influence the success of fresh water fish farming a gap that this study intends to fill.

1.3 Purpose of the Study

The purpose of the study was to assess the factors influencing fresh water fish farming in Embu North District.

1.4 Objectives of the Study

The specific objectives of the study were:

1. To assess ecological factors influencing fresh water fish farming in Embu North District.
2. To assess social economic factors influencing fresh water fish farming in Embu North District.

3. To determine how training and extension services influence fresh water fish farming in Embu North District.
4. To establish the influence of marketing on fresh water fish farming in Embu North District.

1.5 Research Questions

The study aimed at answering the following research questions:

1. How do ecological factors influence fresh water fish farming in Embu North District?
2. To what extent do social economic factors influence fresh water fish farming in Embu North District?
3. To what extent does training and extension services influence fresh water fish farming in Embu North District?
4. How does fish marketing influence fresh water fish farming in Embu North District?

1.6 Significance of the Study

The findings of this study will be used to improve the fresh water fish farming in terms of revenue, efficiency and expansion hence enabling the government's economic growth for the achievement of millennium development goals and vision 2030. This will consequently improve the living standards of majority of Kenyans who are struggling to make a living as fresh water fish farmers. The study aims at creating a better insight into the fresh water fish farming and therefore introduction of the most appropriate interventions can be determined. Besides being a platform for future Government policy on fresh water fish farming, the study will be useful to future scholars as it will also add to the existing body of knowledge.

1.7 Limitations of the study

The findings of the study are limited to Embu North District in Embu County and the findings can serve as a baseline data for other studies dealing with fresh water fish farming in other areas in Kenya.

The researcher encountered inconsistency of information gathered caused by varied level of knowledge and perception by fish farmers. Although most of the fish farmers from the area of

study were literate, some of them filled the questionnaires with the help of research assistants as they were unable to fill the questionnaires and the research assistant had to fill for them.

1.8 Delimitations of the study

The study was conducted in Embu County and focused on some of the factors influencing active fresh water fish farmers with one or more fish ponds in Embu North District.

1.9 Basic Assumptions of the study

It was assumed that all the respondents would give the correct answers without any bias. The other assumption was that the instrument used would give reliable results and that all respondents would be honest, cooperative and provide reliable responses. It was also assumed that all the 164 fish farmers issued with questionnaires would respond but the study showed that only three failed to return the questionnaires.

1.10 Definition of significant terms

Aquaculture	It is the farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants with some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding and protection from predators.
Aquaculture production	Aquaculture production refers to output from aquaculture activities, which are designated for final harvest for consumption.
Brackish water culture	The cultivation of aquatic organisms where the end product is raised in brackish water, such as estuaries, coves, bays, lagoons and fjords, in which the salinity may lie or generally fluctuate between 0.5% and full strength seawater.
Economic Stimulus Programme	Federal government programme designed to counteract weak economic activity with stimulus in form of

	government spending on infrastructure and other initiatives, tax breaks, and subsidies.
Fish Farming	Fish farming involves raising fish commercially in tanks or enclosures, usually for food.
Fishery	Refers to an activity leading to catching, taking or harvesting of fish. It may involve capture of wild fish or raising of fish through aquaculture.
Fresh water culture	Cultivation of aquatic organisms where the end product is raised in freshwater, such as reservoirs, rivers, lakes, canals and groundwater, in which the salinity does not normally exceed 0.5%.
Mariculture	Refers to aquaculture practiced in marine environments. Particular kinds of aquaculture include algaculture (the production of seaweed and other algae); fish farming; shrimp farming, shellfish farming, and the growing of cultured pearls.

1.11 Organization of the study

The first chapter comprises of the background to the study, statement of the problem, purpose of the study, objectives of the study, research question, significant of the study, limitations of the study, delimitations of the study, basic assumptions of the study and definition of significant terms. Chapter Two contains literature review citing global, national and local fish production on factors influencing fresh water fish farming ,a section of Ecological factors influencing fresh water fish farming, Social Economic factors influencing fresh water fish farming ,trainings and extension services offered to fish farmers, influence of market on fresh water fish farming. Theoretical framework featuring development theories, the concept of sustainable fish farming, conceptual framework summarizing the literature review and knowledge gaps. Chapter Three describes the methodology used in the study. It includes the research design, target population, sampling techniques and sample size, data collection procedures, validity and reliability of research instruments, data analysis technique ethical considerations and operationalisation of

variables. Chapter Four covers findings from data analysis, presentation of findings and interpretation of findings. It is concluded with summary of the chapter. Chapter Five covers summary of findings, discussion, conclusions and recommendations of the study. It is concluded with suggested areas for further research and contribution to the body of knowledge. The references cited from various sources are listed and lastly appendices are given.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of empirical literature on factors influencing fresh water fish farming. These determinants include ecological factors, social economic factors, trainings and extension services, influence of market on fresh water fish farming, general challenges facing fresh water fish farming and sustainability of fish farming. The chapter also presents the theoretical frame work of the study, conceptual framework and the research gaps for further study.

2.2 Factors influencing fresh water fish farming

There are various factors influencing fresh water fish farming in Embu North District namely ecological factors, social economic factors, training and extension services and fish marketing. Fish is a popular diet all over Africa. A report conducted by the Food and Agriculture Organisation (FAO) on The State of World Fisheries and Aquaculture (2008), states that the fish sector is a source of income and livelihood for millions of people around the world (FAO, 2008). Employment in fisheries and aquaculture has grown substantially in the last three decades, with an average rate of increase of 3.6 per cent per year since 1980. It is estimated that, in 2008, 44 million people were directly engaged, full time or, more frequently, part time, in capture fisheries or in aquaculture and at least 12 per cent of these were women (Foeken, *et al*., 2008). On average, each jobholder provides for three dependants or family members. Thus, the primary and secondary sectors support the livelihoods of a total of about 540 million people, or 8.0 percent of the world population.

Millennium Development Goal (MDGs) Number 1 calls for a reduction of 50% between 1990 and 2015 in the number of people who suffer from hunger and whose income is less than US$1 per day (Foeken and Owour, 2008). Further, the number of people living in poverty is estimated to have risen from 11 million or 48% of the population in Kenya to 17 million or 56% in 2001. Consequently, urban poverty is rising fast. As a result, new strategies for coping with poverty

have to be devised to cope with the dire situation for example multiple sourcing of cash incomes and fresh water fish farming (Foeken and Owuour, 2008).

The view of fresh water fish farming is supported by (Zezza and Tascoti,2010), who state that it may have a role to play in addressing issues of food insecurity, which are bound to become increasingly important with the secular trend towards the urbanisation of poverty and of population in developing regions (Zezza and Tascoti, 2010). Fresh water fish farming provides a substantial share of income for the urban poor, and for those groups of households to which it constitutes an important source of livelihood (Zezza, *et al*., 2010).

According to Halwart *et al*.(2007), a number of subsistence-level fish farmers have turned into small-scale commercial fish farmers to produce for both the local and export markets hence making a significant contribution to both food security and foreign exchange earnings in Kenya.

2.3 Ecological factors

According to Chaudhuri, 2008, for effective aquaculture, one has to gain familiarity and control Water quality to enhance its biological productivity; one has to understand fish nutrition so as to be able to formulate nutritionally balanced fish diet; one has to delve deep into fish genetics so as to be able to evolve new varieties and strains which bestow commercial advantages to the product in terms of superior growth rate, nutritive value, bonelesness, taste and odour. Therefore one has to prevent incidence of fish infections and diseases through prophylactics and therapeutics. Tilapia, Catfish and Trout are the fish species commonly kept in fish ponds but according to Mbugua (2008), Tilapia is the main species of fish that is farmed in Kenya. Tilapia males are preferred for culture because they grow faster than females. Females use considerable energy in reproduction and do not eat when they are incubating eggs. Males only culture permits the use of longer culture periods, higher stocking rates and fingerlings of any age. High stocking densities reduce individual growth rates, but yields per unit area are greater. If the growing season can be extended, it should be possible to produce fish of up to 500 grams. Expected survival for all-male culture is 90 percent or greater. A disadvantage of male mono-sex culture is that female juveniles are discarded.

2.3.1 Water and temperatures

According to Carballo (2008), sites should be selected for fish farms only where water of the required volume and quality is available at the times needed for operating the farm. Preference should be given to sites where a gravity water supply to the farm is possible. The quality of the water available must be such that the desired fish can be raised, e.g. fresh, brackish or salt water. Gravity drainage of the ponds should be possible. The site should be in the vicinity of transportation routes, or where the access road can be constructed economically. In the proximity of inhabited areas, considerations of public health and the necessity of guarding against poachers should be kept in mind.

Water can hold large amounts of heat with a relatively small change in temperature. This heat capacity has far reaching implications. It permits a body of water to act as a buffer against wide fluctuations in temperature. The larger the body of water, the slower the rate of temperature change. Furthermore, aquatic organisms take on the temperature of their environment and cannot tolerate rapid changes in temperature. Water has very unique density qualities. Most liquids become denser as they become cooler. Water, however, gets denser as it cools until it reaches a temperature of approximately 39ºF. As it cools below this point, it becomes lighter until it freezes (32ºF). As ice develops, water increases in volume by 11 percent. The increase in volume allows ice to float rather than sink, a characteristic that prevents ponds from freezing solid. Far from being a universal solvent, as it is sometimes called, water can dissolve more substances than any other liquid. Over 50 percent of the known chemical elements have been found in natural waters, and it is probable that traces of most others can be found in lakes, streams, estuaries, or oceans.

Nasser et al. (2012) reported that water quality and quantity in the fish pond is very important to fish production. He indicated that the following instructions should be followed carefully: Quality water should neither be too acidic or alkaline, should contain enough dissolved oxygen and should not be muddy or have any offensive colour; Pond water should be free from pollutants like detergents, oil films, petrochemicals and maintain pond water which should be green; water PH level should be between 6.5 and 9 since when the water PH level is low (in

acidic condition), the water tastes sour and prevents phytoplankton growth, the pond should be limed using agricultural lime; watch out for low dissolved oxygen which is revealed when fish come up to gasp for air, and when the water has an offensive colour; if symptoms of low oxygen are detected, take immediate action like stopping fertilization, reducing feeding rate, changing the water and replacing with fresh oxygenated water; Prevent run-off water from entering the pond by constructing proper drainage channels; locate ponds far away from industrial centres, oil fields, and chemicals. This is the first step to preventing toxic pollution which can lead to death of fishes; maintain pond water level especially during dry season. Replenish water by adding new water to influence water temperature. This is also good time to plant trees to provide shade for the pond and finally remove thick black mud from the bottom of the pond from time to time.
According to Johnson (2013), the most common feeding mistake is overfeeding. Overfeeding occurs anytime the fish are eating more than they need. This can make fish sick and excessive amounts of waste that strains the limits of what can be biologically reduced, results in a decline of water quality. Fish that are overfed in typical ornamental pond facilities will eventually develop large bellies and begin to look a little bit like tadpoles, with the big body and the wispy tail. That will not usually kill the fish, but the impact on the liver and other internal organs can and will be severe. Fish should be fed no more than three times per day. In cooler waters, they should be fed once per day.

Carballo (2008) also reported that the size of earthen ponds built today can vary anywhere from 20 square meters to 20 hectares (44 acres) or more. Pond size is determined by the type of species cultured, the intensity of the system, size and maturity of the species being farmed, access to capital, land availability, water availability, the harvesting method, and even the marketing and sales goals of the project.

According to Helfrich (2009), Fish kills caused by pollution in ponds are rare however the most common pollutants that cause fish kills in ponds are pesticides. Pesticides can enter a pond with storm runoff from an agricultural field, orchard, golf course, or residential landscaping. They can also reach a pond by drifting through the air during crop dusting or spraying. Because pesticides are extremely toxic to fish, great care must be taken to keep them well away from ponds.

Herbicide pollution can cause oxygen depletion by killing phytoplankton, rooted aquatic plants, or both. Pollution can contaminate living fish and make them unsafe to eat, but this is rare in private ponds unless the pond is impacted by industrial pollution, livestock wastes, acid mine runoff and golf course drainage. Fish kills resulting from disease usually only occur when fish are overcrowded.

El Sayed (2006) reported that pond conditions, seed supply, availability of fish species, sizes of fish, feeds and operating techniques, should be taken into consideration in determining how much should be reasonably stocked. The data in the previous year, such as sizes, yields, survival rate, marketing rate and food conversion rate are taken as factors determining stocking density for the following year.

According to Mbugua (2008), tilapia is the main species of fish that is farmed in Kenya. There is also the African cat fish that is farmed with tilapia. Water quality is an essential element in aquaculture and that can affect the yields. It takes about 6 – 9 months for the fish to mature.
There are public and private hatcheries. Maurice (2010) reported that private hatcheries and nursing farms are very popular to small-scale farmers and produce about 80% of fingerling supply.
According to Elamin (2006), aquaculture could cover the gap between supply and demand but there are also many forces which could pull production in the opposite direction making it difficult for the industry to grow substantially enough to meet demand in the decades to come.

2.4 Social economic factors

In other studies conducted by (Ahmed and Lorica 2002), they sought to provide a framework for examining aquaculture's linkages to food and nutritional security by highlighting key role of aquaculture in household food and income systems in developing countries (Ahmed and Lorica, 2002). Examples were taken from Asian countries and it was established that there was a steady growth over the last decade with regard to employment, income and consumption. From the study that was conducted there was clear evidence of positive income and consumption on households. There is increased recognition for improved and balanced nutrition, including

critical vitamins and minerals in the diet and the need for improved sanitation, hygiene and living environment which are related to income and purchasing power improvement.

(Ahmed and Lorica, 2002), indicate the scope for more empirical studies to be carried out on the varied opportunities that aquaculture would provide to improve the income, employment and food consumption within households. Since food insecurity mainly affects poorer communities, (Ahmed and Lorica 2002), targeted small subsistence-oriented farmers in their study. They looked at the key socio-economic and policy factors affecting aquaculture adoption and its impact on poor and asset less people. Even though there is potential for fish farming in Africa, very few governments have a long term plan for aquaculture and this makes it difficult for them to quantify their production targets as far as fish farming is concerned.

The development and wider adoption of aquaculture can be seen as a significant basis for improving household food security and other needed welfare (Ahmed and Lorica, 2002). Aquaculture has the potential to contribute to the food and nutritional status of people in at least three ways (adoption-income linkages; adoption-employment linkages; and adoption-consumption linkages).

2.4.1 Land tenure

According to MaCPherson and Agyenim-Boaten (2001), where there is no formal land registration and boundaries are imprecisely defined by traditional methods there are land tenure litigations. As a result ethnic conflicts over land boundaries in these areas are reported. Where matrilineal inheritance is practiced, women's tenure can be insecure if the husband dies intestate. In areas where patrilineal system dominates, land ownership is less available to women (MaCPherson and Agyenim-Boaten, 2001). Problems with land tenure have affected agricultural development projects and can similarly affect aquaculture and culture-based fisheries. Some local rulers depend on fishermen's fees for the upkeep of their stools and so do not care if there is over-exploitation of the fisheries (Dey, 2000; Muzaffar and Helaluddin, 2001).

Land ownership in Kenya is very important for households. This is because it has the tendency to appreciate quickly over time. Households can be able to sell their lands in times of financial

difficulties as a coping mechanism. However, the net acquisition of land is not very high. This means that in as much as a lot of people are acquiring lands; a large majority of owners are also selling their lands in order to cope with the economic situation. It is only in the rural areas where there were some improvements in the land ownership. The rural poor do not have any improvement in the net land ownership. This means that the increase in the land ownership in the rural areas is due to the well to do people in the villages.

2.4.2 Quality of Feeds affects fish farming

The quality of feed produced is also very important. For example, according to Quansah *et al.* (2007), a test of a sample of eleven common feeds and four organic fertilizers used in Ghana indicated three of the feeds (biscuit waste, groundnut husk, and dried termite) and three of the organic fertilizers (cow manure, pig manure, and cow blood) contained fecal streptococci. These and many pathogens may be passed on in effluents to receiving waters (Quansah *et al.*, 2007).

2.4.3 Capital and land

According to Adu (2005), banks are willing to lend money for the construction of fish ponds but the conditions for the loans are strict and make them suitable mostly for those who are already well established economically. Generally, the estimated market value of the collateral has to be at least equivalent to the amount of funds loaned (Adu, 2005). For example, the practical experience of bank officers in commercial aquaculture is weak and most bank managers refer any loan request by a fish farmer to the headquarters in Accra, before deciding on whether or not to give credit. This difficulty in assessing formal credit, a lot of farmers resort to informal credit. Most informal credits do not carry interest except for specialized money lenders. Money lenders charge very high interest rates of between 50-100 % and are for short periods.Asian Development Bank Evaluation (2005) reported that 69% of small scale farmers caught fish from their own ponds. This implies that land ownership is a great factor to consider in fresh water fish farming.

2.4.4 Sustainability of fish farming

The challenges facing sustainability are several, and include environmental management, social conflicts, welfare issues, market stability and the international competitiveness in our domestic marketplace (Moccia and Hynes, 1998). In addition, the reduction of production costs, perceived food safety issues and consumer confidence are three more important challenges that affect aquaculture sustainability (Bureau, 2006). From all these challenges, environmental management is the one that is critical, particularly in reference to the identification of solid waste fish farm effluents in the aquatic environment.

The pressure on the aquaculture industry from environmental groups and regulatory agencies has constrained its growth, but also accelerated scientific developments to overcome these obstacles. The complexity of the legislation regulating aquaculture in developed countries relies on how provincial and federal jurisdiction affects property rights (Moccia and Bevan, 2000). Agencies such as Fisheries and Oceans, Environment Canada, and the Ministry of Natural Resources on both the federal and provincial levels, as well as other local regulatory agencies, play a role in aquaculture licensing. Each of these agencies uses a different definition of sustainability depending on their point of view, making the licensing process tedious, prolonged and sometimes unsuccessful. An in-depth review of aquaculture legislation can be found in Moccia and Bevan (2000).When it comes to environmental management of waste in land based operations, the Ministry of the Environment is responsible for administering several Acts that regulate the use, treatment, management and disposal of water and wastewater. However, the application of these regulations to cage aquaculture can be confused and complicated.

2.4.5 Lack of insurance of aquaculture

According to Pillay (1994), there is a general perception that aquaculture is a high risk activity involving a risk higher than other food production industries such as poultry, pigs, cattle etc. This may be due to various reasons. Firstly, fish is raised in an aquatic medium, generally outside the control of the farmer’s direct observation and care as compared to the other food production industries. Also, aquaculture is comparatively a new industry and is still on a learning curve to establish itself on par with other allied industries. There are a lot of risks available to the sector.

These include the state of technology, technical and managerial status, and uncertain financial support (Pillay 1994). Another group of risk also poses a challenge to the sector. These include diseases which reduce the stock, accidents, poaching, natural disasters, use of sub-standard facility inputs, production contamination and loss of income due to competition and over-production. These types of risks are common to all such ventures and not aquaculture alone (Pillay 1994).

2.5 Trainings and extension services

Fisheries extension services may be defined as the dissemination of the educational advances of institution to persons unable to take advantage of such in a normal manner. Fisheries extension brings to the fishermen, fish farmers, and fish processors that form of educational assistance best suited to their needs.

The inability of the farmers in developing countries, including Kenya, to produce at a rate that can meet the need of the population has been linked to lack of access to crucial information on improved agricultural practices, among other factors. This is exacerbated by the dearth of agricultural extension workers through whom farmers can be reached. This results from the limited resources available to the public extension agencies with which farmers are reached free of charge in developing countries (Budak, *et al.* 2010). Therefore, in a bid to promote farmers' access to extension services, various forms of agricultural extension finance payments have been instituted in some parts of the world, like in the United Kingdom, Netherlands, Sweden, Germany, Chile and Portugal (Budak *et al.* 2010; Rivera & Cary, 1997). This trend would reduce the economic burden on government and increase the efficiency and effectiveness of extension (Shekara, 2004). The trend would also enhance sustainability in fish production.

Sustainability in the context of fish farmers' willingness-to-pay for extension services is premised within the meaning of sustainability as posited by the World Commission on Environment and Development (1987): meeting the needs of the present without compromising the ability of the future generation to meet their own needs. A positive attitude of fish farmers towards financing extensions services can enhance both ecological and socio-economic concepts

of sustainability: It can make fish production levels relatively adequate for the present and future generations without reducing the ecosystem potentials. Besides, it can increase or maintain fish output to meet the social and economic needs of the actual and future generations.

Agricultural extension department is the most important public service institution with the widest range of responsibilities for agricultural and rural development (Oladebo, 2004). The conduct of agricultural extension work in Nigeria shows that one of the primary responsibilities is to help farmers make efficient use of available resources to meet the nation's food needs. Agricultural extension services promotes the determination of technical choice for specific agricultural population and area by making use of farm diagnosis, articulated needs of the rural farmers and identified target domains and arousing their interest in their problems. In this regard, agricultural extension provides a vehicle of technology transfer by initiating the development, transfer and diffusion process of innovation (Abalu, 1998). According to (Falusi 1991) agricultural development is a rural development approach through which the right technology, effective extension services, access to inputs, adequate market and complementary infrastructural facilities essential to improve productivity and boost the standard of living of rural dwellers are provided. The clamors for higher productivity in fish farming can be achieved not only by coming up with improved technology but to properly organize adequate extension services. This is when the impact of improved technology can have desired effects on fish farmers (Agbamu, 2000).

One approach to determining desirable extension agent behaviour and performance is to begin with the farmers' point of view (Oladosu, 2006). Some useful indications of farmers expectation of extension agents behavior was confirmed by (Boone, 1986), who found widespread resentment towards extension agents among farmers because they resent advise from agents who adopt superior attitudes. Many scientists are now convinced that it is no longer desirable to use a transfer of technology approach in which the extension administrators decide on the targets to be realized by the field-level extension agents. Agbamu, 2000). A more participatory approach is instead preferred, in which farmers decide which changes are desirable and what kinds of support are needed from extension to realize changes (Oladele, 1997).

A participatory approach requires that the extension organization becomes a learning organization with the ability to discover which changes are desirable in each specific situation. It is easier to adopt a participatory approach or a farmer-led extension system or a farmers' association than in a government environment extension organization (Agbamu, 2000). According to (Adu, 2005), the first stage towards the adoption of an innovation is to become aware that it exists. Awareness does not just mean that an innovation exists but that it is potentially of practical relevance to the farmers (Adu, 2007). The major role of agricultural extension is to help farmers to make decisions through which they can realize their own goals and to learn from their own experience (Van den Ban and Howkins, 1996).

Despite the efforts of extension agents to alleviate rural poverty and support fish farmers to improve their competencies in different aspects of fish farming and also to be more responsible with environmental and natural resources, there are indications that the efficiency and quality of the support provided by the extension agents have not been fully utilized by fish farmers. The general objective of the research aimed at analyzing fish farmers' awareness and participation in extension agents' linkage activities in a coastal and inland States, Nigeria. The specific objectives are to determine the level of awareness of fish farmers to extension agents' activities and ascertain the level of participation of fish farmers in these activities.

In Ghana, the Directorate of Fisheries and the Ministry of Agriculture provide free extension services and other technical services to fish farmers which include the production of fingerlings for sale at government-operated fish hatcheries. In addition, non-governmental organizations and universities have also provided some technical assistance to fish farmers in effort towards the development of aquaculture in Ghana (Quagrainie *et al*. 2009). However, the Fisheries Directorate, are represented at the farmer contact level by Agricultural Extension Agents (AEA). This is because, Fisheries extension capacity for aquaculture activities; was very weak because this area was not part of the curriculum of the agricultural colleges (FAO, 2000, 2009).

Result and Method demonstrations were particularly very effective as majority of the client groups were resource poor and illiterate or semi-literate, and as such they had the tendency of

avoiding taking risk. Demonstrations offered them opportunity to observe the difference between the improved and the traditional culture practices. It created greater impact when they were able to see that someone from their own community had been successful in following the recommended package of practices and benefited. These result demonstrations also created a sustainable teaching method based on seeing is believing and also developed the confidence of the extension agents.

Demonstration sites were also used for conducting in situ training for the 164 fish farmers (Table 2.1) through display of the crop and demonstration of various steps of the package of practices. Learning through this method was concrete as it was essentially a doing method and allowed for repetition and practical exercises. The success of the demonstration was ensured because of its simplicity and presentation of concrete results.

Table 2.1 Fish farmers in Embu North District

Division	**Number of fish farmers**
Manyatta	70
Ruguru	55
Nginda	39
Total	164

Source: Ministry of fisheries and development, annual report 2011

2.6 Influence of marketing on fresh water fish farming

Marketing is the process of planning and executing the conception, pricing, promotion, and distribution of ideas, goods, services, organizations, and events to create and maintain relationships that will satisfy individual and organizational objectives (Boone and Kurtz, 1998). The American Marketing Association defined marketing as an organizational function and a set of processes for creating, communicating and delivering value to customers and for managing customer relationships in ways that benefit the organization and its stakeholders (AMA, 2004).

Markets and marketing are critical mediating institutions in rural livelihoods for over all development. Markets, when they work, can be an efficient mechanism for the exchange of goods and services, the coordination of buyers and sellers and the allocation of resources in an economy (DFID, 2006). Marketing of aquatic products is playing an important role in the exchange and flows of products from producers to consumers. Fish marketing has been mostly developed and driven by the private sector, which is also observed in other south-east Asian countries like India, Thailand and the Philippines (FAO, 2001a). Marketing of aquatic products for example in Bangladesh is inherently complex due to the existence of different type of markets, distribution channels, channel intermediaries, contracts and heterogeneous consumers (Alam, 2001). According to Alam (2001), different types of aquatic products from different sources are channeled in different ways to the domestic and international markets. Marketing of aquatic products can be broadly characterized as domestic marketing and export marketing.

Almost all fishes (95%) produced in Bangladesh are consumed locally (DFID, 2005). Fish from different sources (culture, capture and marine) are distributed to the consumers throughout the country by channel intermediaries. Although all sorts of fish for consumption may be sold side by side at the same time and within the same retail market to consumers, the marketing and distribution channels of fish from culture, capture, and marine fisheries vary to some extent. The domestic fish marketing chain is commonly described as long passing through 4-5 intermediaries (Dey, 2000; Muzaffar and Helaluddin, 2001).

According to Adu (2005), the main challenge is that the extension services to individual farmers normally focus on improving production, while neglecting marketing, processing (cold chains, live marketing, smoking and value added products), socio-economic factors, and the adoption of aquaculture. Because of this, the farmers have little knowledge as to how to market their products. Adu (2005) explains that fish marketing is mostly centralized around the big cities of a country.

Studies have revealed that most farmers sell their fish raw at local and nearest urban markets, with the prices varying with the weights of the fish. Farmers would, therefore, not likely adopt

improved management practices while proceeds from sale of fish are low (MoLFD 2007). Current marketing information is largely informal and obtained by talking to buyers/ traders or sellers who have conducted transactions. The fact that most consumers were paying premium prices for fish species reared could influence the fish species adopted by farmers (Henryon et al 1998). To tackle the problem of marketing, cooling facilities are essential and farmers should have a collective approach on the matter.

2.7 Theoretical frame work

The study will be guided by the following development theories:-

2.7.1 Modernization and Development

Modernization as a way of development can be traced from the first half of the 20th century in the history of western-industrialized countries. Modernization became in reality an economic development theory. It was taken generally that for third world countries to develop; they had to follow the same stages as European Countries went through some decades ago. The theory emphasized that poor countries of the world were poor because they were dependent on agriculture, used traditional means of production, lacked technological innovations and generally had an illiterate society.

Development is by the modernization theorists characterized as a movement from a state of backwardness with subsistence economy, to a modern, industrial society with higher income and productivity rates. This school of thought however ignores the concrete and complex processes of change and struggle in real social formations. According to Lee (2000), modernization is an environmentally and socially destructive ideology, which retains a power to shape trajectories of economic development within which sustainability is problematic.

In Kenya, the national poverty reduction policy and strategy is based on modernization ideology. It emphasizes the concept of transforming the economy from being poor where most people are locked into traditional subsistence production into a modern economy where agents in all sectors are able to participate actively in economic growth. According to modernization theory, those

who work in the informal sector are largely people with low levels of education and even lack formal education skills. They produce at a small scale and their contribution to the country's economy is negligible if it is there at all. Determining the level of development basing on per capita income thus excludes such people from the development process and this is typical of the majority of fresh water small scale fish farming in Kenya.

Despite the exclusion characteristic of modernization path to development, many of the development strategies in Kenya are based on modernization ideologies. The use of modernization ideas therefore has been necessary in this study especially in assessing whether it caters for all or excludes some people in the development process.

2.7.2 Alternative Development

This paradigm rejects economic growth as an end in itself, and instead emphasizes welfare and human development with increased choices (Martinussen, 1999). It emerged in the 1970's as a critique to mainstream economic model of modernization that failed to address the problem of massive poverty and environmental sustainability. It was inspired by the works of John Friedman who saw the previous attempts to development as 'failure' and alternative development as 'hope'. As a new approach, alternative development hoped to improve the living conditions of the poor especially in rural areas and at the same time be compatible with emerging environmental concerns.

The main idea about alternative development was not to replace mainstream development path of modernization through the state but rather to transform them so that the disempowered poor are included in political and economic processes and have their rights as citizens and human beings acknowledged. It therefore became a bottom-up approach with the major concern on people and not only on production and profits. Alternative development focuses on the fulfillment of practical and strategic interests through collective mobilization-the empowerment approach. This has increasingly been used to mean increasing people's capacities so that they become self-sustaining, independent and able to make decisions that affect their lives. The theory points out that its only through people-centered and bottom-up approaches to development through which

people are empowered; socially, economically as well as psychologically.Through the 'basic needs approach' of alternative development theory, fish farming is very important as an alternative source of food (proteins), source of income for Kenyan farmers thus able to meet other basic needs like clothing, housing and education. It is important to note that the use of 'Alternative Development' theory in this study helps to understand factors influencing fresh water small scale fish farming in the study area.

2.7.3 The Concept of Sustainable Development

The term was first used in early 1980's in the World Conservation Strategy but became popular after the publication; 'Our Common Future' by the World Commission on Environment and Development (WCED) in 1987. According to Ashley and Carney (1999), in Johnston et al (2000), about eighty definitions of 'sustainable development' can be identified. They point out that the most widely used is that of WCED (1987): "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". By this time, international debates had been characterized more and more by considerations about the impact of growth and socio-economic change upon the physical environment. From this definition, the emphasis on 'needs' is closely related to problems of poverty especially in the Third World. It is emphasized that fulfilling of human needs and aspirations is the most important goal for all development efforts throughout the world (Martinussen, 1999). On the other hand, sustainability seen from the SL approach, is not merely about meeting basic needs or subsistence living but views this as rather the first step.

Globally, the concept of sustainability has been the major focus in the formulation of development objectives as well as in connection with the design of strategies, which increasingly take into account environmental concerns. In simple terms, sustainability may be taken to mean that, a specific activity can continue or a resource is available for at least the medium, and it is not associated with or dependent upon rapidly depleting inputs (Roberts and Muir in Reinertsen and Haaland, 1995; Helmore and Singh, 2001). Sustainability can mean different things to different people (Redclift 1990 and Tickell 1992), though most would agree that it involves three elements of futurity, equity and the environment (Pearce, 1993) It is important to note that the

term has acquired different connotations within particular fields; for instance in institutional projects particularly in economically deprived areas, the term sustainable development is used to define whether projects are likely to continue once external support has been withdrawn. It relates with project effectiveness, financial viability, technical capacity and social acceptability.

Sustainability is important because it implies that progress in poverty reduction is lasting, rather than fleeting because there is accumulation of broad capital base that provides the basis for improved livelihoods, especially for poor people. With regard to this study, the term sustainability is used to determine whether the long term objectives of fresh water small scale fish farming are achievable through the aquaculture project. Broadly speaking, sustainability is a key indicator of success or failure in development projects. Thierry Lemaresquier of UNDP's Social Development and Poverty Elimination Division (SDPED) had this to say; "projects that are based on empowerment and improvement of livelihoods of the poor stand a much better chance of surviving once the initial funding and effort has run out of gas" (Helmore and Singh 2001).

2.8 Conceptual Framework

According to Bogdan and Biklen (2003), a conceptual framework is a basic structure that consists of certain abstract blocks which represent the observational, the experiential and the analytical or synthetically aspects of a process or system being conceived. The interconnection of these blocks completes the framework for certain expected outcomes.An independent variable is that variable which is presumed to affect or determine a dependent variable. It can be changed as required, and its values do not represent a problem requiring explanation in an analysis, but are taken simply as given (Dodge, 2003). The independent variables in this study are: To assess ecological factors influencing fresh water fish farming; To assess social economic factors influencing fresh water fish farming; To determine how training and extension services influence fresh water fish farming and to establish the influence of marketing on fresh water fish farming in Embu North District. A dependent variable is what is measured in the experiment and what is affected during the experiment. The dependent variable responds to the independent variable. The dependent variable in this study is sustainable fresh water fish farming.

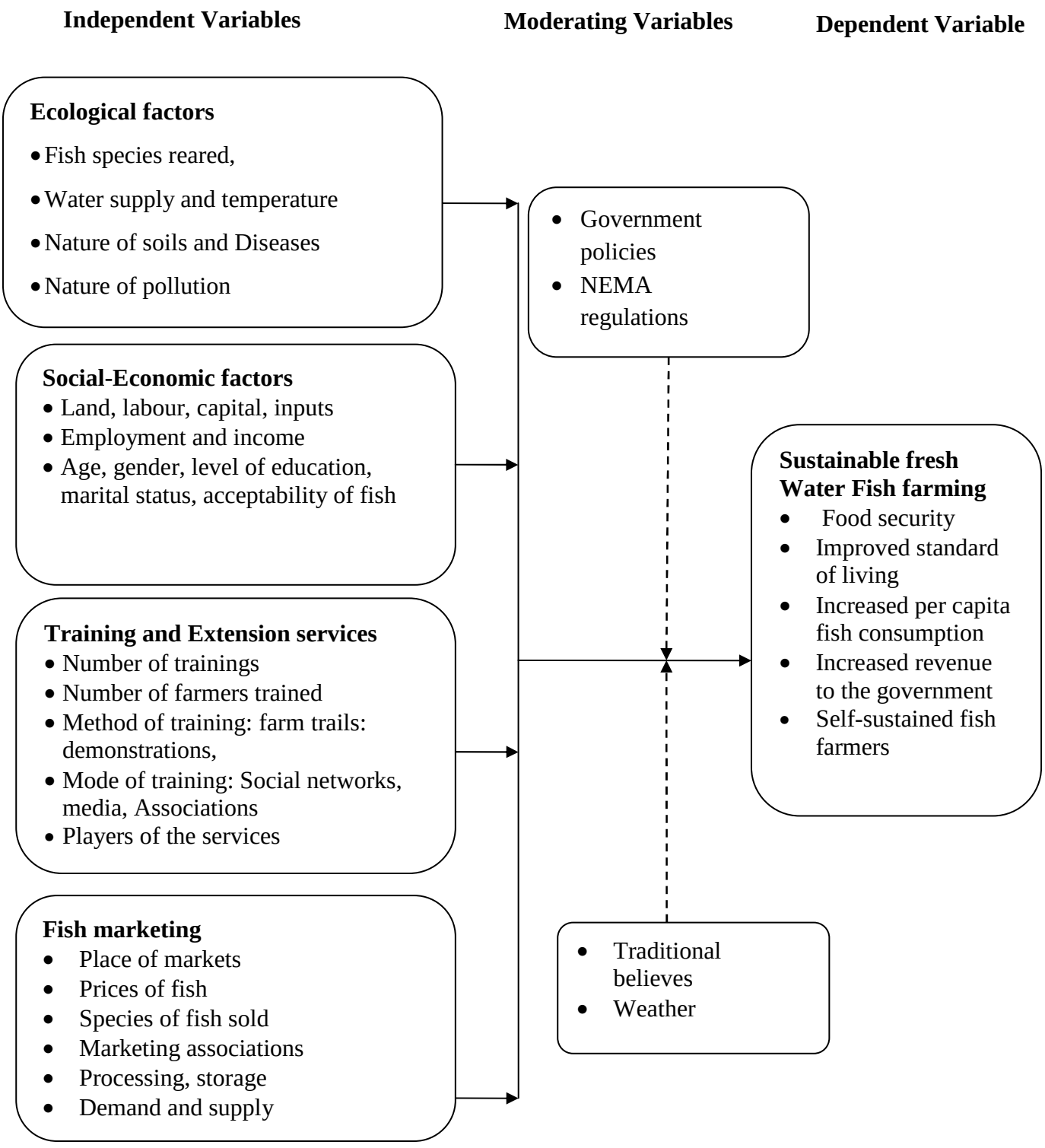

Figure 2. Conceptual Framework

2.9 Knowledge gap

The literature review of this study shows that fresh water fish farming has huge potential for expansion in Kenya but fish-farming systems are underdeveloped and are practiced at low levels of intensification. The study reflected on the ecological factors influencing fresh water fish farming, the social economic factors influencing fresh water fish farming, the trainings and extension services offered to fresh water fish farmers and the influence of marketing on fresh water fish farming. The study did not consider about the effect of technology and other determinants of successful fresh water fish farming hence creating a gap for further study. There's therefore the need to carry out further research on determinants of fresh water fish farming.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the research design, target population, sampling technique, sample size, data collection methods, data collection instruments, reliability and validity of the data collection instruments and finally the data analysis are presented in the chapter, ethical considerations and Operational definition of variables.

3.2 Research Design

For the purposes of this study, the researcher employed descriptive research design. A descriptive study is concerned with determining the frequency with which something occurs or the relationship between variables (Bryman and Bell, 2003). Descriptive research design was a valid method for researching factors influencing fresh water fish farming in Embu North District and as a precursor to quantitative studies. The design was deemed suitable since it helped to describe the state of affairs as it exists without manipulation of variables which was the aim of the study.

3.3 Target Population

The target population for this study was164 respondents consisting of 160 active fresh water fish farmers with one or more fish ponds, the chairman of Embu North District fish farmers marketing Association and 3 Area Extension Officers (Table2.1). Mugenda and Mugenda (2003) reported that the target population should have some observable characteristics, to which the researcher intends to generalize the results of the study.

3.4 Sampling Techniques and Sample Size

The sample of respondents was drawn from 160 active fresh water fish farmers with one or more fish ponds, the chairman of Embu North District fish farmers marketing association and 3 Area Extension Officers. Purposive sampling technique was used to select the respondents. The technique allows a researcher to use cases that have the required information with respect to the objectives of the study (Mugenda and Mugenda, 2003). Cases of subjects are handpicked

because they have information or they possess the required characteristics. This study therefore, took a census of the 164 respondents from Embu North District. According to Dooley (2007), when the sample is small it is important to take the whole population in order to determine the needs of an organization.

3.5 Data Collection Instruments

Data was collected by use of questionnaires. Questionnaires were cheap to administer to respondents who were scattered over a large area. It was convenient for collecting information from a large population within a short span of time. The questionnaires had both open and closed ended questions. The structured questions were used in an effort to conserve time and money as well as to facilitate in easier analysis as they were in immediate usable form; while the unstructured questions were used to encourage the respondent to give an in-depth and felt response without feeling held back in revealing of any information.

3.5.1 Validity of the Instruments

Validity of the instruments was established by peers and a panel of experts from the Department of Extra Mural Studies .The research instrument were availed to the experts and peers, who established its content and constructed its validity in order to ensure that the questionnaire included an adequate and representative set of items which contain the dimension and elements of concepts under study.

3.5.2 Reliability of the Instruments

This research study used test-rest method which involves administering the same scale or measure to the same group of respondents at two separate times. This was after a time lapse of one week. A pilot study was conducted in the district. 10 fresh water fish farmers were picked randomly for the pilot study. Test re-test method was used to test for reliability of the instrument. The instruments were administered to the respondents and re-administered to the same respondents after one week. This was in line with (Shuttleworth, 2009), who stated that the instrument should be administered at two different times and then the correlation between the

two sets of scores computed. This was done using Pearsons Product-Moment correlation coefficient Formula. The formula is as follows:

$$r = \frac{\left[\sum xy - (\sum x)(\sum y)\right]}{\sqrt{\left[\sum x^2 - \frac{(\sum x)^2}{N}\right]\left[\sum y^2 - \frac{(\sum y)^2}{N}\right]}}$$

A correlation coefficient of above 0.7 was deemed to mean that the instrument was reliable and measurable.

3.6 Data Analysis techniques

The questionnaires were edited for the purpose of checking on completeness, clarity and consistency in answering research questions. The data was coded, tabulated and analysed using Statistical Package for Social Sciences and MS Excel based on study objectives. Descriptive statistics was computed and study findings were presented using percentages and tables and interpretations made.

3.7 Ethical considerations

All respondents were treated with courtesy and respect in order to avoid misunderstanding between the enumerators and respondents and they were informed of the purpose of the study. Each respondent was politely requested to fill the questionnaire and assured of confidentiality with regard to any information they had provided.

3.8 Operational definition of variables

The operational definition of variables is given in Table 3.1

Table 3.1: Operational definition of variables

Objectives	Type of Variables	Indicator(s)	Measurements	Measurement scale	Tools of analysis	Type of data analysis
To assess ecological factors influencing fresh water fish farming in Embu North District	**Independent** Ecological Factors	Types of fish species in a pond	Number of fish species reared in a pond	Ratio	Percentages means	Descriptive
		system of water supply	number of water supply systems	Ratio	Percentages means	Descriptive
		Drainage of water from a pond	Number of times per unit time	Ratio	Percentages means	Descriptive
		pond water temperatures for warm species	Degree centigrade/Celsius	Ratio	Percentages means	Descriptive
		Pond water temperatures for cold species	Degree centigrade	Ratio	Percentages means	Descriptive
		Quality of soils	Content of gravels Depth of the soils	Ratio	Percentages means	Descriptive
		Types of predators	Number of predator	Ratio	Percentages means	Descriptive
		Nature of water pollution	sources of pollution	Ordinal	Percentages means	Descriptive
		Feeding	Types of feeds, Frequency of feeding	Ordinal	Percentages means	Descriptive
To assess social-economic factors influencing fresh water fish farming in Embu North District.	Social Economic factors	Land Labour capital inputs	Kenya shillings per ha total wages per month rate of bank interest per annum number of fingerlings per pond, kilograms of fish feeds consumed per day, kilograms of fertilizers utilized per pond	Ratio	Percentages means	Descriptive

		Employment Income generation	Number of employees in fish farms Type of employment opportunities Monthly income Per capita	Ratio Ratio	Percentages means	Descriptive
		Age	Number of years	Ratio	Percentages means	Descriptive
		gender	Number of Male Female	Ratio	Percentages means	Descriptive
		Level of education	Number of Primary Secondary Tertiary Degree	Ratio	Percentages means	Descriptive
		marital status	Number of: Married Single Divorced widowed	Ratio	Percentages means	Descriptive
To determine how training and extension services influence fresh water fish farming in Embu North District.	Training and Extension services	Training Extension services	Frequency of Farm trials number of Demonstrations number of Players of the services Number of trainings Number of farmers trained methods of training: Social networks, media, number of Associations	Ratio	Percentages means	Descriptive
To establish the influence of marketing on fresh water fish farming in Embu North District.	Fish marketing	Place of markets	Place of markets	Ordinal	Percentages means	Descriptive
		Prices of fish	Cost per species harvested Cost per size of fish	Ratio	Percentages means	Descriptive
		Species of fish sold	Type of fish harvested per pond	Ordinal	Percentages means	Descriptive
		Marketing associations	Number of associations in the area	Ratio	Percentages means	Descriptive
		Demand and supply	Number of consumers and suppliers in the market and	Ratio	Percentages means	Descriptive

			Forces of supply and demand			
		Storage Facilities	Methods of storage facilities	Ordinal	Percentages means	Descriptive
		Processing	Methods of processing	Ordinal	Percentages means	Descriptive
	Dependent Sustainable fresh water fish farming	Food security Improved standard of living Increased per capita fish consumption Increased revenue to the government Self-sustained fish farmers	Level of food safety Rate of fish consumption Level of wealth Level of GDP Level of sustainable fish farming Level of foreign currency	Ratio	Percentages means	Descriptive

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter contains data analysis, presentation and interpretation of findings. The study intended to assess factors influencing fresh water fish farming in Embu North District. The results of the study are presented following the listed sub-headings: questionnaire return rate, description of the study subjects, ecological factors influencing fresh water fish farming, social economic factors influencing fresh water fish farming, how training and extension services influence fresh water fish farming and the influence of marketing on fresh water fish farming.

4.2 Questionnaire Return Rate

The questionnaire return rate was 99 % as 161 out of 164 questionnaires were returned. This was possible since the questionnaires were administered by trained research assistants who administered questionnaires and waited for the respondents to complete the questionnaires. The questionnaires were collected immediately and in cases where the questionnaires were left behind, they were collected the following day.

4.3 Demographic Characteristics of the respondents

This section gives the respondent's gender, age, level of education, marital status, family size and whether the respondent is the household head. These social attributes were relevant to the study since they enabled the respondent to provide information that is valid, reliable and relevant to the study.

4.3.1 Study responses by gender

The respondents from Embu North District who engaged themselves in fresh water fish farming were asked to state their gender. The responses are shown in Table 4.1.

Table 4.1: Gender of the respondents

Gender of respondents	Frequency	Percentage
Male	82	50.9
Female	79	49.1
Total	161	100.0

The study findings indicated that 82 (50.9%) of respondents were males while females were 79(49.1%).The study showed that gender was not a major factor in the area of the study.

4.3.2 Respondents by age

The respondents were asked to indicate their ages from among choices of age classes given. The age of the respondent has an influence on the ability to engage in fresh water fish farming activities. The respondents responses are shown in Table 4.2

Table 4.2: Age of respondents

Age of respondent in years	Frequency	Percentage
Below 30	17	10.6
31-40	42	26.1
41-50	43	26.7
51-60	48	29.8
Above 60	11	6.8
Total	161	100.0

The research findings show that 133 (82.6%) respondents are in age bracket of 31-60 years. This indicates that majority of the respondents are in their middle age and therefore suitable in undertaking fish farming activities which require energy and effective decision making.

4.3.3 Marital status of the respondents.

The respondents were asked to indicate their marital status. Table 4.3 shows the distribution of the respondents by marital status.

Table 4.3 Marital status of the respondents

Marital status	Frequency	Percentage
Married	124	77
Single	20	12.4
Divorced	6	3.7
Widow	11	6.9
Widower	0	0
Total	161	100

The study findings indicate that majority 124(77%) of the respondents were married. Marriage ascribes familial responsibilities to farmers and therefore farmers become more serious in terms of their participation in fish farming activities.

4.3.4 Distribution of the respondents by their level of education

The respondents were asked to indicate their highest level of education and Table 4.4 shows the results.

Table 4.4: Respondents level of education

Level of education	Frequency	Percentage
Primary	63	39.1
Secondary	77	47.8
Tertiary	8	5.0
University	13	8.1
Total	161	100.0

The findings show that 63 (39.1%) respondents had primary education and 77 respondents (47.8%) had secondary education. Therefore, this indicates that majority of the respondents are literate and could undertake fish farming activities well.

4.3.5 Family size of respondents

The respondents were asked to indicate their family size. Table 4.5 shows the distribution of the respondents by family size.

Table 4.5: Family size of the respondents

Family size	Frequency	Percentage
Below 3	39	24.2
3-5	70	43.5
6-8	36	22.4
Over 8	16	9.9
Total	161	100.0

The study indicated that 70 (43.5%) families had 3-5 members. Some of family members offered labour in fish farming activities and hence reduced the amount spent on labour cost.

4.4 Ecological factors influencing fresh water fish farming

Ecological factors such as fish species reared, water supply and temperatures, nature of soils and diseases, pollution and types of predators influence fish farming in the study area.

4.4.1 Fish species reared

The respondents were requested to indicate major species of fish which they rear. Table 4.6 shows the main species of fish reared.

Table 4.6: Main species of fish reared

Fish species	Frequency	Percentage
Tilapia only	81	50.3
African Catfish only	36	22.4
Trout only	2	1.2
Tilapia and African Catfish mixed	42	26.1
Total	161	100.0

The study showed that majority 81 (50.3%) of respondents stocked Tilapia only while 80 (49.7%) respondents stocked Tilapia and African Catfish mixed, African Catfish only and Trout fish. Trout fish is less popular since it does well in cold areas. The fish species stocked depended on marketability, fast growing, taste of fish and other reasons like availability of fingerlings.

The respondents were asked to indicate reasons for their choice of fish species. Table 4.7 showed reasons for stocking various fish species.

Table 4.7: Reasons for stocking fish species

Reasons	Frequency	Percentage
Very marketable	72	44.7
Fast growth	56	34.8
Better taste	30	18.6
Other reasons	3	1.9
Total	161	100.0

The study showed that 72(44.7%) respondents stocked fish species basing on its marketability, 56(34.8%)respondents stocked fish because of its fast growth while the rest stocked fish because of better taste and other reasons.

The respondents were further asked to indicate their sources of fingerlings. Table 4.8 shows the source of fingerlings.

Table 4.8: Source of fingerlings

Source of fingerlings	Frequency	Percentage
Government hatchery	60	37.3
Private hatchery	95	59.0
Neighbours	6	3.7
Total	161	100.0

The study indicated that majority 95(59.0%) of the respondents obtained their fingerlings from private hatchery, while the rest 66(41% of respondents obtained fingerlings from the Government hatchery and from the neighbours.

The respondents were also asked to indicate about the type of fish pond they keep, number of fish ponds they have, factors which led to the construction of the fish pond type, determinants of the number of fish ponds they have and number of years the fish ponds had been operational. The results are shown on Table 4.9, Table 4.10, Table 4.11, Table 4.12 and Table 4.13 respectively**.**

Table 4.9: Type of fish ponds

Type of fish ponds	Frequency	Percentage
Earthen	56	34.8
Liner	103	64.0
Concrete	2	1.2
Total	161	100.0

The study indicated that majority103(64.0%) of respondents had liner type of fish pond while only 2 (1.2%) respondents had concrete type of fish ponds.

Table 4.10 Factors which led to construction of the type of fish pond

Factor	Frequency	Percentage
Quality of soils	65	40.4
Water temperatures	77	47.8
others	19	11.8
Total	161	100.0

The study showed that 77(47.8%) respondents indicated that water temperatures is a great factor when considering construction of a fish pond in the area of study.

Table 4.11: Number of fish ponds

Number of fish ponds	Frequency	Percentage
1	60	37.3
2	64	39.7
3	22	13.7
4	12	7.4
Over 4	3	1.9
Total	161	100.0

The study indicated that most 64 (39.7%) of the respondents had only 2 fish ponds while only 3(1.9%) respondents had over 4 fish ponds.

Table 4.12: Determinants of the number of fish ponds

Determinants	Frequency	Percentage
Market demand	41	25.5
Availability of capital	80	49.7
High profit from sales	27	16.7
Availability of land	12	7.5
others	1	0.6
Total	161	100.0

The research indicated that availability of capital as shown by 80 (49.7%) respondents was the main determinant of the number of fish ponds each respond had followed by market demand.

Table 4.13: Number of years fish ponds were operational

Number of years	Frequency	Percentage
Less than 1 year	60	37.3
1-5 years	74	46.0
Over 5 years	27	16.7
Total	161	100.0

The findings indicated that majority 74(46.0%) of the respondents had fish ponds which had been operational from 1-5 years followed by young farmers whose fish ponds were in operation for less than one year.

4.4.2 Water supply and temperature

The respondents were asked to indicate their main source of water, means by which water got into the pond, how often the water level was maintained and finally how often optimal water temperatures were monitored. The results are shown on Table 4.14, Table 4.15, Table 4.16 and Table 4.17 respectively.

Table 4.14: Main sources of water

Water sources	Frequency	Percentage
Wells	42	26.1
Streams	65	40.4
Springs	30	18.6
Others like piped	24	14.9`
Total	161	100.0

The study showed that most 65(40.4%) of respondents obtained water for their ponds from streams, while 24 (14.9%) respondents obtained water from other sources.

Table 4.15: Means by which water got into the pond

Means	Frequency	Percentage
Gravity	81	50.3
Pumping	60	37.3
Others like hose pipe	20	12.4
Total	161	100.0

The study indicated that majority 81(50.3%) of the respondents got water into the pond through force of gravity while 20 (12.4%) respondents fill their ponds through the use of other means like hose pipe.

Table 4.16: How often the water level is maintained

Maintenance of water	Frequency	Percentage
Daily	24	14.9
Weekly	101	62.7
Monthly	34	21.2
Others	2	1.2
Total	161	100.0

According to the study majority 101 (62.7%) of respondents maintained the water level in the fish ponds on weekly basis while 2 (1.2%) respondents did not maintain the water level regularly.

Table 4.17: How often optimal water temperatures are monitored

Monitoring	Frequency	Percentage
Daily	41	25.5
Weekly	88	54.7
Monthly	25	15.5
Others	7	4.3
Total	161	100.0

According to the study majority 88(54.7%) of respondents monitored water temperatures in the fish ponds on weekly basis while 7 (4.3%) respondents did not monitor the water temperature regularly.

4.4.3 Nature of soils and diseases

The respondents were asked of factors leading to construction of fish ponds and the main diseases experienced by fish farmers. The results are shown on Table 4.18 and Table 4.19 respectively.

Table 4.18: Factors which led to construction of the type of fish pond

Factor	Frequency	Percentage
Quality of soils	65	40.4
Water temperatures	77	47.8
others	19	11.8
Total	161	100.0

The study showed that 65(40.4) respondents indicated quality of soils and water temperature77 (47.8%) as great factors leading to construction of fish ponds in the area of study.

Table 4.19: Main fish diseases

Main diseases	Frequency	Percentage
None	90	55.9
Stress due to lack of oxygen	56	34.8
Fungal diseases	15	9.3
Total	161	100.0

The study showed that majority 90(55.9%) of the respondents had not experienced any fish problems or diseases.However,56(34.8%) respondents experienced fish stress due to lack of oxygen in the ponds.

4.4.4 Kind of pollution experienced

The respondents were asked to state the kind of pollution experienced in fresh water fish farming in the area of study. The results are shown on Table 4.20.

Table 4.20: Kind of pollution experienced

Kind of pollution	Frequency	Percentage
Chemicals from soil erosion	68	42.2
Left over feeds	35	21.7
Over feeding/excess feeds	48	29.8
Others	10	6.2
Total	161	100.0

The study showed that most 68(42.2 %) of respondents had the problem of pollution from chemicals from soil erosion followed by excess feeds and left over feeds.

4.4.5 Type of fish predators

The respondents were asked to indicate the type of predators they experience in their fish ponds. Table 4.21 shows types of fish predators found in the study area.

Table 4.21: Type of fish predators

Type of predators	Frequency	Percentage
Snakes	30	18.6
Birds	104	64.6
people	8	5.0
Otter	18	11.2
Frogs	1	0.6
Total	161	100.0

The study indicated that majority104(64.6%) of respondents experienced birds as their main fish predator while 57(35.4%) experienced predators like snakes, otter, human beings and frogs. These predators affected the volume of fish produced in the area.

4.5 Social Economic factors influencing fresh water fish farming

The respondents were asked to indicate about how the fish farmers raised money to construct fish ponds, whether fish farming was the main source of income in the household, to state other sources of income, respondents' involvement in the fish farming and form of land ownership. Responses are indicated on Table 4.22, Table 4.23, Table 4.24 Table 4.25, and Table 4.26 and Table 4.27 respectively.

Table 4.22: How money was raised for starting fish pond

Source of money	Frequency	Percentage
Own money	78	48.4
Bank	41	25.5
Cooperative society loan	13	8.1
Government support(ESP)	27	16.8
Others	2	1.2
Total	161	100.0

The findings showed that 78 (48.4%) of respondents used their own money to start fish farming, 41 (25.5%) respondents got money from banks, cooperative societies and government support programme.

Table 4.23: Whether fish farming is the main source of income in the household

Source of money	Frequency	Percentage
Yes	43	26.7
No	118	73.3
Total	161	100.0

The study showed majority118 (73.3%) of respondents practiced mixed farming while 43 (26.7%) respondents practiced fish farming as their main source of income.

Table 4.24: State other sources of income

Other sources of income	Frequency	Percentage
Coffee farming/Tea	80	49.7
Horticulture	20	12.4
Dairy farming	17	10.6
others	1	0.6
N/A	43	26.7
Total	161	100.0

The study has shown that 80 (49.7%) of respondents practice Coffee/Tea farming as their other source of income apart from fish farming, 20(12.4%) respondents practice horticulture, 17 (10.6%) respondents practice dairy farming.

Table 4.25: Respondents involvement in the fish farming

Involvement	Frequency	Percentage
Run the operation myself	76	47.2
My family assist me	66	41.0
Employed fish attendant	19	11.8
Total	161	100.0

The study indicated that 76(47.2%) of respondents run fish farming themselves, 66 (41.0%) respondents are assisted by their families while 19 (11.8%) respondents employ fish attendants.

Table 4.26: Form of land ownership

Land ownership	Frequency	Percentage
Freehold	9	5.6
Family land	45	28.0
leasehold	2	1.2
Own land	105	65.2
Total	161	100.0

The study indicated that majority 105(65.2%) of respondents own land while the rest do fish farming on family land, freehold land and on leasehold land. The owned land acts as a security for obtaining loan to start and expand fish farming.

Table 4.27: Factors influencing fresh water fish farming

Factors	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Contribute to poverty alleviation and food security	3	1.9	5	3.1	2	1.2	47	29.2	104	64.6
Contribute to social well being promoting equity	2	1.2	2	1.2	4	2.5	44	27.3	109	67.7
Provide food of high nutritional value	1	0.6	0	0	4	2.5	21	13	135	83.9
Combination of agriculture and aquaculture improve food supply, income and make farmers self sustained	1	0.6	0	0	4	2.5	24	14.9	132	82
Boosts rural economic development	1	0.6	0	0	4	2.5	32	19.9	124	77
Living near water bodies encourage fish farming	2	1.2	1	0.6	19	11.8	33	20.5	106	65.8
Major source of foreign exchange to government	43	26.7	0	0	18	11.2	34	21.1	66	41
Offer employment opportunities to many farmers	1	0.6	0	0	4	2.5	32	19.9	124	77
Mean	7	4.2	1	0.6	7	4.6	33	20.7	113	69.9

The study showed that on average, 113 (69.9%) of respondents strongly agreed that fresh water fish farming can make an important contribution to poverty alleviation, food security, food supply through combination of agriculture and aquaculture, increase in income and self sustain farmers, boosts rural economic development, Living near water bodies encourage fresh water fish farming, foreign exchange earnings to government and offers employment opportunities to many farmers.

4.6 How training and extension services influence fresh water fish farming

Fisheries extension and training brings to the fishermen, fish farmers, and fish processors that form of educational assistance best suited to their needs. The respondents were asked to indicate whether they attended training organised by ministry of fisheries and other service providers, to name the institution of training, training methods used, number of training conducted and whether the trainings conducted influenced fresh water fish farming. The results are shown in Table 4.28, Table 4.29, Table 4.30, Table 4.31 and Table 4.32 respectively.

Table 4.28: Whether attended training organised by ministry of fisheries and other service providers

Attended training	Frequency	Percentage
Yes	154	95.7
No	7	4.3
Total	161	100.0

The study indicated that majority 154(95.7%) of respondents had attended training organised by the Ministry of fisheries and other service providers while 7(4.3%) respondents had not attended any training.

Table 4.29: Name of the training institution

Name of institution	Frequency	Percentage
None	7	4.3
Ministry of Fisheries	79	49.1
Other service providers	65	40.4
During field days	10	6.2
Total	161	100.0

The study showed that most79 (49.1%) of respondents had attended training organised by the Ministry of fisheries while 7 (4.3%) of respondents had not attended training in any institution.

Table 4.30: Training method used

Method of training	Frequency	Percentage
None	7	4.3
Demonstration	86	53.5
Workshop and seminars	57	35.4
Other methods	11	6.8
Total	161	100.0

The study indicated that majority 86(53.5%) of the respondents received training through demonstrations while 68(42.2%) received training through workshop and seminars. However, 7 (4.3%) of respondents had not received any training.

Table 4.31: Number of trainings conducted

Number of trainings	Frequency	Percentage
None	2	1.2
1	43	26.7
2-3	88	54.7
4-5	24	14.9
Over 5	4	2.5
Total	161	100.0

According to the study majority 88(54.7%) of respondents received 2-3 trainings, 4(2.5%) of respondents received over 5 trainings while 2(1.2%) of respondents received no training.

Table 4.32: Influence of training on fresh water fish farming

Influence of training	Frequency	Percentage
None	17	10.6
Motivation to farmers	68	42.2
Educate farmers on fish farming	75	46.6
Other	1	0.6
Total	161	100.0

The study indicated that the trainings educated majority75(46.6%) of respondents, motivated 68 (42.2%) respondents while the trainings did not influence 17 (10.6%) respondents at all.

4.7 Influence of marketing on fresh water fish farming

Markets and marketing are critical mediating institutions in rural livelihoods for over all development. The respondents were asked about the contribution of Ministry of fisheries in fresh water fish farming, where they market their fish, what influence fish prices, types of fish species

kept and sold, about the prices of various types of fish, source of fingerlings, reason of choice for various species, how various aspects influencing fish farming and how forces of demand and supply influence fish farming. The results are indicated in Table 4.33, Table 4.34, Table 4.35, Table 4.36, Table 4.37, Table 4.38, Table 4.39, Table 4.40 and Table 4.41 respectively.

Table 4.33: Contribution of Ministry of fisheries in fresh water fish farming

Factors	Strongly agree		Agree		Neutral		Disagree		Strongly disagree	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
There are good road-network linking fish farms and market	63	39.1	57	35.4	0	0	19	11.8	22	13.7
There are organized and developed markets for fish products	63	39.1	49	30.4	0	0	31	19.3	18	11.2
Ministry offers enough extension services to farmers	68	42.2	55	34.2	0	0	19	11.8	19	11.8
Government has fish farming policies in place	83	51.6	51	31.7	0	0	8	5.0	19	11.8
Government offers enough manuals to guide fish farmers	43	26.7	103	64.0	0	0	7	4.3	8	5.0
There are government initiatives aimed at promoting fish production	47	29.2	88	54.7	0	0	9	5.6	17	10.6
Mean	60	40	67	41.7	0	0	15	9.6	17	10.7

The study indicated that 63(39.1%) of respondents strongly agree there are good road network linking fish farms and market, 63(39.1%) strongly agree there are organized and developed markets for the fish products, 68 (42.2%) strongly agree that the Ministry of Fisheries offer enough extension services on fish farming to farmers while 83(51.6%) strongly agree that the government has policies in place to be followed by fish farmers. The study also has shown that majority of respondents 103(64%) agree that the government offers enough manuals to guide fish farmers on all farming procedures and 88(54.7%) of respondents agree that there are government initiatives aimed at promoting fish production in the area. However, on average, most 67(41.7%) of respondents indicated that they agree with all aspects.

Table 4.34: Fish markets

Fish markets	Frequency	Percentage
Local market/local people	139	86.3
Other markets	7	4.3
Household	15	9.4
Total	161	100.0

The study indicated that majority139(86.3%) of the respondents sold their fish locally, while the rest 22(13.7%) of respondents sell their fish to open air markets and others consume their fish within the household.

Table 4.35: What influence prices for various fish species

Influence on pricing	Frequency	Percentage
Market demand	22	13.7
Size of fish	105	65.2
Fish type	16	9.9
Fish quality	18	11.2
Total	161	100.0

According to the study majority105(65.2%) of respondents indicated that the price of the various fish species is influenced by the size of the fish while 16 (9.9%)of respondents indicated that the type of fish determined the price.

Table 4.36: Type of fish species kept and sold

Fish species	Frequency	Percentage
None	7	4.3
Tilapia only	107	66.5
Cat fish only	25	15.5
Trout	3	1.9
Tilapia and Catfish	19	11.8
Total	161	100.0

The study indicated that Tilapia species is stocked and sold by majority107 (66.5%) of respondents while only 3(1.9%) of respondents stocked Trout species.

Table 4.37: Price of various fish species kept and sold

	Tilapia type		Catfish type		Trout type	
Cost of fish	**Frequency**	**percentage**	**Frequency**	**percentage**	**Frequency**	**Percentage**
N/A	17	10.6	56	34.8	161	100
100-150	18	11.2	2	1.2	0	0
151-300	83	51.6	16	9.9	0	0
301-500	39	24.2	51	31.7	0	0
Over 500	4	2.5	36	22.4	0	0
Total	161	100	212	100	161	100

The study showed that majority 83(51.6%) of respondents sold their tilapia fish at Kenya shillings 151-300 each, 51(31.7%) of respondents sold their Cat fish at Kenya shillings 301-500 while none of the respondents sold trout type of fish.

Table 4.38: Sources of fingerlings

Sources	Frequency	Percentage
Government hatchery	60	37.3
Private hatchery	95	59.0
Neighbour	6	3.7
Total	161	100

The study showed that majority 95(59.0%) of respondents bought the fingerlings from private hatchery while only 6 (3.7%) respondents bought their fingerlings from neighbours.

Table 4.39: Reasons for choice of fish species kept

Reasons	Frequency	Percentage
Very marketable	60	37.3
Fast growth	95	59.0
Better taste	6	3.7
Other reasons	3	1.9
Total	161	100

The study indicated that majority 95(59.0%) of respondents stocked fish species which had a fast growth while 60 (37.3%) of respondents stocked fish species with high market demand. However, 6 (3.7%) of respondents stocked fish which had better taste.

Table 4.40: Various aspects influencing fish farming

Factors	Not at all		Low extent		Moderate extent		Great extent		Very great extent	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Build capacity support for communities and farmers organizations (CIG)	3	1.9	1	0.6	32	19.9	17	10.6	108	67.1
Organise promotions through trade fairs/stakeholder forums	27	16.8	2	1.2	5	3.1	26	16.1	101	62.7
Develop market information systems and marketing infrastructure	4	2.5	28	17.4	11	6.8	19	11.8	99	61.5
Promoting investment in aquaculture through PPP	3	1.9	28	17.4	9	5.6	26	16.1	95	59.0
Promoting and facilitate value addition for aquaculture products	2	1.2	3	1.9	30	18.6	22	13.7	104	64.6
Develop aquaculture extension guidelines and SOPS	3	1.9	3	1.9	36	22.4	22	13.7	97	60.2
Promoting and facilitating recruitment of new aquaculture species	3	1.9	1	0.6	32	19.9	17	10.6	108	67.1
Selling fish through marketing associations	4	2.5	28	17.4	6	3.7	13	8.1	110	68.3
Mean	6	3.8	11	7.3	20	12.5	20	12.6	102	63.8

The study indicated that building of capacity support for communities and farmers organizations in marketing**,** organizing promotions through trade fairs/stakeholder forums, Develop market information systems and marketing infrastructure, promoting investment in aquaculture through PPP, promoting and facilitate value addition for aquaculture products, develop aquaculture extension guidelines and standard operating systems (SOPS), promoting and facilitating recruitment of new aquaculture species and selling fish through marketing associations impact fresh water fish production of respondents to a very great 102 (63.8%) extent.

Table 4.41: How forces of demand and supply influence fish farming

Forces of demand and supply	**Frequency**	**Percentage**
None	2	1.2
Forces farmers to produce more or to produce less	150	93.2
Enable farmers to plan for where to market their fish	9	5.6
Total	161	100

The study showed that majority 150(93.2%) of respondents were forced to produce more or less by the prevailing forces of supply and demand. That is to produce more when the market demand is high and produce less when the market demand is low.

4.8 Summary of the Chapter

The data collected was analysed using Statistical Package for Social Sciences and tables were used to present data in APA table format. The response rate was 99 %(161 questionnaires), as 164 questionnaires were used and majority of 161 respondents interviewed had secondary level of education as their highest level. The data interpretation focused on ecological factors influencing fresh water fish farming, social economic factors influencing fresh water fish farming, how training and extension services influence fresh water fish farming and the influence of marketing on fresh water fish farming. The study shows that ecological factors,

social economic factors, training and extension services and marketing influence fresh water fish farming in Embu North District.

CHAPTER FIVE

SUMMARY OF FINDINGS, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter focuses on the summary of findings of the study which formed the foundation for discussions. The discussions provided a firm basis upon which conclusions and recommendations were advanced to address factors influencing fresh water fish farming in Embu North District. It also includes suggested areas for further research and contributions made to the body of knowledge.

5.2 Summary of Findings

A summary of findings is given following the four objectives of the study.

5.2.1 Assessment of ecological factors influencing fresh water fish farming

The summary of the first objective sought to assess ecological factors influencing fresh water fish farming in Embu North District. The study showed that 50.3% of respondents stocked Tilapia only, 22.4% of respondents stocked African Catfish only, and 26.1% of respondents stocked Tilapia and African Catfish and only 1.2% of respondents stocked Trout fish. Trout fish is less popular since it does well in cold areas. The fish species stocked depended on marketability, whether fish is fast growing, taste of fish and other reasons like availability of fingerlings. The study showed that most(44.7%) of respondents stocked fish species basing on its marketability, 34.8% of respondents stocked fish because of fast growth while 18.6% of respondents stocked fish because of better taste. The study indicated that majority (59.0%) of respondents obtained their fingerlings from private hatchery while only 3.7% of respondents obtained their fingerlings from neighbours.

The study also indicated that majority (64.0%) of respondents had liner type of fish pond while only 1.2% of respondents had concrete type of fish ponds. The study showed that 47.8% of respondents indicated that water temperature was a great factor when considering construction of a fish pond. The study also showed that 39.7% of respondents had only 2 fish ponds while only

4 respondents had over 4 fish ponds. The research further showed that availability of capital was the main determinant of the number of fish ponds each respondent had according to 49.7% of respondents. A total of 46.0% of respondents had fish ponds which were operational for 1-5 years. The study further showed that 40.4% of respondents obtained water for their ponds from streams, 26.1% of respondents from wells and 18.6% of respondents from springs. The study also indicated that majority(50.3%) of the respondents supplied water into the pond by use of gravity while 12.4% of respondents fill their ponds using other means like hose pipes.Majority (62.7%) of respondents maintained their ponds on weekly basis while1.2% of respondents did not maintain the water level regularly. It was showed that majority(54.7%) of respondents monitored water temperature in the fish ponds on weekly basis . The study showed that 40.4 % of respondents indicated that the quality of soils was a great factor while 47.8% of respondents indicated that water and temperature were great factors too.

The study showed that majority(55.9%) of respondents had not experienced any fish problem or disease. However, 34.8% of respondents experienced fish stress due to lack of oxygen and 9.3% of respondents experienced fungal diseases in their ponds. The study further showed that 55.9% of respondents had not experienced any pollution in their fish ponds and 34.8% of respondents experienced stress due to lack of oxygen in their ponds while only 9.3% of respondents experienced fungal diseases in their ponds. It was also showed that majority (68%) of respondents had problem of pollution from farm chemicals. However, left over feeds and excess feeds caused pollution to 51.5% of respondents. The study has indicated that majority(64.6%) of respondents reported birds were the main fish predator while Other predators were snakes, otter, human beings and frogs.

5.2.2 Assessment of social economic factors influencing fresh water fish farming

The summary of the findings based on objective two which was to assess social economic factors influence fresh water fish farming in Embu North District. The study findings indicated that from the respondents interviewed, 50.9% of respondents were males and 82.6% of respondents were in the age bracket of 31-60 years. This indicates that majority of the respondents are in their middle age and therefore suitable in undertaking fish farming activities which require energy and

effective decision making. The study showed that 77% of respondents were married therefore marriage ascribes familial responsibilities to farmers and therefore farmers become more serious in terms of their participation in fish farming activities. The findings also showed that most (47.8%) of respondents had attained secondary level of education and thus the literacy level in the study area was high. This indicates that majority of the respondents are literate and therefore could undertake fish farming activities well. The study indicated that most (43.5%) of the families had 3-5 members. Some of family members offered labour in fish farming activities and hence reduced the amount spent on labour cost.

The study has indicated that majority(65.2%) of the respondents own land, the findings also showed that majority (48.4%)of the respondents used their own money to start fish farming while 16.8% of respondents got money from government ESP programme. The Other sources of money were from cooperative societies and bank loans.The study showed that 26.7% of respondents practice fish farming as their main source of income and 49.7% of respondents practiced coffee farming as other source of income. A total of 12.4% of respondents practiced horticulture and 10.6% respondents practiced dairy farming. The study indicated that 47.2% of respondents run fish farming themselves and 41.0% of respondents are assisted by their families.

The study showed that on average, 69.9% of respondents indicated that fresh water fish farming can make an important contribution to poverty alleviation and food security, social well being hence promoting social equity, fish provides food of high nutritional value to households, Combination of agriculture and aquaculture improve food supply increase their income and become self sustained farmers, boosts rural economic development ,Living near water bodies encourage fresh water fish farming, is a major source of foreign exchange to government and offers employment opportunities to many farmers.

5.2.3 Determination of how training and extension services influence fresh water fish farming

The summary of the findings based on objective three was to determine how training and extension services influence fresh water fish farming in Embu North District.

The study indicated that majority (95.7%) of respondents had attended training organised by the Ministry of fisheries while 4.3% respondents had not attended any training. The study also indicated that majority (53.4%) of the respondents received their training through demonstrations, 35.4% respondents received training through workshop and seminars while only 4.3% of respondents had not received any training. According to the study majority (54.7%) of the respondents received 2-3 trainings, and only 4 respondents received over 5 trainings. The study indicated that the trainings educated most of respondents 46.6%, motivated 42.2% respondents while the trainings had no influence to10.6% respondents.

5.2.4 Influence of marketing on fresh water fish farming

The summary of the findings based on objective four which was to establish the influence of marketing on fresh water fish farming in Embu North District. The study indicated that most of the respondents 39.1% strongly agreed that there was good road network linking fish farms and market. The study has also showed that 42.2% of respondents strongly agreed that the Ministry of Fisheries offer enough extension services on fish farming to farmers. This is supported by Falusi (1991) who stated that agricultural development is a rural development approach through which the right technology, effective extension services, access to inputs, adequate market and complementary infrastructural facilities essential to improve productivity and boost the standard of living of rural dwellers are provided. The clamors for higher productivity in fish farming can be achieved not only by coming up with improved technology but to properly organize adequate extension services while 51.6% of respondents strongly agreed that the government has policies in place to be followed by fish farmers. The study also has shown that majority(64%) of respondents agreed that the government offers enough manuals to guide fish farmers on all farming procedures and 54.7% of respondents agreed that there was government initiatives aimed at promoting fish production in the area. However, on average, most (41.6%) of respondents indicated that they agreed with all aspects.

The study indicated that majority(86.3%) of the respondents sold their fish locally, 4.3% respondents sell to open air markets and in towns while 9.4% of respondents consume their fish within the household.

According to the study, majority(65.2%) of the respondents indicated that the price of the various fish species was influenced by the size of the fish, 13.7% of respondents said that price depended on market demand, 11.2% respondents indicated that quality of fish determined the price. The study indicated that Tilapia species is stocked and sold by majority (66.5%) of respondents followed by catfish. The study showed that majority (51.6%) of respondents sold their tilapia fish at Kenya shillings 151-300 each while most(31.7%) of respondents sold their Cat fish at Kenya shillings 301-500 while none of the respondents sold trout type of fish.

The study showed that majority (59.0%) of respondents bought the fingerlings from private hatchery while only 3.7% respondents bought their fingerlings from neighbours.The study indicated that majority (59.0%) of respondents stocked fish species which had a fast growth while 37.3% respondents stocked fish species with high market demand. However, 3.7% respondents stocked fish which had better taste.

The study also indicated that building of capacity support for communities and farmers organizations in marketing, organising promotions through trade fairs/stakeholder forums, Develop market information systems and marketing infrastructure, promoting investment in aquaculture through Public Private Partnership, promoting and facilitate value addition for aquaculture products, develop aquaculture extension guidelines and standard operating systems,promoting and facilitating recruitment of new aquaculture species and selling fish through marketing associations influence fresh water fish production of 63.4% respondents to a very great extent.

The study showed that majority(93.2%) of respondents were forced to produce more or less by the prevailing forces of supply and demand. That is to produce more when the market demand is high and produce less when the market demand is low.

5.3 Discussion of Findings

A discussion of findings of the study is presented following on the four objectives of the study.

5.3.1 Influence of ecological factors on fresh water fish farming

The study showed that 50.3% of respondents stocked Tilapia only. This agrees with Mbugua (2008) who reported that Tilapia is the main species of fish that is farmed in Kenya. Trout fish is less popular since it does well in cold areas. The fish species stocked depended on marketability, whether fish is fast growing, taste of fish and other reasons like availability of fingerlings. The study showed that 44.7% stocked fish species based on its marketability, 34.8% of respondents stocked fish because of fast growth while 18.6% respondents stocked fish because of better taste. The study indicated that majority(59.0%) of the respondents obtained their fingerlings from private hatchery while only 3.7% respondents obtained their fingerlings from neighbours.

The study also indicated that majority (64.0%) of respondents had liner type of fish pond while only 1.2% respondents had concrete type of fish ponds. The study showed that 47.8% of respondents indicated that water and water temperature were great factors when considering construction of a fish pond. This agrees with Carballo (2008), who reported that sites for fish farming should be only where water of the required volume and quality is available at the times needed for operating the farm. Preference should be given to sites where gravity water supply to the farm is possible. Swann (2012) further said that water can hold large amounts of heat with a relatively small change in temperature. This heat capacity has far reaching implications. Furthermore, aquatic organisms take on the temperature of their environment and cannot tolerate rapid changes in temperature.

The study also showed that most (39.7%) of respondents had only 2 fish ponds while only 4 respondents had over 4 fish ponds. The research further showed that availability of capital was the main determinant of the number of fish ponds each respond had according to 49.7% of respondents. This also agrees with Carballo (2008), which said that pond size is determined by the type of species cultured, the intensity of the system, size and maturity of the species being farmed, access to capital, land availability, water availability, the harvesting method, and even the marketing and sales goals of the project. The study further showed 40.4% of the respondents obtained water for their ponds from streams, 26.1% from wells, and 18.6% from springs while 14.9% obtained water from other sources. The study also showed that 50.3% of respondents get

water into their pond through force of gravity while 12.4% fill their ponds through use of other means like use of hose pipe. This collaborates with the study by Carballo (2008), who said that preference should be given to fish sites where a gravity water supply to the farm is possible.

According to the study, majority (62.7%) of respondents maintained the water level in the fish ponds weekly while 1.2% did not maintain the water level regularly. It has also been shown that majority (54.7%) of respondents monitored water temperature in the fish ponds weekly while 4.3% did not monitor the water temperature regularly. The study also indicated that water temperature is a great factor to consider when constructing a fish pond. This agrees with Carballo (2008) who reported that aquatic organisms take on the temperature of their environment and cannot tolerate rapid changes in temperature.

The study showed that 34.8% of respondents experienced stress due to lack of oxygen in their fish ponds which are caused by chemicals from farms. This agrees with Helfrich (2009) who said that herbicide pollution can cause oxygen depletion by killing phytoplankton, rooted aquatic plants, or both. This Pollution can contaminate living fish and make them unsafe to eat. However, the study also indicated that left over feeds and excess feeds caused pollution to 51.5% Of the respondents This collaborates study by Johnson (2013), who said that Overfeeding make fish sick and the excessive amounts of waste strains the limits of what can be biologically reduced, resulting in a decline of water quality and sometimes death of fish.
The study has indicated that majority(64.6%) of respondents experienced birds as their main fish predator. The organic farmer (2013) reported that predators especially birds and mammals play an important role in life cycles of certain parasites. Pollution due to high levels of ammonia and parasites causes fish deaths in large numbers. Damage of fish by predators lead to secondary bacterial or fungi infections.

The study findings indicated that 50.9% of the respondents were males. The research also found that 82.6% were in age bracket of 31-60 years. This indicated that majority of the respondents were in their middle age and therefore suitable in undertaking fish farming activities which require energy and effective decision making. This agrees with study by Oriaro (2011) who

reported that inland fish farming is dominated by male farmers. and those in the age brackets between 31-40 years. The findings show that 77% were married. Marriage ascribes familial responsibilities to farmers and therefore farmers become more serious in terms of their participation in fish farming activities. This collaborates with the study by Oriaro (2011) who indicated that Married farmers adapt well to fish farming than other categories. The findings also show that 47.8% of the respondents had attained secondary level of education.This indicates that majority of the respondents are literate and therefore could carry out fish farming activities well. The study indicated that 43.5% of respondents had 3-5 family members. Some of family members offered labour in fish farming activities and hence reduced the amount spent on labour cost.

5.3.2 Influence of social economic factors on fresh water fish farming

The study has indicated that 65.2% of the respondents own land. This agrees with Asian Development Bank Evaluation (2005) who reported that 69% of small scale farmers caught fish from their own ponds. The findings also showed that 48.4% of the respondents used their own money to start fish farming while 16.8% used money from government support (ESP). This agrees with Adu (2005), who reported that banks are willing to lend money for the construction of fish ponds but the conditions for the loans are strict and make them suitable mostly for those who are already well established economically. This forces famers to use their own money. The study showed that 26.7% of the respondents practice fish farming as their main source of income The study has also shown that 49.7% practice coffee farming as their other source of income apart from fish farming, 12.4% practice horticulture and 10.6% practice dairy farming. The study has also indicated that 47.2 % of the respondents run fish farming themselves, 41.0% are assisted by their families while 11.8% employ fish attendants.

The study showed that on average, 69.9% of respondents indicated that fresh water fish farming can make an important contribution to poverty alleviation and food security, social well being hence promoting social equity, fish provides food of high nutritional value to households, Combination of agriculture and aquaculture improve food supply increase their income and become self sustained farmers, boosts rural economic development ,Living near water bodies

encourage fresh water fish farming, is a major source of foreign exchange to government and offers employment opportunities to many farmers. This agrees with report by Halwart et al.(2007), who reported that a number of subsistence-level fish farmers have turned into small-scale commercial fish farmers to produce for both the local and export markets hence making a significant contribution to both food security and foreign exchange earnings in Kenya. This further agrees with Department for International Development (2000) which reported that small-scale inland fisheries or aquaculture when well supported and managed plays a critical role in generating wealth and sustaining economic growth.

5.3.3 Influence of Training and extension services on fresh water fish farming

The study indicated that majority (95.7%) of respondents had attended training organised by the Ministry of fisheries while 4.3% had not attended any training. This collaborates with the study done by Falusi (1991) who said that agricultural development is a rural development approach through which the right technology, effective extension services, access to inputs, adequate market and complementary infrastructural facilities essential to improve productivity and boost the standard of living of rural dwellers are provided. The trained farmers improved the productivity of their fish ponds. This is also supported by Agbamu (2000) who reported that the clamors for higher productivity in fish farming can be achieved not only by coming up with improved technology but to properly organise adequate extension services. This is when the impact of improved technology can have desired effects on fish farmers.

The study also indicated that majority (53.4%) of respondents received training through demonstrations. The study indicated that the trainings educated 46.6% of respondents and motivated 42.2% of the respondents. This is supported by Kumar (1999) who reported that demonstrations offer farmers opportunity to observe the difference between the improved and the traditional culture practices. Demonstrations create greater impact when farmers are able to see that someone from their own community had been successful in following the recommended package of practices and benefited. These result demonstrations also create a sustainable teaching method based on seeing believes and also develop the confidence of the extension agents.

5.3.4 Influence of marketing on fresh water fish farming

The study indicated that most (39.1%) of respondents strongly agreed that there are good road network linking fish farms and market. This is supported by Standger (2011) who reported that a good road network will ensure that supplies are brought to the farm and products taken to the market smoothly. The study also indicated that 39.1% of respondents strongly agreed that there are organized and developed markets for the fish products, 42.2%of respondents strongly agreed that the Ministry of Fisheries offer enough extension services on fish farming to farmers while 51.6% of respondents strongly agreed that the government has policies in place to be followed by fish farmers. The study also has shown that majority (64%)of respondents agreed that the government offers enough manuals to guide fish farmers on all farming procedures while 54.7% of respondents agreed that there are government initiatives aimed at promoting fish production in the area. However, on average, 41.6% of respondents indicated that they agreed with all aspects. This is supported by Falusi (1991) who stated that agricultural development is a rural development approach through which the right technology, effective extension services, access to inputs, adequate market and complementary infrastructural facilities essential to improve productivity and boost the standard of living of rural dwellers are provided. Agbamu (2000) also reported that the clamors for higher productivity in fish farming can be achieved not only by coming up with improved technology but to properly organize adequate extension services

The study indicated that 86.3% of respondents sold their fish locally. This agrees with Department for International Development (2005) who reported that almost all fishes (95%) produced are consumed locally and within neighbouring towns as also stated by Adu (2005).

According to the study, majority (65.2 %) of respondents indicated that the price of the various fish species is influenced by the size of the fish. This is supported by Ministry of Livestock and Fisheries Development (2007) who revealed that most farmers sell their fish raw at local and nearest urban markets, with the prices varying with the weights of the fish.

The study indicated that Tilapia species is stocked and sold by majority (66.5%) of respondents while only 1.9% of respondents stocked and sold Trout species. The study has shown that 51.6%

of respondents kept and sold their tilapia fish. This collaborates with the study by Mbugua (2008) who reported that tilapia is the main species of fish that is farmed in Kenya.

The study showed that majority (59.0%) of respondents bought the fingerlings from private hatchery. This is supported by Maurice (2010) who reported that private hatcheries and nursing farms are very popular to small-scale farmers and produce about 80% of fingerling supply.

The study indicated that 59.0%) of respondents stocked fish species because of their fast growth. This is supported by study by Musa *et al. (*2012) who stated that there is a need to address the issue of faster growth rate performance in fish in order to meet the high demand of fish and to favour high shorter growth span.

The study also indicated that building of capacity support for communities and farmers organizations in marketing, organising promotions through trade fairs/stakeholder forums, Develop market information systems and marketing infrastructure, promoting investment in aquaculture through Public Private Partnership, promoting and facilitate value addition for aquaculture products, develop aquaculture extension guidelines and standard operating systems promoting and facilitating recruitment of new aquaculture species and selling fish through marketing associations impact fresh water fish production of 63.4% of respondents to a very great extent. This is supported by Gillibran (2002) who stated that focus should be placed on the safety of foods being sold on the markets to ensure some standards in ensuring food safety and the quality of fish products, whilst reducing the risks to human health and ecosystems from chemical.

The study showed that 93.2% of respondents were forced to produce more or less by the prevailing forces of supply and demand. That is, to produce more when the market demand is high and produces less when the market demand is low. This is supported by Elamin (2006),who stated that aquaculture could cover the gap between supply and demand but there are also many forces which could pull production in the opposite direction making it difficult for the industry to grow substantially enough to meet demand in the decades to come.

5.4 Conclusions of the study

The followings conclusions were made from the study:

It is observed that fresh water fish farming improved the livelihood of the people living in Embu North District and the study concludes that fresh water fish farming is a source of income, employment and a profitable family venture which has flourished in the area due to influence of ecological and social economic factors, training and extension services offered to farmers and availability of local market. Demand for fish was considered high and that is why majority of people between the age brackets of 31 to 60 years were engaged in fresh water fish farming along with other farming activities.

Secondly, high market prices for tilapia influenced the type of fish species reared in the area. The study also shows that fish markets have not been well developed and a majority of the farmers sell raw fish harvested locally. The study concludes that alternative sources of income existed and fish farming was therefore not the major source of income to many. This is attributed to various constrains that hinder the development of fresh water fish farming which include limited access to finance, Technical support, government policies, NEMA regulations and traditional believes and change of weather.

Thirdly, majority of fish farmers had a problem of contamination in their fish ponds due to decomposed fish feeds lasting in the fish ponds. This could be as a result of fish farmer's failure to maintain the fish ponds on a daily basis as the study result showed that majority of fish farmers maintained their fish ponds on weekly basis.

Fourthly, the study shows that extension services offered to farmers has got a great influence on fresh water fish farming in the area. Majority of farmers seems to have attended the trainings offered by different service providers and the method of training seems to make farmers have interest in fish farming as they are able to see for themselves through demonstrations in the best fish farms within the area. Trainings also seem to have influenced fish farmers to produce high quality fish which are able to fetch high prices.

5.5 Recommendations

The following recommendations were made from the findings of this study

1. The Government and other private partners should take the initiative of providing high quality fish species, fish farming best practices which are standardized and regular trainings to fish farmers through farm trials and demonstrations in order to keep farmers updated.

2. The Government should subsidize fish farming inputs in order to encourage and entice fish farmers to start and continue with fish farming without challenges of acquiring finances to expand and maintain their farms.

3. The Government should also organize fish industries and markets in order to encourage fresh water fish farming from small scale to large scale fish farmers due to assured fish market, fish processing and affordability of finances from financial institutions and by doing so the farmers will feel secure hence more fish farmers will join fish farming in the area.

4. Fresh water fish farmers should be encouraged to form fish farming associations for the purposes to coming together to share ideas, experiences and suggestions. Through the same associations the Government and other partners facilitate their support which eventually bring development in the area for example fish feed palater in the area was situated in Runyenjes Constituency which is far to be accessed by all farmers therefore an additional of more would be highly accepted.
5. Environmental institutions like N.E.M.A should come up with more policies which will help in regulating pollution by farm chemicals which is a major kind of pond pollution in this study.
6. The Government with private Partners should come up with many institutions for Research and development on fisheries for the purposes of coming up with variety of fish species, possible diseases and all the required inputs and culture systems in order to enhance sustainable fresh water fish farming.

5.6 Suggested areas for further Research

The following are the suggested areas for further study:

1. A Study to find out why fresh water fish farming production does not satisfy the demand for fish although there is a great potential of fresh water fish farming in Kenya should be done.
2. Another study to find out why the youth are not engaged in fresh water fish farming should be carried out in Embu North District.
3. Also a study on assessment of other factors influencing fresh water fish farming in Kenya such as technology, determinants of successful fresh water fish farming and challenges facing fresh water fish farming in Kenya should be carried out.

5.7 Contribution to the body of knowledge

Objective	**Contribution to knowledge**
To assess ecological factors influencing fresh water fish farming in Embu North District.	Tilapia is the most popular fish species kept as shown by most (44.7%) of respondents and majority of fingerlings are obtained from the private hatcheries in the area of the study. Therefore ecological factors influence fresh water fish farming.
To assess social economic factors influencing fresh water fish farming in Embu North District.	Besides fish farming, majority (72.7%) of respondents practiced coffee, dairy, tea and horticulture farming as other sources of income. Fish farming improve income, boosts rural economic development, earn foreign exchange, enhance food security, generate wealth and lead to sustainable economic growth. Therefore social economic factors influence fresh water fish farming.

To determine how training and extension services influence fresh water fish farming in Embu North District.	Majority of fish farmers attended trainings organized by Ministry of Fisheries and Development. Demonstration was the most effective method of extension as shown by majority (53.4%) of respondents. Therefore training and extension services influence fresh water fish farming.
To establish the influence of marketing on fresh water fish farming in Embu North District.	Good road network.organised and developed markets are important in fish farming. Most fish products are sold locally as shown by (86.3%) of respondents. The forces of demand and supply influence fish farming in Embu North District. Therefore marketing of fish products influence fish farming

REFERENCES

Abalu, G.O.I. (1998). *Building and Institutionalizing an Effective Agricultural technology transfer process in Nigeria*: Research and Extension for more food and income to farmers. Proceeding of the Second Annual Farming System Research and Extension Workshop in South-Eastern Nigeria, Umudike Nigeria. January 10-14.pp51-60.

ADB (2005).An evaluation of small scale fresh water rural aquaculture. Cabi publishers, Wallingford, United Kingdom.

Adu, A.O. (2007).*Utilization of Forestry - Related Technologies Among catchments Areas of forestry Research Institute* (south west Nigeria) Ph.D Thesis Department of Agricutural extension and Rural Development, University of Ibadan, Nigeria.

Adu, A.O. (2005).*Socio-Economic Impact of Forestry-Related Technologies Utilization among Farmers in South West Nigeria.* Unpublished Seminar Paper in the Department of Agricultural Extension and Rural Development. University of Ibadan.

Agbamu, J. U. (2000). *Agricultural Research Extension Linkage Systems*. An International Perspective. Agriculture Research and Extension Network.

Ahmed, M.A. and Lorica, (2002). Improving developing country food security through aquaculture development - lessons from Africa. Food Policy 27, 125-141.

Alam, S. (2001) *Production, accessibility and consumption patterns of aquaculture products in Bangladesh*. FAO, 2001: Production, accessibility and consumption patterns of aquaculture products in Asia: A cross country comparison. FAO, Rome.

AMA (2004) *The AMA's official definition of marketing—its conception, evolution, and latest incarnation*. Marketing News, September, 15, 2004. American Marketing Association.

Ashley, C and Carney (1999). *Sustainable livelihoods*: Lessons from early experience. London

Baulcomb J.S. (2003). *Journal of Nursing Management*. 11(4):275-80. Management of change through force field analysis.

Bogdan, R. C and Biklen, S. K. (2003*). Qualitative Research for Education: An introduction to Theories and Methods (4th ed.):* Pearson Education group. (pp. 110-120). New York

Boone and Kurtz (1998). Marketing. Contemporary Marketing Wired, Dryden Press.

Boone, (1986). *Foundations and Changing Practices in Extension. In D. J Blackburn (ed.), Philosophical Foundations of Extension. (pp 1-9)*: Guelph Publishers. Ontario.

Bryman, A and Bell, E (2003*), Business Research Methods Oxford University Press.*

Budak, D. B., Budak, F. and Kaçira, Ö. Ö. (2010). *"Livestock Producers' Needs and Willingness to Pay for Extension Services in Adana Province of Turkey". African Journal of Agricultural Research, 5(11):1187-1190.*

Bureau, (2006). *Sustainability of Ontario's Aquaculture Industry: 2006 and Beyond.*

Carballo, E (2008).Small scale fresh water fish farming. Agromisa Foundation, Netherlands.

Chaudhuri,H(2008*).Aquaculture Beyond 2000.*Daya Publishing house, University of California,U.S.A.

Cooper, D.R and Schindler, P.S. (2003), Business Research Methods (8th edn) *McGraw-Hill*: New York.

Creswell, John W (2003), *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.* Sage Publications, Inc. Thousand Oaks

Dey, M. and Prein, M. (2006) NAGA: *WorldFish Center* Quarterly 29,

Dey, M., M. Ahmaed, K. M. Jahan and M.A. Rab (2003) *Liberalization vs Barriers*: Experiences from selected fish exporting countries. WorldFish Center, Batu aung Bayan Lepas, Penang, Malaysia.

Dey, M.M. (2000) *Analysis of demand of fish in Bangladesh*. Aquaculture Economics and Management 4 (1/2), 63-82.

Dey, M.M., Rab, M.A., Paraguas, F.J., Piumsombun , S., Bhatta , R., Alam, M.F. and Ahmed, M. (2005b) *Fish consumption and food security:* a disaggregated analysis by types of fish and classes of consumers in selected Asian countries . Aquaculture Economics and Management 9, 89-111.

DFID (1997). DFID *Fisheries Bangladesh Issue 2-1997*. Dhaka 1212: Department for International Development (DFID) of Bangladesh.

DFID (2000). *Introduction to sustainable livelihoods (SL) and its relationship of project work. www.livelihoos.org.* Accessed 03.04.06

DFID (2002a) *Better livelihoods for poor people: The role of agriculture*. Consultation Document. Department for International Development. London.

DFID (2005) *Making market systems work better for the poor* (M4P): An introduction to the concept. Discussion paper prepared for the DFID-ADB 'learning event', ADB Headquarters, Manila.

DFID (2006) *Making fisheries market work for poor in Cambodia*. Department of Fisheries, Cambodia and Department For International Development (DFID).

DFID/FAO (2000). *Inter-agency Experience and Lessons*: from the forum on operationalising SLAs. FID/FAO.

Dooley, D. (2007), *Social Research Methods*: Prentice Hall. New Delhi.

Edwards, P. and Demaine, H. (1998). *Rural aquaculture*: overview and framework for country reviews. FAO, Rome.

Edwards, P., Litle, D. C. and Yakupitiyage, A. (1997). *A comparison of traditional and modified inland artisanal aquaculture system.* Aquaculture Research. 28: 777-787.

Falusi, A. O. (1991). *Promoting Small-holder Agricultural Development in Nigeria*. The ADP Experience. Agriscope: A Newsletter of the Federal Department of Agriculture, 9(2), 47-89.

Food and Agriculture Organization of the United Nations (FAO) (1997). *Review of the state of world aquaculture*. FAO, [November 20, 2005] Rome.

Food and Agriculture Organization of the United Nations(FAO),(2001a) *Production, accessibility, marketing and consumption patterns of freshwater aquaculture products in Asia: a cross-country comparison.* (FAO)Fisheries Circular. No. 973. Rome, FAO. 2001. 275p.

Food and Agriculture Organization of the United Nations (FAO), 2000, 2009. *National Aquaculture Sector Overview*. In: Fisheries and Aquaculture. Fisheries and Aquaculture Department. Ghana.

Food and Agriculture Organization of the United Nations (FAO). (2007). *Aquaculture production, 2006.* Year book of Fishery Statistics-Vol.96/2. Food and Agriculture organization of the United Nations, Rome, Italy.

Food and Agriculture Organization of the United Nations (FAO) 2008. *Ihe State of World Fisheries and Aquaculture,* (FAO, Rome, 1997), Table 1, p. 5.

Food and Agriculture Organization (FAO) 2010.Securing Sustainable Small Scale Fisheries.RAP publication, Bangkok, Thailand.

Foeken. Dick W.J and Owuor, S. O. (2008). *Farming as a livelihood source for the urban poor of Nakuru, Kenya*. Geoforum, 13.

Government of Kenya (GOK) (2009), *Economic Stimulus Programme*, overcoming today's challenges for a better tomorrow Government printer. Kenya, Nairobi.

Halwart, M; Soto, D and Arthur, J (2007). Cage Aquaculture.FAO Fisheries and Aquaculture Department, Rome, Italy.

Helfrich,L.A (2009).*Pond Management. Fish kills*. Department of Game and Inland Fisheries,Viginia.

Helmore K and Singh N, (2001) *Sustainable Livelihoods, Building on the Wealth of the Poor*. Kumarian Press, Inc. USA.

Johnson,E (2013).*Feeding Koi and pond fish*. Charles Thomas publishers, Wareham, USA.

Johnston, R. J et al (2000). *The Dictionary of Human Geography*. 4th Edition, Blackwell Publishers Inc, Oxford London, UK.

Lee, R (2000) *The Dictionary of Human Geography*, 4th Edition, 128-518

MacPherson, N.J., and C.E. Agyenim-Boateng. (2001). *The development of aquaculture and culture-based fisheries in Ghana: the social and cultural contexts*.

Martinussen, J. (1999). *Society, State and Market*: A guide to competing theories of development. University Press Ltd, DHAKA.

Mbugua H.M. (2008) A Comparative Economic Evaluation Of Farming of Three Important Aquaculture Species In Kenya. Blackwell Publishing, United Kingdom.

Moccia, R.D. and D.J. Bevan (2000). *Aquastats, Ontario Aquacultural Trout Production in 1988 with a Historical Perspective of the Industry's Development*

Moccia, R.D. and J. Hynes. 1998. *Sustainability of Ontario's Aquaculture Industry: 1998 and Beyond.* Canadian Aquaculture Directory, Contact Canada. Fred Haynes Publ. p.29-31., Georgetown, Ontario, Canada.

MOLFD (2007). Ministry of Livestock and Fisheries Development, Annual Reports, Livestock Production Division, Nairobi, Kenya.

Mugenda, O.M. and Mugenda, A.G. (1999). *Research Methods*: Quantitative and Qualitative Approaches. Acts Press, Nairobi.

Mugenda,O. M. and Mugenda, A. G. (2003). *Research Methods*: Quantitative and Qualitative Approaches. Acts Press, Nairobi.

Muzaffar and Helaluddin, (2001). *Making fisheries market work for poor in Cambodia*. Department of Fisheries, Cambodia and Department for International Development (DFID).

Nasser,N; Zaman, A;Karim,L and Khan,N (2012).An efficient routing protocol for RGB sensor based fish pond monitoring system. IEEE Computer Society, Bacelona, Spain.

Ngechu. M. (2004) *Understanding the research process and methods*. An introduction to research methods. Acts Press, Nairobi.

Nsubuga,Y.K.(2003).Research Methods (4th edition)*Mc Graw-Hill:New* York.

Oladebo, J. O. (2004). "*Resource-use Efficiency of Small and Large Scale Farmers in South-Western Nigeria:* Implications for Food Security". International Journal of Food and Agricultural Research, 1(12):227-235.

Oladele (1997). *Analysis of the institutional Research-Extension-farmers linkage system in southwestern Nigeria.* Ph.D Thesis in the Department of Agricultural Extension and Rural Development, University of Ibadan, Ibadan.

Oladele, O. I. and Fawole, O. P. (2007). *Farmers' perception of the relevance of Agriculture Technologies in South-Western Nigeria*. Journal of Human Ecology, 21(3), 191 - 194.

Oladosu I. O. (2006). *Implications of Farmers Attitude Towards Extension Agents on Future Extension Programme Planning in Oyo State of Nigeria*. Journal of Social Science, 12 (2), 115 - 118.

Oladosu, I. O. and Okunade, E. O. (2006). *Perception of Village Extension Agents in Disseminating Agricultural Information in Oyo Agricultural Zone of Oyo State. Journal of Social Science,* 12(3): 187 - 191.

Oriaro, P (2011).Factors influencing implementation of inland fish farming enterprises. University of Nairobi, Kenya.

Orodho, J.A. (2004). *Element of Education and Social Science Research Methods*.: Masola Publishers. Nairobi.

Pearce (1993) Blue Print; *Measuring Sustainable Development*. P; 224. Earth Scan Publications Ltd, London

Pillay (1994). *Insurance and risk management for the aquaculture industry*. In: Pillay, T.V.R. and Dill, A.W.M (Editors), (1979). Advances in Aquaculture, Fishing News Books Ltd, Farnham, UK.

Quagrainie, K. K., Amisah, S., and Ngugi, C. C. (2009). *Aquaculture information sources for small-scale fish farmers: the case of Ghana.* Aquaculture Research, 40(13), 1516-1522.

Quansah, J.E., G.L. Rochon., K.K. Quagraine., S. Amisah., M. Muchiri., and C. Ngugi. (2007) *Remote Sensing Applications for Sustainable Aquaculture in Africa*.

Redclift (1990) *Sustainable Development*. Earth Scan Publications Ltd, London.

Reinertsen, H. and Haaland, H (1995). *Sustainable Fish Farming*. SINTEF Aquaculture, Trondheim, Norway. Published by A.A.Balkema/Rotterdam/Brookfield, in "The Sustainable Use of Global Oceanic Resources by Martin Holdgate- Former IUCN Director.

Rivera and Cary, (1997). *Institutional Research-Extension-farmers linkage system in southwestern Nigeria.* Ph.D Thesis in the Department of Agricultural Extension and Rural Development, University of Ibadan, Ibadan.

Shekara, P. C. (2004). *"Status of Private Extension in India"*.

Swan, L (2012).*A fish farmers guide to understanding water quality.* Department of animal sciences, Illinois,Indiana.

The Organic Farmer (2013).Cut costs by using mud to make fish ponds. Rodale press, Nairobi, Kenya.

Tickell (1992) *Sustainable Development*. Earth Scan Publications Ltd, London P; 224.

Van den Ban, A. W. and Hawkins, H. S. (1996). *Agricultural Extension*. Oxford: Blackwell Science.

WCED (1987). *Our Common Future*: Oxford University Press. New York.

Zezza,Alberto and Tasciotti,Luca. (2010). *Urban Agriculture, poverty, and food security*: Empirical evidence from a sample of developing countries. Food Policy 35, 265-273.

APPENDICES

APPENDIX 1: LETTER OF INTRODUCTION TO THE RESPONDENTS

Rose Karimi Njeru
P.O. Box 2904-60100
Embu, Kenya
Email: rosenjerukarimi07@yahoo.com
Date:……
To whom it may concern

Dear Sir/Madam.

I am a Postgraduate student at the University of Nairobi, pursuing a Masters of Arts Degree in Project Planning and Management. As part of partial fulfillment for the degree I am conducting a research study on: The Factors Influencing Fresh Water Fish Farming in Embu North District, Kenya.

I would appreciate if you would kindly spare a few minutes of your time to answer the following questions in regard to The Factors Influencing Fresh Water Fish Farming in Embu North District .The information you give will be treated with confidentiality and in no instance will your name be mentioned in this research. In addition, the information will not be used for any other purpose other than for this research

Your assistance and co-operation will be highly appreciated.

Thank you in advance

Yours Faithfully,

Rose Karimi Njeru
Reg. No: L50/82354/2012

APPENDIX 2: QUESTIONNAIRE FOR ALL RESPONDENTS

Instructions

Kindly fill the following questions by ticking or filling in appropriate spaces provided except where otherwise indicated.

Section A: Background Information

1. Please indicate your gender?

(a) Male [ ] (b) Female [ ]

2. Are you the head of the household?

(a) Yes [ ] (b) No [ ]

3. Please indicate your age.

(a) Below 30 [ ] (b) 31 – 40 [ ] (c) 41 – 50 [ ] (d) 51 – 60 [ ] (e) above 61 [ ]

4. What is your marital status?

(a) Married [ ] (b) Single [ ] (c) Divorced [ ] (e) Widow [ ] (f) Widower [ ]

5. What is the size of your family?

(a) Below 3 [ ] (b) 3-5[ ] (c) 6-8 [ ] (d) Over 8 [ ]

6. What is your highest academic qualification?

(a) Primary [ ] (b) Secondary [ ] (c) Tertiary [ ] (d) University [ ]

(e) Others (specify) ……

Section B Ecological Factors

7. (a)What are the main species stocked in your ponds?

(a)Tilapia only [ ] (b) African Catfish only [ ] (c) Trout [ ] (d) Tilapia and African catfish mixed [ ] (e) others (please specify…….

(b) Please state the reason for the choice of the preferred species……..

8.(a)What are the sources of fingerings?

(a)Government hatchery [ ] (b) Private hatchery [ ] (c) Neighbors [ ]

(d)Others (please specify)……

(b) Are the fingerings available at reasonable cost? Explain your answer……...

9. (a) How many fish ponds do you have? ……

(b) Explain what has led to the number of fish ponds you have……...

10. For how many years have your fish pond/s been operational?

(a)Less than 1 year [ ] (b) 1 – 5 years [ ] (c) Over 5 years [ ]

11. What type of pond do you have?

(a)Earthen Pond [ ] (b) Liner Pond [ ] (c) Concrete Pond [ ]

12. What factors lead to construction of the above type of ponds?

a) Quality of soils [ ] b) Water temperatures [ ]

c) Others (please specify…….....

13. What is the main source of water in your ponds?

(a) Wells [ ] (b) streams [ ] (c) Springs [ ]

(d) Others (please specify)……...

14. How does water get in to the ponds?

(a) Gravity [ ] (b) Pumping [ ]

(c) Others (please specify)……

15. How often do you maintain pond water required level?

(a)Daily [ ] (b) Weekly [ ] (c) monthly [ ] (d) others (please specify)…….

16. How often do you monitor the optimal pond water temperatures?

(a)Daily [ ] (a) Weekly [ ] (a) monthly [ ]

(b) Others (please specify)…….……..

17. Which are the main fish predators in your farm?

1……..

2…….....

18. Which are the main diseases affecting fish in your farm?

1……..

2…….....

19. Which kind of pollutions influences fish farming in your farm?

1……

2……

20. Are fish feeds available for purchase, or are suitable ingredients available so the farmer can produce his Own? (a)Yes [ ] (b) No [ ]

If yes give some information on the most preferred type of fish feeds

(a)Commercial feed ……

(b) Homemade feeds……

(c)others (please specify)…….....

21. How often do you fertilize your pond?

(a)Once a month [ ] (b) twice a month [ ] (c) others (please specify)……..

(b)Are fertilizers and lime available at reasonable cost? (a)Yes [ ] (b) No [ ]

If yes give some information on the following

(a)home Made, estimated cost [ ] (b)purchased, manure kshs[ ] (c) fertilizer kshs [ ]

C. Social Economic Factors

22. How did you raise money to start your fish farming?

(a)Own money [ ] (b) Bank loan [ ] (c) Coo-operative society loan [ ]

(d)Government Support through ESP [ ] (e) others (please specify)……

23. (a) Is fish farming your main source of income?

(a)Yes [ ] (b No [ ]

(b)If not please state if you have other sources of income apart from fish farming…….

24. What is your involvement in the fish farming?

(a)Run the operation by myself [ ] (b) my family assist me [ ]

(c)I have employed fish farm attendants [ ]

25. What is the ownership of the land tenure on which you do the fish farming?

(a)Freehold [ ] (b) Family land [ ] (c) leasehold [ ] (d) Own land [ ]

26. The following are some of the factors influencing fresh water fish farming, what is your level of agreement? Use a scale where 1- strongly disagree, 2- disagree, 3- neutral, 4- agree and 5- strongly agree.

	1	2	3	4	5
Factors influencing fresh water fish farming					
Fresh water fish farming can make an important contribution to poverty alleviation address the problems of poverty and food security					
Fresh water fish farming makes an important contribution in social well-being hence promoting social equity					
Fish provides food of high nutritional value for households					
When Fresh water fish farmers combine agriculture and aquaculture they improve their food supply, increase their income and become self-sustained farmers.					
Fresh water fish farming boosts rural economic development.					
Living near perennial water bodies encourages Fresh water fish farming.					
Fresh water fish farming is a major source of foreign exchange to the Government.					
Fresh water fish farming offers employment opportunities to many people.					

D. To assess the trainings and extension services offered to fresh water fish farmers in Embu North District.

27. Have you attended any training organised by Ministry of fisheries and other service providers?

(a) Yes [ ] (b) No [ ]

If yes please explain the following information about the trainings and extension services conducted

a. Name of training institution…….

b. Method of training used 1. Demonstration [ ] 2. Workshop/seminar [ ] 3. Other[ ]

c. Number of trainings received last year……

28. Do you think the training and extension services influence fresh water fish farming in this area? (a) Yes [ ] (b) [ ]

If yes explain ……

Section E: Influence of marketing on fresh water fish farming Embu North District.

29. Indicate your level of agreement with the following statements regarding the contribution of Government through the Ministry of fisheries in Embu North District. Please tick on your level of agreement.

	Strongly Agree	Agree	Disagree	Strongly Disagree
There are good road network linking the fish farms and market				
There are organized and developed markets for the fish products				
The ministry of Fisheries and Development offers enough extension services in fish farming to the farmers				
The Government has policies in place to be followed by fish farmers				
The Government offers enough manuals to guide fish farmers on all farming procedures				
There are Government initiatives aimed at promoting fish production in the area				

30. Where do you market your fish?

i…….

ii……

31. What influences market prices for various species of fish harvested?.....

32. How do farmers ensure marketing of fish produced in Embu NorthDistrict…….....

33. Please indicate the type of fish you sell and at what price

Type.....Price.....

Type.....Price.....

34. Please rate the following statements on their impact on fresh water fish production. Use a scale of 1-5, where 1- not at all, 2-low extent, 3-moderate extent, 4-great extent, 5-very great extent

	1	**2**	**3**	**4**	**5**
Build capacity support for communities and farmers' organizations (Common Interest Groups) in marketing					
Organizing promotions through trade fairs/stakeholder forums					
Developing market information systems and marketing infrastructure					
Promoting investment in aquaculture through Public Private Partnerships (PPP).					
Promoting and facilitate value addition for aquaculture products					
Developing aquaculture extension guidelines and standard operating procedures (SOPs)					
Promoting and facilitating recruitment of new aquaculture species					
Selling fish through marketing associations					

35. How do the forces of demand and supply influence fish farming in Embu North District? .....

……

Thank you for your time and participation