PERFORMANCE OF SMALL-SCALE COMMERCIAL FISH FARMING SUPPORTED BY ECONOMIC STIMULUS PROGRAM IN NYERI COUNTY, KENYA

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C50/CE/24890/2012

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF MASTERS IN ARTS (REGIONAL AND URBAN PLANNING) IN THE SCHOOL OF HUMANITIES AND SOCIAL SCIENCES OF KENYATTA UNIVERSITY

JUNE, 2022

DECLARATION

This thesis is my original work and has not been presented for a degree in other university.

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We confirm that the work reported in this thesis was carried out by the candidate under our supervision.

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DEDICATION

I dedicate this work to my loving Mum Jacinta Wangari and my siblings Rita and Ronald for their unwavering support, prayers and sacrifices throughout my period of study.

ACKNOWLEDGEMENT

My gratitude goes to my supervisors, Dr. Philomena Muiruri and Dr. Jackson Musau for their support during the preparation of the proposal, analysis of data and compilation of the final report. Thanks to my colleagues notably Dr. KipropKibos, Samuel Thiong'o and Michael Njihia for their insights and encouragement.

I recognize the efforts, advice and contribution of Mr. Gakuo, the head of Nyeri County fisheries department, Jason Mwiti, Mathira the West Fisheries extension officer and his colleague Mr. Mutiso from Mathira East for the support in data collection efforts. Lastly, my gratitude goes to the study respondents, the farmers and key informants, for their cooperation during data collection.

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ABBREVIATIONS AND ACRONYMS

APA	:	American Psychological Association
CIDP	:	County Integrated Development Plan
DFO	:	Department of Fisheries Office
ESP	:	Economic Stimulus Program
FAO	:	Food and Agriculture Organization
GDP	:	Gross Domestic Product
GOK	:	Government of Kenya
GPS	:	Global Positioning System
KNBS	:	Kenya National Bureau of Statistics
Kshs.	:	Kenya shillings
MoFD	:	Ministry of Fishery Development
NACOSTI	:	National Commission for Science Technology and Innovation
SDGs	:	Sustainable Development Goals
SPSS	:	Statistical Package of Social Studies
UN	:	United Nations
USA	:	United States of America

ABSTRACT

The global economic recession of 2008-2009 made the government of Kenya introduce economic stimulus packages to cushion their citizens. Fish farming program was one of the stimuli introduced to provide income to farmers and diversify food sources in selected 160 high potential fish farming constituencies in Kenya. Each selected constituency was supported to construct and stock 300 fish ponds to selected farmers who had land and reliable water sources. All the six constituencies of Nyeri County benefited from the program despite fish farming been a new activity in terms of fish management and consumption, because of her economic and cultural orientation. Selected farmers were supported with funds to construct ponds, 1000 fingerings for each pond, training and initial fish feeds.

The study examined how the new practice performed in an alien county that had no cultural linkage. It examined social-economic factors that influenced farmers to adopt fish farming, farmers training influence on the adoption of fish farming, the consequent effects of fish farming on farmers' income and households' fish consumption patterns and the challenges facing fish farmers in the county. The study used cross-sectional survey design applying both qualitative and quantitative approaches. It was carried out in Mathira constituency of Nyeri County and targeted 1566 fish farmers who benefited from government ESP support in Nyeri County. Purposive sampling was used to select the sample constituency and systematic sampling to identify the study respondents. Open ended questionnaires were administered to the respondents and interview scheduled with key study informants. Secondary data was obtained from critical textual analysis of books journals, reports, thesis and dissertations. Analysis was done with and aid of SPSS version 23 creating themes around the study objectives. Quantitative data was analyzed in terms of percentages. Logit regression model used to determine social economic factors that influenced adoption of fish farming and chi square tested the associations and relationships between variables. Presentation of analyzed data was by bar-graphs, pie-charts and tabulation followed by brief explanations. The study found that age of the farmer, family size, membership to a farmers group, household frequency of fish consumption and marital status were significant in explaining farmers will to adopt fish farming. Further farmers training had a strong association with adoption of fish farming at x^2=98.571, p=0.001, a statistically significance between fish farming and household income of farmers at x^2=58.068, p=0.001, a strong association between fish farming and change of consumption patterns at x^2=120.313, P=0.001 and inadequate extension services, quality fingerings and high prices of fish feeds were main farmers challenges. The study recommends inclusion of farmers' socio-economic characteristics when introducing new farming technologies, investing more on farmers training and ascertaining availability of quality fish feeds and fingerings affordable by the farmers. The study findings provide the impact of trainings in awareness and skills acquisition, the viability of fish farming substituting other low performing small-scale income generating agricultural activities and its impact in provision of safe, affordable high quality food sources.

CHAPTER ONE

INTRODUCTION

The chapter presents the background of the study, statement of the problem, objectives, hypothesis, research questions, significance and justification, scope and limitation and ethical consideration.

1.1 Background of the study

Global recession is a period of significant decline on economic activities lasting for more than six months. In 2008 – 2009, the world experienced one of its greatest economic recession which was caused by financial deregulation and high household borrowing by borrowers with poor credit histories in USA (Verick and Islam, 2010). It therefore led to collapse of major investments in housing, mortgages and banking sectors and whose effects were felt by her trading and credit partners across the world. Major world economies experienced sharp drop in their investments and consumer spending, which lowered the demand for goods and consequently, led to a drop on exports and imports. The introduction of single currency in European countries and rise in oil prices worsened the crisis resulting in many investments laying-off their employees and the rate unemployment rose in USA and European countries (Verick and Islam, 2010).

Some unemployed African immigrants returned home, foreign remittances contracted, direct foreign investments reduced, private sector financing programs were restricted, foreign development aid to African countries reduced drastically and her commodity prices declined significantly. These led to economic slow-down and rise in poverty levels in Sub Saharan countries (Dullen *et al.*, 2010). In South Africa, shrinking of

world exports, led to reduction in production from mining and manufacturing sectors. As a result, jobs were lost, consumer spending contracted and there was rise in household debts. In Kenya the effects of the crisis were aggravated by 2008 post-election violence, escalating oil prices and continuing food crisis due to adverse weather conditions. Her economy growth rate shrank from 7.1% in 2007 to 1.7% in 2009 (GoK 2009).

Various governments responded with varied economic measures. The government of USA provided trillions of dollars in form of bail out and stimulus to loans, asset purchases, guarantees and direct spending to its banks. This provided funds for customers' withdrawals offsetting the declining consumption and lending capacity (Katkov, 2012). Banks regulations were tightened in Canada to maintain lower debt to equity ratio and investors wrote off short loses and banks interest rates reduced to the lowest bound for an agreed period (Gordon, 2017). In United Kingdom, the government bought shares in some banks and introduced rescue package restoring market confidence and stabilizing banking system (Pettinger, 2020). The government of China mobilized her state owned enterprises and ban king systems to participate in stimulus program. It also provided tax breaks and rebates on goods to spur investments and local consumption of goods, a shift from export reliance to internal consumption especially on automobiles and household appliances (Dullen *et al.*, 2010).

Most African countries, Kenya included, were severely affected by the recession which led to hard economic times due to the drop in consumer spending. As a result, most of the countries came up with various strategies of curbing the effects of the

global recession including lowering taxes and starting labor intensive development projects to increase spending. For example, South Africa lowered bank interest rates and introduced three years' stimulus to expand public works and infrastructure investment programs. The government of Tanzania, introduced stimulus on compensation and loan scheduling guarantee, to banks and food distribution and social support programs to agricultural subsidies. The government of Kenya undertook reforms in capital stock and strengthened regulation and coordination of financial institutions (GoK 2009). The Kenyan government also introduced a stimulus package that initiated a number of programs to mitigate the effects not only for the recession, but for post-election violence and food crisis (GoK 2009). The stimuli programs aimed at boosting consumption, creation of employment opportunities and provision of long term food security solution. Stimuli on long term food security were channeled towards expansion of irrigable land and establishment of small scale commercial fish farming (GoK 2009).

Fish farming stimulus funded the construction of 300 fish ponds in 160 selected constituencies, the ponds were stocked with fingering, supported with initial fish feeds and farmers trained on pond construction and management practices (MoFD, 2012). Nyeri County was one of the beneficiaries of this program whose aims were to improve livelihoods through provision of an extra source of income and promotion of food security. Majority of the Nyeri County residents had no economic and cultural association with fish farming or fish consumption, prior to the ESP fish farming. Hence, the introduction of small-scale commercial fish farming in all six constituencies in Nyeri County was a new idea to the County farmers. Approximately 2,400 fish ponds were established across the county with Mathira constituency having

439 fish farmers, the highest number of farmers among all other County constituencies (MoFD, 2012). Therefore, this study examines social-economic factors that led to adoption of fish farming, its effects on farmers' household income and on consumption patterns in the county. It also identifies challenges of the new agricultural activity (fish farming) in Nyeri County in diversifying farmers income sources and food security.

1.2 Problem Statement

Small-scale crop and dairy farming were the dominant commercial agricultural activities in Nyeri County. Yet, government of Kenya between 2009 and 2012, supported the establishment of small-scale commercial fish farming in Nyeri County under Economic Stimulus Program (ESP). It aimed to diversify food sources and increase farmers' income to the County population who had negative socio-economic orientation towards fish farming and consumption. Through the program, funds to construct fish ponds were provided at Kenya shillings. 40,000 per pond, farmers' technical training sponsored, each pond stocked with 1000 initial fingerings and 15 kilograms of fish feeds. The study was therefore carried to investigate; the socio-economic factors that influenced adoption of fish farming by farmers in the county and the corresponding effects on farmers' income and fish consumption and in the County.

1.3 Study Objectives

1.3.1 General Objective

The study assessed the performance of small-scale commercial fish farming that was supported by economic stimulus program in Nyeri County.

1.3.2 Specific Objectives

Specific objectives of the study were to:

i. Determine the socio-economic factors influencing adoption of fish farming in Nyeri County, Kenya.
ii. Examine the effects of training on adoption of fish farming in Nyeri County, Kenya.
iii. Evaluate the effects of fish farming on farmers' incomes in Nyeri County, Kenya
iv. Evaluate the effects of fish farming on household consumption pattern in Nyeri County, Kenya.
v. Establish the challenges facing fish farming in Nyeri County, Kenya.

1.4 Research Questions

The study sought to answer the following questions;

1. How do socio-economic factors influence adoption of fish farming in Nyeri County, Kenya?
2. How does farmers' training influence the adoption of fish farmers in Nyeri County, Kenya?
3. What are the effects of fish farming on farmers' income in Nyeri County, Kenya?
4. What are the effects of fish farming on household consumption pattern in Nyeri County, Kenya?
5. What are the challenges facing fish farming in Nyeri County, Kenya?

1.5 Research Hypotheses

The study was premised on the following hypotheses;

Ho_1: Household socio-economic factors do not have a significant influence on adoption of fish farming in Nyeri County, Kenya.

Ho_2: Farmers training had no influence on adoption of fish farming in Nyeri County, Kenya.

Ho_3: Fish farming has no significant effects on farmers' household income in Nyeri County, Kenya.

Ho_4: Fish farming has no significant effects on household fish consumption in Nyeri County, Kenya.

1.6 Significance and Justification of the Study

The study is significant to program planners since fish provides human body with low fat high quality protein rich with omega 3 fatty acids, vitamins D and B2 and other vital mineral nutrients that keep the human heart and brain healthy however, it was considered alien food in Nyeri County. Introduction of fish farming aimed to boost fish production and consumption. The findings provide the national and county planners the resultant impacts of program on fish consumption in Nyeri County.

Small-scale farmers in Nyeri County who were the program target, had no cultural linkage with fish rearing and relied mostly on tea, coffee, dairy and other subsistence agricultural activities for income and food. These traditional crops are recording decline in returns and yields and planners are designing programs and policies to diversify agricultural activities in the region. The study finding establishes the

viability of fish farming been a substitute income generating farming activity and diversifying farmers' sources of income in the study area.

According to 2010 Kenya constitution, agriculture was devolved to County governments. The study informs the County government of Nyeri, fisheries department on the impact of the training methodologies applied, languages used, number of training sessions and farmers' attendances on adoption of fish farming technology. Further, it informs on farmers, training impact on awareness creation and on areas of improvement.

To the government of Kenya, fish farming was a policy program by government to ensure safe, sufficient and quality food sources as outlined in UN Summit of 2015 Sustainable Development Goals (SDGs) agenda 2. The study findings inform the government on the effectiveness of fish farming in achieving the envisioned SDGs Agenda 2 on safe, sufficient and quality food sources and outlines the program shortcomings to help planners rethink on intervention to address them.

1.7 Scope of the study and limitation

The study focused on small-scale commercial fish farming program in Nyeri County initiated by the government of Kenya under economic stimulus program. Specifically on key socio-economic factors that influenced adoption of fish farming in Nyeri County, the influence of its adoption on household income and consumption patterns. The study respondents were the small-scale fish farmers supported by the ESP while, the County, Sub-County fisheries department officers, the area chiefs and Development officer were the key study informants.

However, several challenges were encountered during the study. Randomly selected sample of farmers were dispersed within the entire sampled constituency. In order to administer questionnaires to each of them, directions to their respective farms were sought from the Sub-county fisheries extension officers. Secondly some participants were deceptive however they were explained on the purpose of the study, assured on confidentiality and privacy of any information given. Finally, prior arrangements and appointments were made with the respondent and avoided bungled meeting.

1.8 Ethical Consideration

Authorization to carry the study was sought from NACOSTI (**Appendix IV**) and proceeded to Nyeri County government for authorization (**Appendix V).** Appointments were sought with the County administrators for introduction and explanations on the study purpose and scope. Later introduced to the Sub-County officers and the farmers and informed on the study purpose and their roles. Study respondents were assured their anonymity, confidentiality and respect of their information. Their permission to participate was sought voluntary without any coercion and participants were treated as participants and not subjects. Any work referred to was acknowledged using APA format.

1.9 Operational of Terms and Definitions

Active farmers – These are farmers who were involved in the fish farming program

Adoption of fish farming – Taking up of fish farming activity by farmers

Fish farming – The practice of rearing and managing fish in the ponds by farmers

Commercial fish farming – Rearing and managing of fish in the ponds for sale to local and urban markets.

Economic stimulus Program – Government funded activities to increase spending and consumption of its citizens to cushion them during economic down turns.

Fish farm – a piece of land which hosts fish pond/s

Fish pond – a designated area covered with water where fish are reared

Fish vendors – Traders buying fish from farmers and sell at the market places.

Performance – The economic accomplishment in terms of gains or losses.

Training – Technical education and assistance to farmers, equipping them with skills on fish farming.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The chapter reviews related literature on global economic recession, its causes and effects. It explains on interventions taken by different government to cushion its citizen from the effects. The chapter also explains on supported fish farming, factors influencing its adoption, its effects on household income, fish consumption pattern and its challenges. The chapter finally presents the theoretical foundation and conceptual framework that guided the study.

2.2 Global Economic Recession of 2008-2009

Economic recession is a period of significant decline on economic activities which last for more than six months. Four global economic recessions have been witnessed since the world-war II. These recessions were reported in 1975, 1982, 1991 and the 2009. The economic recession of 2009 started in United States of America. Data on income inequality in USA in 2008, showed 10% of the population holding 42.2% of the national income while, the rest of the population (90%) held only 51.8% (Johnston and Hausman, 2014). The rise in demand for housing led few overconfident, wealthy investors engaged on risky housing investments using unregulated financial institutions with a premise that economic growth rate would continue (Milanovic, 2009). Housing prices drastically rose up as a result of increased demand leading into high consumer and household borrowing. Later the housing prices fell and major housing investments collapsed. The financial institutions became greatly indebted and

fell into financial crisis, stock market prices declined and USA fell into a recession (Rajan, 2010).

The effects of USA economic recession were felt by other partner countries through various channels. Imports by developed countries declined affecting negatively the global trade volumes. The imports value from European Union countries, Japan and USA fell drastically and elicited a worldwide crumple of international trade and sharp drop on investments and consumer spending. The sharp drop in exports led to investments freezing hiring on new employees, dismissals and layoff of the other employees. This contributed to rising unemployment in developed countries of USA, Spain, Denmark and Turkey. As a result, the global economy contracted by 2% by 2009 (Katkov, 2012).

Low demand of goods from developed countries resulted to decline in trade and commodity prices from developing countries. Further, there was reduction on credit facility from international banks, decline on foreign direct investments, contraction of foreign remittances, restriction on financing of programs by the private sectors and decrease of direct foreign aid for development to African countries (Verick and Islam, 2010). In South Africa, production from mining and manufacturing sectors shrank due to decline in export market and contraction of consumer spending (Marais, 2009). As a result, jobs were lost and household debts rose up. These resulted to economic slowdown and rise of poverty levels in Sub-Saharan African countries. The above effects were also experienced in Kenya, worsened by post-election violence and adverse weather condition of 2008. Her economic growth declined from 7.1% to 1.7% between years 2007 to 2009 (GoK, 2009).

Governments responded differently to the crisis; USA introduced $800 billion fiscal stimulus to offset the declining consumption and lending capacity by bailing out loans and asset purchase guarantees. This was to restore faith in commercial transactions and create or save 3 to 4 million jobs (Verick and Islam, 2010). Chinese government mobilized state oriented economic investments and banking systems to provide stimuli programs, starting with urgent infrastructural investments. It also provided tax reliefs and rebates to many household goods to boost internal consumption of her goods; a shift from reliance on exports (Mingran, 2018). To sustain her investments, Canadian government reduced the interest rates to lower bound and made conditional commitment with financial institutions to maintain the policy for two years (Gordon, 2017). The investors therefore were persuaded to write off short term loses and insured mortgage purchases.

Low income countries of sub-Saharan Africa introduced stimuli at varied magnitude to increase their expenditure on public investments on basic infrastructure; food production, road and ports construction and power generation (World Bank, 2013). South African government in-order to prevent job loss, create new jobs and provide emergency food relief to needy households, it relaxed the exchange controls by cutting interest rates, introduced investment program on infrastructure development and escalated programs on public works (Marais, 2009). In government of Tanzania, introduced a stimulus package to improve food distribution and to support social programs on agricultural input subsidies was introduced. It also relaxed monetary policies by providing compensation stimulus to banks to facilitate them finance private sectors, and relief borrowers (Lunogelo *et al.*, 2010).

Apart from strengthened financial institutions regulation and supervision, Kenyan government introduced a Ksh22 billion stimulus program (GoK, 2009). The stimulus was to advance economic revitalization, establish long term solutions on food problems, create economic pillars at rural areas, increase numbers of hand-on employment vacancies, and promote regional development, equity and social stability (Mwega, 2009). The stimulus initiated a number of programs in various sectors. To provide employment, the government initiated youth employment program dubbed *kazi kwa vijana,* which beside providing employment, it was to boost domestic consumption necessary to stimulate and spur economic growth. It also funded the establishment of markets for fresh produce through construction of small scale retail entrepreneurs sheds and wholesale markets; rehabilitation of schools and upgrading of some public health facilities. On food security and regional development, the stimuli were directed towards expansion of irrigable land for maize and rice and introduction of small-scale commercial fish farming (GoK, 2010).

2.3 Economic Stimulus on Fish Farming

The fisheries sub sector was identified for stimulus in the economic pillar. It aimed to facilitate poverty alleviation by providing food security, create employment opportunities and encourage fish farming and consumption in rural areas. The pillar envisioned to deliver an annual national growth of 10% (GoK, 2010). The stimulus was introduced to fund small-scale commercial fish farming in 2009 and implemented in two phases. In the first phase of 2009/2010 financial year, 140 selected political constituencies benefited with funds to construct 200 fish ponds, 15 kg of fish feeds and 1000 mono-sex tilapia fingerlings. Farmers were also trained on fish pond

construction and pond management practices. In second phase, 2011/2012 financial year, additional 100 fish ponds were added to each of the first 140 constituencies and 20 additional new constituencies benefited with each 300 fish ponds. This made the total number of government funded fish ponds countrywide to be 48,000 (Musyoki *et al.*, 2015).

The six constituencies of Nyeri County benefited from the program namely; Kieni, Mathira, Mukurweini, Othaya, Tetu and Nyeri town. Each constituency was funded to construct 300 fish ponds, supported with 1000 fingerings and 15 kg of feeds. Selected farmers were trained on ponds construction and pond management by the constituency fishery officer, who also supervised the implementation of the program. Despite the negative cultural orientation of fish farming and consumption, the program was highly adopted in the county.

2.4 Factors influencing adoption of fish farming

Fish farming is the rearing of fish commercially in enclosures such as ponds for food or sale. Fish is rich with proteins that are of low fat, rich with omega 3 fatty acids and vitamins D and B2. It is also contains calcium and rich in phosphorous among other vital minerals such as iron, zinc, iodine, magnesium and potassium. Consumption of fish help to maintain blood pressure, aid in brain, vision, and nerves development, decreases risks of many diseases like arthritis and diabetes and prevent inflammations (FAO, 2017). Commercial fish is a source of income to farmers and earns revenue to government as well as contributing to national food security. It also creates employment opportunities from farms to processing factories.

There has been an influx in demand of fish, despite decline in capture fisheries sources. This led to governments and donors to support fish farming. Farmers were supported to start fish farming with funds to construct fish ponds, fingering, fish feeds, farmers' training on fish farming and extension services. The support was aimed to influence farmers adopt fish farming and increase fish production.

The government of Pakistan supported farmers to adopt fish farming and integrate it in rice fields. The practice increased farmers' income by 20 percent (Muddasin and Waquis, 2019). After Chinese government reformed her agricultural program, it initiated and supported fish farming program. The program absorbed all the surplus labour force released by the reform program (World Bank, 2007). Edwards (2000) observed that farmers in Thailand got institutional support inform of training, extension services and inputs however, they were required to own or rent land for fish culturing and understand the value of fish. In Bangladesh Islam and Sakib (2014), noted that age, level of education, family annual income, social participation and knowledge on fish culturing by the farmer, positively correlated with adoption of fish farming techniques in rice fields.

Africa was observed by Brummet and Williams (2000) to have great potential for fish farming. Majority of fish farming projects in Africa were initiated and sponsored by donors or governments. After the sponsorship of the projects was withdrawn, there were reported successes and failures of the projects (Dey *et al.*, 2006). Subsistence small-scale projects in poor rural areas reported most of the failures while the large-scale projects reported most of the successes (FAO, 2002). However government and donors are putting up mechanisms to rehabilitate and modernize the infrastructure

facilities that were been used initially to facilitate the reintroduction of fish farming (Hecht, 2006).

Wetegere (2009) realized that adoption of fish farming was influenced by varied social cultural variables. They included; the sex, age, formal education, religious beliefs of the farmers and farmers training services provided. He also observed that economic variables; family income, land sizes, risks and profitability of the project too determined the adoption of fish farming and concluded that the later was the dominant factor. This indicated that fish farmers' were more likely to be driven by demand for cash than demand for household consumption especially in areas with limited cash crop cultivation.

Fish farming in Kenya was started in 1920s. In 1960s, the government of Kenya introduced a campaign dubbed "eat more fish" with an aim to popularize and support fish farming. However, it declined gradually such that by mid 1990s it was only practiced by small-scale farmers at subsistence levels with low production (Ngugi *et al.,* 2007). Introduction of ESP for fish farming reawakened fish farming in Kenya (Obudho, 2014). Fish farmers were supported with funds to construct fish ponds, initial 1000 fingerlings and 15 kilograms fish feeds per fish pond. Farmers were also trained on pond management practices and extension services provided (GoK, 2009). About 48,000 fish ponds were established by the program (MoFD, 2012). Between 2011 and 2012, Obudho (2014), observed increased fish production from 12,154 to 21,800 metric tons: an increase attributed to the program. Gatonye and Gakuu (2018) further attributed the success of program to improved training services provided.

According to FAO (2011), agricultural planners must consider the following variables before introduction of a new farming model for adoption; its benefits on household income, ability to provide household food, farmers training and extension services, cost of inputs and the profitability of the venture. Previous studies focused on the failure and challenges of the fish farming however, the program achievements on; fish rearing, trading and consumption behavior pattern in areas changed and could associated with the introduction of the program. Supported by an increase in fish rearing and consumption could have spurred income creation in the county. The study investigated the income benefit of the fish farming program and its effects on community behavior on fish consumption. These effects were as a result of fish and fish farming information given during farmers training session and later diffused into the entire community. Hence this study justified the introduction of fish farming in alien counties and quantified its gains in diversifying income and food security sources in Nyeri County.

2.5 The Influence of farmers training on adoption of fish farming

Training is the acquisition of skill and knowledge. It improves the capability, capacity and productivity of the trainee. Fish farming was a new agricultural practice in the study area, and therefore farmers were equipped with prerequisite technical and management skills through training. Mixed training methods approaches were employed including grouped training, demonstration ponds and farm visits.

According to Obwanga and Lewo (2017), information materials such as posters, brochures, radio features and video presentation are used to dissemination fish farming information and skills to farmers. In Bangladesh, Yeasmin (2014) observed a

positive correlation between governments sponsored farmers training and fish farming effectiveness. He observed that integrating fish farming in rice fields needed high level training. On the contrary in India Deboral *et al*., (2012), observed that aquaculture had slow growth since training services organized and funded by the government were poorly organized and attended with poor results. They found that majority of fish farmers sourced extension and training services from private service providers and recommended for the strengthening of the fisheries department to offer quality training services.

Inadequate training personnel's hindered the growth of fish farming in Uganda therefore, farmer's association prioritize on training services to boost their production (Stutzman*etal.*, 2017). According to Wetengere (2009), initial adequate training led to high adoption of fish farming in Tanzania however, fish farming declined steadily when follow-up extension services were discontinued. Therefore, continuous training and regular farm follow-up services were paramount to sustain fish farming.

The 1960 Kenya government supported campaign on 'eat more fish' program. Inadequate training and extension services were observed by Gitonga *et al., (*2004) to be the main reasons for its failure. Similar trend was observed by Oloo (2011), who realized that fish farmers from Kisumu took long time before realizing good returns from their phase one ESP established fish ponds because extension and training services were inadequate. Similarly, in the counties of Kiambu and Machakos these services were observed by Musyoki *et al.*, (2015), to lessen farmers' profits. Unlike farmers, secondary schools in the county of Kiambu that benefited from fish farming program overcame the challenge by engaged their respective teachers of agriculture in training and extension services to pond managers (Patrick and Kagiri, 2016).

The studies described above illustrated that training services played a crucial role in imparting fish farmers with pond management skills. Any shortcoming on training either initially or after adoption limited farmers' profit margins and led to farmers abandoning fish farming. They also identified that inadequate extension officers hindered its further growth. This study posits that training services drove farmers to adopt fish farming and later assisted in establishing their fish ponds. Contrary to the previous studies this study assessed the significant aspects of training services that influenced farmers to adopt fish farming. Further it identified shortfall of the training sessions that contributed to farmers' failures on pond management practices.

2.6 Effects of fish farming

Comparative to other agricultural enterprise in the world, fish farming has grown from 0.8 million to 2.8 million tonnage between the years 2000 to 2004 (FAO, 2017). This makes it among the fast growing agricultural enterprises, and observed by FAO, (2008) as a substitute to crop farming. Reduction of fish catch from natural waters and the increased demand for aquatic animals' protein due to their high calorific potential could have contributed greatly to fish farming becoming among the fastest growing animal food production sector globally (FAO, 2012).

Fish farming has employed about 30% of the workforce in fisheries sector globally; 97% of them are from Asian countries, 1% and 1.5% from Africa and American continents respectively (Boto, 2013). Asian countries long history on fishing makes the continent to have majority of fish farmers globally (Edwards, 2000). Consumption of fish in Latin American countries was low; their high production largely was for export market creating rural employment in the sub-continent (FAO, 2017). The sub-

continent practice fish farming entirely for commercial purposes, therefore, fish farming generates income to farmers and other stakeholders.

There are some reported positive developments of fish farming in some Sub-Saharan Africa countries (Boto, 2013). They include Kafue fish farm in Zambia and Lake Harvest projects in Zimbabwe (Roderick, 2002). These developments have provided constant supply of fish to the increasing demand for fish, offering reliable income to the farmers (FAO, 2011). Further, they uplift the rural economy, are sources of food and raise farmers' and immediate residents' living standard and nutritional status (Gupta and Halwart, 2004). Majority of the farmers adopt fishing farming to earn income rather than to provide food for domestic consumption.

It's notable that farmers' who adopted fish farming programs mainly came from the rural poor households which had high unmet demand for cash. Despite being considered tedious by some farmers, fish farming supplements farmers' households' budgets and help to meet large part of their domestic demand for nutritious food. The study investigates the income benefit of fish farming to farmers and the corresponding source of nutritious food security to other farmers and entire community households.

2.6.1 Effects of Fish Farming on farmers Households' Income

Income is money received regularly from an investment. The practice of fish rearing creates vast numbers of employment opportunities in hatcheries, pond construction and on pond management. Farmers later sell their fish to traders and factories generating income. Therefore, fish farming generates income from selling of fish and by creating employment (Belton and little, 2011).

Many rural farmers change to fish farming to supplement their sources of income (Johan and Pemsl, 2011). In Tanzania a correlation between farmers' income and adoption of fish farming showed that farmers who adopted fish farming had an increase in their household income (Mulokozi *et al.,* 2020). Mulokozi *et al.,* (2020) further observed fish farming generated 13% of the farmers' income through fish sales. Similar observations were found by Shoko *et al*., (2019) in Tanzania. Dey *et al*., (2010), observed that integrating fish farming with other agricultural activities in Malawi led six times increase of cash to rural households. Workforce to dig out fish pond was mainly provided by local youth population, who in return earned wages. Gachucha *et al.,* (2014) realized that introduction of fish farming by the government increased rural income from the wages paid to the youth for ponds construction.

Buying and selling of fish products promotes trade. Access to either local or regional fish markets yielded significant income to farmers from Makueni County (Wesonga, 2018). According to Kimathi *et al.,* (2013), fish farming was profitable to farmers from Tigania East who had access to urban markets. From these studies farmers who had reliable market for their fish took fish farming to be an alternative source of income. However, fish are highly perishable and require ready market and efficient or refrigerated transport system. When markets become uncertain, farmers suffer from post-harvest losses and fluctuation in prices, increasing farmers' risks. Hence local markets are more preferred over regional markets. This study established consumption level by non-fish farmers' population and ascertained presence of reliable rural fish markets for sustainable and steady income to farmers.

Moreover, Kimathi *et al*., (2013), studied a population of farmers who sold their fish produce to urban markets. This study investigated all fish market outlets including domestic retail sales to non-fish farmers' household for consumption. It also determined the quantities and prices of fish sold and the frequencies. This helped to quantify farmers' income from a community that had negative cultural orientation towards fish rearing and consumption.

2.6.2 Effects of Fish Farming to Consumption Pattern and National Food Security

Fish farming provides fish. Consumption of fish provides low fat protein and essential mineralogical nutrients which are low in calories and cholesterol levels (FAO, 2012). Fish farming has impacted positively in provision of nutritious food to large number of rural and urban population (Felipski and Belton, 2018). Therefore, it has played a major role in achieving household and national food security. Mosopele, (2017), found that an outbreak of lung cattle disease in Botswana in 1990 led into farmers searching for an alternative farming activity. Most of this farmers according to Mosopele, (2017) adopted fishing which helped them to provide food for their household. Later, in a study by Nnyepi, *et al.*, (2015) in the area, established that children from the households that adopted fishing as an alternative had higher nutritional status than their counterparts from households that adopted other activities. Hence adoption of fishing farming led to farmers' household consuming nutritious meals (fish) improving their children health. Similar results were found in a comparative study by Nguka *et al.* (2017) in Western Kenya. The respondents of the studies above, had a culture of fishing by design and the study areas were near water-

bodies that were suitable habitats for fish however, respondents of this study and the study area had fishing and fish consumption been an alien practices.

According to Kimathi *et al.,* (2013), establishment of fish farming under ESP in Tigania East resulted to farmers' household introducing fish in their diets. In the end farmers' households reported increased fish consumption however, the program aimed to benefit both the farmer and the entire neighbourhood households with provision of nutritious food. This study assessed the program effects on consumption patterns of fish by the wider neighbourhood households. It posited that the domestic rural sales translate to uptake of fish by non-fish farmers' households.

2.7 Theoretical framework

The study was based on adoption diffusion theory by Rogers (2003). The theory is popular in studying adoption of new practices and how it spreads and integrates with the recipients. According to the theory, adoption refers to uptake of a different activity from the previous one by someone as a strategy of self-enrichment. The person decides and starts to use a new idea, method or practice perceived new or unfamiliar to individuals within a particular area. Diffusion involves passing of information of a new idea or practice from the source to the targeted recipients through organized channels of communication and in overtime to the whole target society. For the success of the spread of any idea it must have the four determinants; a channel of communication, characteristic of the practice, distinctiveness of targeted recipients' and an established social system. Channels for communication are set standards to transmit an idea about the perceived practice for the benefit of the targeted community members. Attributes are perceived benefits of the practice after adoption

and how it integrates or coexists with values and the characteristics of recipients. Social systems are individuals past experience and how the practice addresses their needs.

In recent years' the theory was used in determining the diffusion of new agricultural and information technologies and other practices. Ndah (2014) applied the adoption diffusion theory to assess the adoption and diffusion process of fish farming in Cameron. Meijar *et al.*, (2015) applied the theory to analyze and explain the roles of knowledge, attitudes and perceptions during the uptake of agro-forestry by the small holders' Sub-Saharan Africa farmers'. Helitzer *et al.,* (2020) used the theory to evaluate how telehealth program had spread in the rural areas of Mexico. These studies demonstrated that Rogers, (2003) adoption diffusion theory is useful in conceptualization fish farming adoption in new area (Nyeri County) which had no cultural association with fish farming or eating. It explains how, why and at what rate fish farming information was disseminated to members of a social system.

Training officers were the agents to train on fish rearing, its economic and nutritional value for the success of the program. The theory proposes that every new idea (fish farming) had to have relative benefit and observable characteristics over other traditional agricultural practices. The results must be tangible with social and economic advantage. This would make fish farming influence the attitude change of fish farmers and neighbourhood households toward fish consumption enlarging the fish market. This study determined the social economic acceptability of the program in the study area. However, the theory assume that new ideas are always desirable, contradicting the systematic process of any change that required, first to change the consumer, before introduction a new idea or innovation (Senge, 2006). The program

assumed that sensitization and training of fish farmers on importance of fish and fish farming diffused and trickled down to the entire society.

2.8 Conceptual Framework

Figure 2.1 shows the relationship between the study variables; the dependent, intervening and independent. The establishment of small-scale commercial fish farming was supported by government of Kenya through the Economic Stimulus Program. Beneficiaries of the program were provided with capital to construct fish ponds, initial fingerings and feeds and also training and extension services. Fish farming was an alien practice in the study area; therefore adoption of fish farming by farmers was determined by farmers' socio-economic and external characteristics which led to establishment of fish ponds and rearing of commercial fish; the study independent variables.

The adoption was necessitated through effective awareness campaign and training services by the department of fisheries. Training and development officers sensitized residents on the practice, they impacted knowledge of fish management, influencing farmers' perception towards fish farming through awareness creation of its benefits, through extension and advisory services provided by training and development officers; study intervening variables. Afterwards fisheries department recruited farmers to benefit from the program and scheduled further farmers' training sessions.

Yields from farmers pond was for domestic consumption and commercial sales. Increased fish production and awareness resulted to expanded domestic sales to non-fish farmers' households in the neighbourhood and excess surpluses sold

commercially for local markets and fish factory. These generated income to the farmer and provided fish for consumption by the community despite some barriers towards management of fish farming (study dependent variables).

The study examined the association between farmers training and fish farming adoption. It later determined the effects and significance of fish farming on farmers' income in the study area. Finally, the study established the barriers of fish farming activity. The framework was modified through inclusion of training services to the adoption of fish farming which had been observed by previous studies to be a the program challenge.

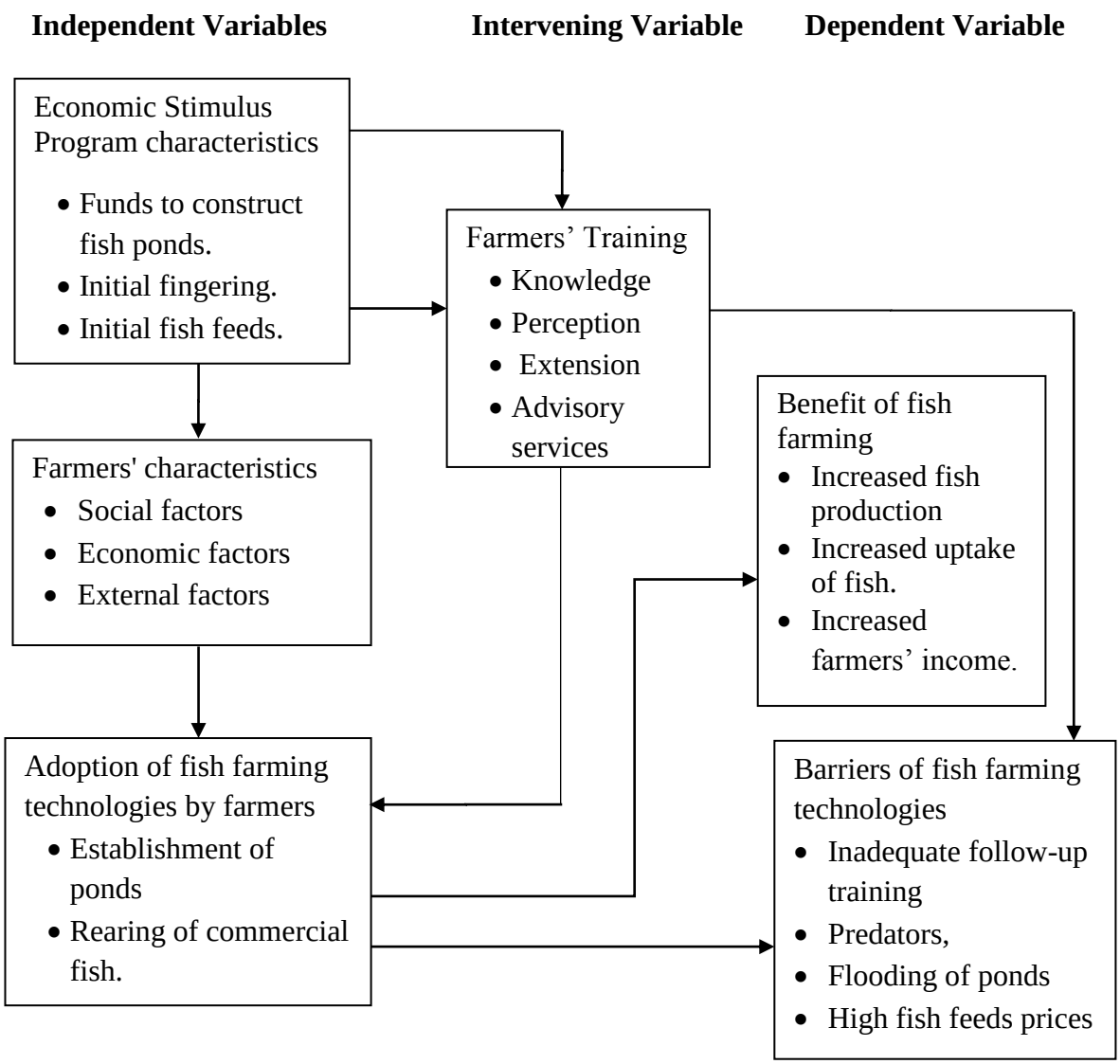

Figure 2.1: The adoption, establishment and achievement of ESP supported small scale commercial fish farming.

Source: Adopted and modified from Rogers, (2003).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The chapter covers the study area, research design, study variables, target population, sampling techniques, data collection instruments and data analysis procedures.

3.2 Study area

3.2.1 Location of the study area

The study was carried in Nyeri County which lies between latitudes 0^0 and 0^0 38'South and longitudes 36^0 38'E and 37^0 2'East covering an estimated area of about 3,337.5km^2. Nyeri County comprises of eight sub-Counties namely; Mathira East, Mathira West, Tetu, Mukurweini, Nyeri Central, Othaya, Kieni East and Kieni West as shown in Figure 3.1. Nyeri County borders Laikipia to the North, Meru to the North East, Kirinyaga to the East, Murang'a to the South and Nyandarua to the West.

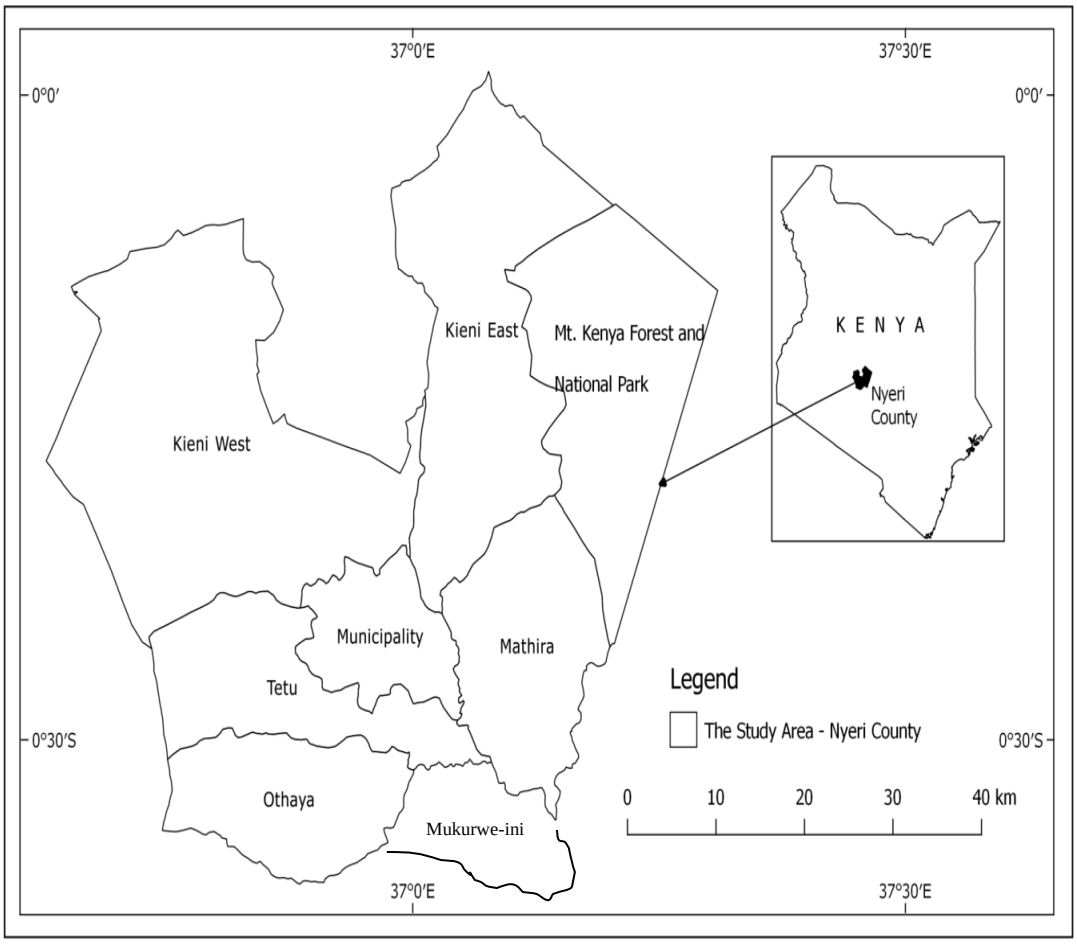

Figure 3.1: Map of Nyeri County.
Source: (Nyeri County CIDP, 2018).

3.2.2 Physical features

The main physical features are Mount Kenya (5199m) to the East and the Aberdare ranges (3999m) to the West. Nyeri County topography is relatively flat on western part and steep ridges and valleys with a few hills on the Southwards. Therefore, it is characterized by rolling landscape with several permanent and seasonal rivers, tributaries of Rivers Tana and Athi.

3.2.3 Climatic conditions

The study area is located along the equator. Equatorial climatic conditions dominates the area and characterized by double maxima rainfall between the months of March to May and October to December, with an annual rainfall ranging between 500 and 1500mm. Annual temperature of the study area ranges between 12 to 32 degrees Celsius. The county has natural forest around Mount Kenya and Aberdare ranges and scattered shrubs in the semi-arid lowland of Kieni.

3.2.4 Population

Nyeri County has an estimated population of 759,164 persons comprising of 384,845 females, 374,319 males and a population density of 228.3 persons per kilometer squared in 248,050 households (KNBS, 2019). Over 60% of Nyeri County's population is below 40 years. The highest population per age bracket stands at 19.8% for ages between 10 and 19 years while the lowest population per age bracket (1.9%) comprise of persons above 80 years (KNBS, 2019).

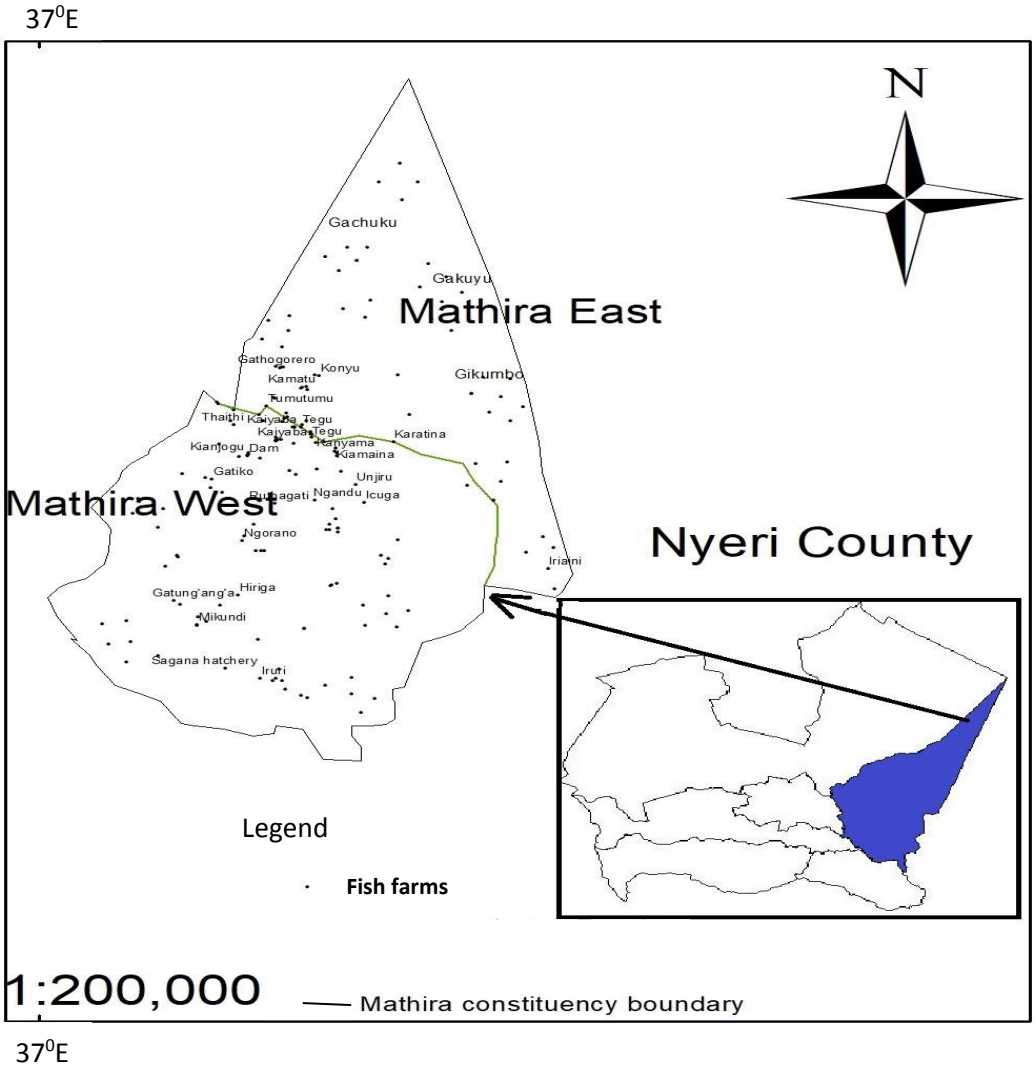

Figure 3.2: Map showing the location of sampled fish ponds in Mathira Constituency.

Source: Mathira Development Plan.

3.2.5 Socio-economic activities

Small scale agriculture is the main economic activity in Nyeri County and comprises of both the growing of subsistence food crops such as maize, beans, potatoes and vegetables and cash crops such as coffee, tea and horticulture. The small-scale farmers in Nyeri County equally practice dairy, pig, sheep, goat farming and poultry keeping. However, agriculture faces several challenges including fluctuating market prices, mismanagement of co-operative societies, crop failures because of

unpredictable weather patterns and which has resulted to low income amongst farmers.

3.2.6 Fish farming

Fish farming entailed the sitting of the fish pond. The program preferred the earthen ponds; these are ponds dug below the earth surface. Land area, type of the soil and water supply were the considered physical factors, while availability during training sessions and labour were the required human factors expected from farmers.

Site for fish ponds construction should be relatively level, large enough for present and future expansion, free from flooding or any form of run-off pollution from the adjacent land uses; pesticides, herbicides or insecticides. Deep soils with high clay content at the lower layers to prevent downward water seepage. Where the soils have low clay content polythene liners are placed around inside the pond as shown in photograph 2. Fish ponds require constant and adequate quantity and quality water supply to withstand seasonal fluctuations. The water should have high concentration of oxygen, relatively free from silt, aquatic insects and toxic substances.

Extension officers assisted identified farmers to site the fish ponds and later they supervised their ponds excavation photograph 3.1. Government through ESP provided capital for excavation at a rate of Kenya shillings 40,000 per 3000cm^2 pond. Farmers therefore hired area youths to excavate the ponds manually using hand tools like hoes and shovels as shown in photograph 3.1 below.

Photograph 3.1: Excavation of ESP funded fish ponds at Mathira constituency

Excavated ponds were earthed on the walls and ground using clay soil. Polythene liner was placed on the inner surface of the pond to prevent water seepage before they are filled with water as shown in the photograph 3.2 below.

Photograph 3.2: Polythene liners being spread around the fish ponds at Kianjogu in Mathira west sub-county

To allow the growth of natural fish food in the ponds, organic manure from cattle, goats or poultry are applied on the floor of the pond at a rate of 5 kilograms per $100cm^2$ and later filled with clean water. Inorganic fertilizer; Di-ammonium phosphate and urea, are applied to the water at a rate of 2grams per $1m^3$ by first dissolving it in a bucket of water, stirred and the solution sprinkled around the pond or suspend small bags of the fertilizer just under the water surface.

Mono-sex tilapia fingerlings between 20-40 grams are stocked at a density of 1-2 fingerlings per m^2. To increase pond productivity and speed up fingerlings growth, they were fed on supplement feeds provided by the program or bought from the shops. Feeds are throwing out in small amounts in the ponds at specific time of the day; this makes the fingerlings accept the feeds and learn on when and where to receive their feeds. Best times to feed the tilapia species are between 10.00am and 4.00pm when pond water temperatures and dissolved oxygen are reasonably high since tilapia browses all day long. Feeding time provides the best opportunity to observe fish health and their rate of growth.

Selected farmers provided land, water and dedicate their time in training on fish farming. Training was done by the extension officers. They applied variety of training methods to disseminate information to farmers on pond management, predators control, fish preparation, and importance of fish consumption. Some training sessions were administered at make-shift rooms and trainees fully involved during the sessions as shown in photograph 3.3 below.

Photograph 3.3: Fish farmers training session at Kaiyaba Mathira West Sub-county.

In other training sessions like predator control, training officers used demonstration methods at sub-county demonstration ponds such as net stretching as shown in the photograph 3.4 below.

Photograph 3.4: Fish Farmers training on predator control at a demonstration pond at Kaiyaba Mathira West Sub-county.

Tilapia fish are ready for harvesting between 250-350 grams (table-size fish). At this stage training sessions were organized at farmers' pond site to help farmers learn from each other and extension officers supervise the activity. Farmers fully participate in the activity under the guidance and supervision of the training officers as shown in photograph 3.5 below. This helped them to perfect their skills, form partnership and collaboration during some fish farming activities. Moreover, harnessing individualized skill, share and learn from each other.

Photograph 3.5: Fish farmers training on preparation of fish after harvesting at Sagana scheme – Mathira west Sub-County

Fish consumption was an alien feeding tendency in the study area therefore; training officer sometimes organized training sessions at selected farmers homestead on fish preparation to sensitize the farmers of various ways of making fish as shown in photograph 3.6.

Photograph 3.6: Fish preparation method demonstrated at farmers' homestead Ngorano location Mathira West Sub-county.

During such training session trainees tasted fish delicacy which aroused them to champion for fish consumption in their households as shown in photograph 3.7.

Photograph 3.7: Farmers treated to a fish delicacy after a training session at Karatina Mathira East Sub-county

The government provided the farmers with the fingerlings, partial fish feeds, sponsored the training sessions and promised reliable market for their fish at fish factory that were government funded. These inspired farmers to start fish farming under economic Stimulus program in the county.

The introduction of fish farming through the economic stimuli program (ESP) led to establishment of fish ponds in the country which are estimated at 48,000 fish ponds with tilapia, catfish and trout as the main species reared (Nyeri County CIDP, 2018). Table 3.1 below shows the fish ponds establishment, active ponds and fish farms per sub-County in Nyeri County as at 2017.

Table 3.1: ESP Fish ponds establishment in Nyeri County

Constituency	Sub County	Initial ESP funded fish ponds	Numbers of fish farmers	Constituency total number of fish farmers	Percentage
Mathira	Mathira West	300	266	439	73.1
	Mathira East	300	173		
Tetu	Tetu	300	217	217	72.2
Nyeri town	Nyeri Central	300	213	213	71
Mukurweini	Mukurweini	300	208	208	69
Kieni	Kieni East	300	107	348	58
	Kieni West	300	241		
Othaya	Nyeri South	300	141	141	47
	Total	**2400**	**1566**	**1566**	**65.25**

Source: MoFD - Nyeri County (2017).

As illustrated in Table 3.1, each sub-county was funded to establish 300 fish ponds totaling to 2400 fish ponds Nyeri County. There were 1647 active fish ponds, managed by 1566 farmers. Mathira constituency had the highest number of fish farmers at 73.1%, followed by Tetu 72%, Nyeri town 71%, Mukurweini 69%, Kieni 58% and Othaya 47%. The study identified Mathira constituency with 73.1% to be its

sample, since it had the highest percentage of fish farmers who were continuing with fish farming.

3.3 Research Design

The study employed a cross-sectional survey design where identified study respondents were interviewed to give a comprehensive investigation of the study topic. The study gathered information from farmers about the fish farming business from pond establishment through fingerings rearing to fish marketing. Pre-tested questionnaire and key informant interview schedule were the study primary tools and sources of data. Secondary data was collected from written government reports and other related published studies. The above tools helped to give data with actual description of the fish farming situation from the recipient farmers at the ground level and correlated with other recorded data. These provided a comprehensive, detailed and appropriate data that showed the relationship between the study variables (Bryman and Bell, 2003) which provided informed general situation of fish farming at the entire study area (Kothari, 2004).

The instruments were validated by subjecting the questionnaires to peer students (peer debriefing) and some questions were rephrased. They were then subjected to the fisheries extension officers and some repetitive questions adjusted and others deleted.

3.4 Variables of Analysis

The study examined farmers' socio-economic characteristics that influenced fish farming adoption and the training features that influenced fish farming in Nyeri County. It also examined benefits of fish farming on farmers' income and on provision of food security to farmers' households and to the local community. Finally

assessing the challenges faced by fish farmers who adopted the activity. The study identified government support to farmers' through ESP, farmers' socio- economic factors and adoption of fish farming to be the study independent variables; farmers' Training, extension and advisory services to be the intervening variable; fish farming benefits in increasing production, farmers income and food security were the study dependent variable.

3.5 Target Population

The study targeted 1,566 fish farmers supported by government of Kenya to start small scale commercial fish farming in Nyeri County (MoFD, 2017). However, the study sample constituency (Mathira) population was 439 fish farmers. Therefore, 439 fish farmers supported through the ESP were indentified to be study population.

3.6 Sampling Procedure and Sample Size

Purposive sampling was used to identify sample constituency. Mathira constituency with a total population of 439 fish farmers, the highest number of fish farmers in Nyeri County constituencies was identified. The study selected a sample size of 343 fish farmers from the sample constituency (Mathira) in Nyeri County following Cochran formula (1963) as below;

$$n = \frac{n_o}{1+\left(\frac{(n_o - 1)}{N}\right)}$$

Where n = Study sampled size,

n_o = Sample constituency study population

N = County fish farmers' population

The study sample size was;

$$n = \frac{439}{1 + \left(\frac{439 - 1}{1566}\right)}$$

$$= 343.0509$$

Mathira constituency has two sub-Counties, Mathira West and Mathira East with varying number of fish farmers.' The distribution of the study respondents was proportionate to the number of fish farmers per each sub-County with Mathira West having a total of 208 respondents while Mathira East had 135 respondents

Simple random sampling was used to select the individual farmers from both Mathira West and Mathira East Sub-Counties, to be the respondents of this study. Lists of farmers from both Sub-Counties were sourced from the Sub-County fisheries department. The process to arrive at the individual farmers followed arranging the farmers last names alphabetically and serializing them. Corresponding serial numbers were written on a piece of paper, folded and put in a box per Sub-County. The box was shaken and the folded pieces of papers were picked one by one without replacement until the sample study population from both Sub-Counties was achieved.

Guided by the extension officers from the fisheries department from each Sub-County, the respondents' farms were traced, their GPS Coordinates taken **(Appendix III)** and later mapped as illustrated in **Figure 3.2.**

Purposive sampling was used to sample the key informants who included County and sub-County fisheries officer and the county development officers.

3.7 Data Collection Instruments

The research utilized both the questionnaires and interview schedules for data collection. Open-ended questionnaires, whose development was guided by the study objectives, were administered face to face to the sampled fish farmers **(Appendix I).** Interview schedules were administered to the key informants with help of an interview guide **(Appendix II)** and information gathered was used to clarify some information obtained from farmers.

3.8 Data Collection Procedure

Two research assistants per sub-County were recruited, trained on the content of the questionnaire and data collection ethics before the actual data collection.

Interviews were scheduled with the study informants using the interview guide in Appendix II. Their consent to tape record the interview was also sought for future clarification of some information.

3.9 Piloting of Data Collecting Instruments

Piloting and reconnaissance surveys were conducted in Tetu, the constituency with second highest percentage of fish farmers (Table 3.1). Simon (2011), a pilot study should consider a sample of 10 – 20% of the number of study participants. Purposive sampling was applied to select the participant and involved the fish farmers' beneficiaries of ESP support and the Tetu Sub-County fisheries officer.

From the pilot study, some questions were rephrased to reduce the ambiguity.

The pilot study results were used to test the reliability of the study instruments (Sekeran and Bougie, 2008) and computed using Cronbach, (2004), Alpha formula,

$$\alpha = \frac{N.\bar{c}}{\bar{v} + (N-1).\bar{c}}$$

Where: N= Number of items

$\bar{c}$ = Average covariance between item-pairs, and

$\bar{v}$ = Average variance

All the constructs had a Cronbach's Alpha coefficient greater than 0.7 (Pallant, 2001) and hence all the constructs were reliable for further involvement in the study.

3.10 Data Analysis

Completely filled questionnaires were collected. The responses given numerically coded before they were stored in a database template using statistical package for social sciences (SPSS) version 23 computer software. Later the data was described using frequencies, means, percentages and cross tabulations and presented by bar-graph, pie-charts and tables. Comparisons and associations of ratio and categorical data were done using Chi square following the equation described below;

$$\chi^2 = \Sigma \frac{(O-E)^2}{E}$$

Where;

χ^2 = Chi square

O = observed value

E = expected value

For objective one, logistic regression was used to determine the factors influencing adoption of fish farming in the study area as illustrated in the equation below;

$$P = \frac{e^{a+bx}}{1 + e^{a+bX}}$$

Where;

P is the probability of a 1

e is the base of the natural logarithm

a and b are the parameters of the model

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents results of the study following data analysis of the information gathered from questionnaires as guided by the study objectives. The study aimed at empirically investigating the effects of fish farming in Nyeri County, Kenya.

4.2 Response rate

Out of the 343 questionnaires that were administered, 222 were returned having been duly completed representing a return rate of 64.7%. The failure to secure 100% response rate was as a result of some farmers who had initially constructed fish ponds having abandoned fish farming at the time of the data collection. However, according to Edwards *et al.*, (2002), a response rate of above 60% is adequate to give credible findings and therefore the response rate from this study was considered sufficient.

4.3 Social–economic characteristics of the respondents

The study aimed to describe the socio-economic characteristics of the respondents with an aim of understanding the distribution of the key variables in Nyeri County

4.3.1 Age of the respondents

Majority of the respondents (32%) were aged between 35 – 44 years old followed by those aged 45 – 54 years (27%) while the least number of respondents (8%) were aged between 65 and 74 years old (Table 4.1).

Table 4.1: Distribution of Respondents by Age

Age Group	Frequency	Percentage
25-34	53	24
35-44	72	32
45-54	60	27
55-64	20	9
65-74	17	6
Total	**222**	**100**

Source: Field data, 2020

The distribution of fish farmers across age groups indicated that fish farming mainly attracted the middle aged farmers more than the older farmers. This is the age group that is considered to be the most productive, economically active and take risk at any viable income generating activity. Similar distribution was found by Maina *et al*., (2014), and Salau *et al.*, (2013), in Kenya and Nigeria, respectively, who noted that majority of fish farmers' were within the age brackets of 30 to 50 years.

4.3.2 Education level of the respondents

Majority of the respondents (35%) had secondary level of education, 34% had attained primary level and only 31% of the respondents had attained tertiary education level (Figure 4.1).

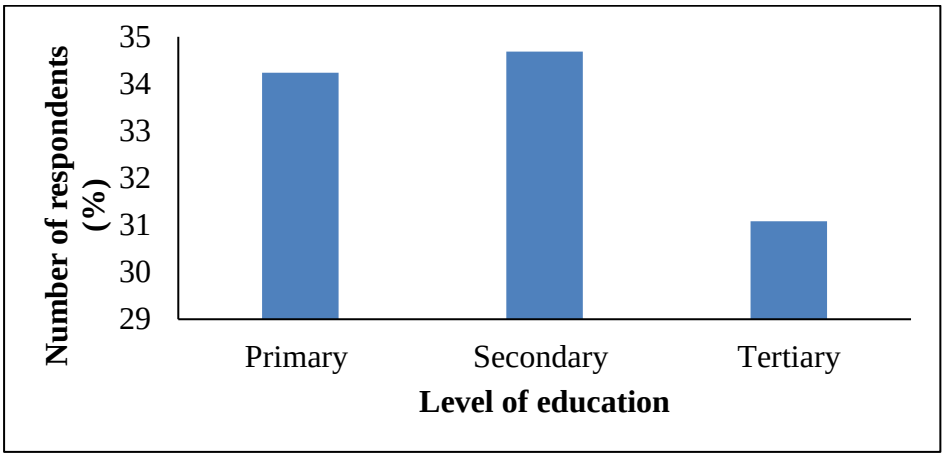

Figure 4.1: Distribution of Fish Farmers by Levels of Education
Source: Field data, 2020

This indicated that more fish farmers had moderate education levels and were in a capacity to adopt the different skills required to successfully implement fish farming. The observation was contrary to Wesonga, (2018) and Salau *et al.*, (2013) who observed that farmers with low education level were not likely to adopt fish farming since it was a high skills activity.

4.3.3 Family size

Majority of the respondents (54%) had family size not exceeding 4 members, 36% of the households had between 5 to 9 members and only 10% of the fish farmers were drawn from large families with more than 10 members (Figure 4.2).

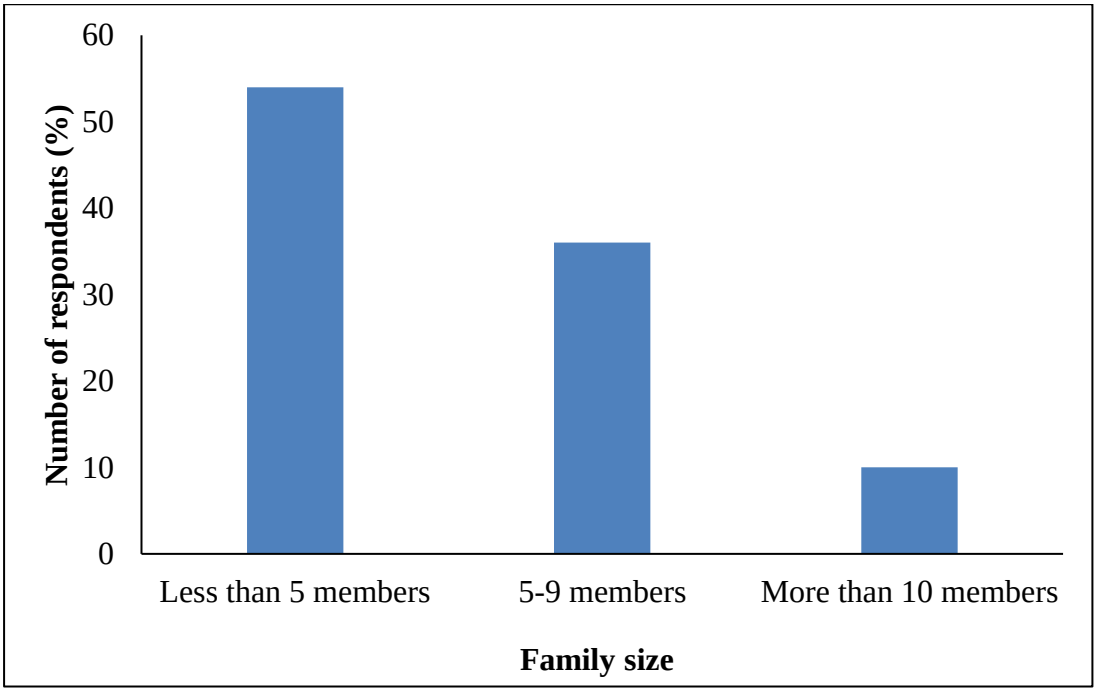

Figure 4.2: Distribution of Fish Farmers by Family Size
Source: Field data, 2020

The results indicate that the smaller families were likely to implement new innovations including fish farming for income generation. This agrees with Johan and

Pemsl, (2011) who noted that the smaller families were more likely to adopt the newly introduced practices more than large sized families.

4.3.4 Main occupation of the respondents

Majority (41%) of the respondents were small-scale subsistence farmers, 25% small-scale commercial farmers growing tea or coffee while the least number of respondents were casual employees (Table 4.2).

Table 4.2: Distribution of Fish Farmers by Main Occupation

Occupation	Frequency	Percent
Casual employees	12	5
Permanent employees	25	11
Self employed	40	18
Commercial farmers	55	25
Subsistence farmers	90	41
Total	**222**	**100**

Source: Field data, 2020

The findings indicated that prior to the introduction of fish farming under the ESP, majority of the respondents were small-scale subsistence and commercial farmers. This was because the program targeted small-scale farmers with land, water sources and those who were available for training sessions. The results disagree with Wesonga (2018) and Ngugi *et al.*, (2007) who found that majority of fish farmers were either in business or salaried professionals.

4.3.5 Respondents' main economic activity after introduction of ESP fish farming

After the introduction of fish farming, most (30%) of the respondents who took up fish farming took it as their main farming activity (Table 4.3).

Table 4.3: Current Respondent's main agricultural activity after introduction of ESP fish farming

Farming Activity	Frequency	Percentage
Fish Farming	66	30
Fruit growing	12	5
General subsistence farming	17	8
Coffee	60	27
Maize	30	14
Potato	20	9
Poultry	9	4
Dairy	8	4
Total	222	100

Source: Field data, 2020

4.4 Socio-demographic factors influencing adoption of fish farming in Nyeri County

Respondents' education levels, main occupation, group membership, training frequencies, land size and family size were significantly associated with adoption of fish farming in Nyeri County (Table 4.4).

4.4.1 Factors influencing willingness to adopt fish farming in Nyeri County

The Logit model for explaining factors influencing willingness to adoption of fish farming in Nyeri County was significant at $p<0.01$ and correctly predicted 86% of both those willing and unwilling respondents (Table 4.5). Five variables: age of the household head, family size, education level of the household head, membership to groups, frequency of fish consumption at the household and marital status were significant ($p<0.5$) in explaining the will to adopt fish farming in Nyeri County (Table 4.5) Age of the household head positively ($\beta=0.099$, $P=0.029$) influenced the willingness to adopt fish farming in Nyeri County (Table 4.5).

Table 4.4: Univariate results of socio-demographic factors influencing adoption of fish farming in Nyeri County

Socio-demographic characteristics		**No**	**Yes**	**$\chi 2$ Value**	**$\chi 2$ P value**
Marital status of the HHH	Married	69 (40%)	104(60%)	2.09	NS
	Single	14(29%)	35(71%)		
Education level of the HHH	Primary education	4(5)	72(95%)	90.41	0.001
	Secondary education	60(78%)	17(22%)		
	Tertiary education	19(28%)	50(72%)		
Main occupation of the HHH	Small-scale	32(22%)	116(78%)	67.53	0.001
	Medium-scale	6(29%)	15(71%)		
	Large-scale	45(85%)	8(15%)		
Training before initiating fish farming	No	4(31%)	9(69%)	0.26	NS
	Yes	79(38%)	130(62%)		
Follow-up trainings	No	15(40%)	22(60%)	0.19	NS
	Yes	68(37%)	117(63%)		
Group membership	No	22(27%)	59(73%)	5.70	0.012
	Yes	61(43%)	80(57%)		
Frequency of household consumption	Daily	15(48%)	16(52%)	4.63	NS
	Weekly	48(39%)	74(61%)		
	Monthly	12(26%)	35(74%)		
	At harvesting	8(36%)	14(64%)		
Training frequency	Weekly	46(38%)	75(62%)	9.85	0.007
	Bi-weekly	12(71%)	5(29%)		
	Monthly	23(30%)	54(70%)		
		Mean	**Mean**		**t-test**
Age of the HHH		43.79	42.04		NS
Size of the family		5.14	4.43		0.057
Land size		3.34	3.89		0.005

NS = Not significant at 10% confidence levels, HHH = Household head
Source: Field data, 2020

Table 4.5: Logit regression model analysis of factors influencing adoption of fish farming in Nyeri County

	B	S.E.	Wald	Sig.	Exp(B)
Age of the HHH	0.099*	0.045	4.758	0.029	1.104
Occupation of the HHH	-1.225	0.398	9.484	0.802	0.294
Education level of the HHH	-2.458**	0.55	20.002	0.001	0.086
Family size	0.971*	0.347	7.850	0.005	0.379
Land size	0.502*	0.042	1.667	0.002	0.294
Training before fishpond	0.087*	1.214	0.005	0.043	1.091
Follow-up trainings	0.602	0.558	1.166	0.280	1.826
Membership of the groups	3.28**	0.843	15.124	0.001	0.038
Frequency household consumption	0.627*	0.255	6.035	0.014	1.873
Marital status of the HHH	2.878	0.869	10.966	0.901	1.776
Training frequency	0.263	0.202	1.695	0.193	1.300

N=222, *Significant at 5% probability level, ** Significant at 1 % probability level
Source: field data, 2020

This implies that the willingness to adopt fish farming increased with an increase in age, therefore older the farmers had higher likelihood of adopting fish farming in Nyeri County. This could be explained by the old farmers having more experience in farming, may have mastered the art of farming and were therefore more likely to try out new innovations in their area such as fish farming. More so, the elderly farmers were more likely to have bigger pieces of land as compared to the younger farmers, which they could assign to fish farming. This agrees with Amsalu & de Graaff (2007) who noted that the older farmers were more likely to adopt new innovations in Ethiopia and that the argument that older farmers happen to be resistant to innovations might not hold true everywhere and at all times. These findings disagrees with He *et al.,* (2007) who notes that adoption of innovations is higher among younger farmers than among older farmers. According to Mwangi *et al*. (2015) age of the respondents indicated mixed effects on likelihood to adoption of innovations in Kalama suggesting that there could have been some other factors influence in play which was not included in model that could be explored.

Education level of the household head negatively (β=-2.458, P=0.001) influenced the willingness to adopt fish farming in Nyeri County (Table 4.16). This implies that the willingness to adopt fish farming was high among the household head whose education level was low (primary and secondary levels) which also implies that fish farming was not common among the high educated household heads. Outcome from various studies have indicated, technology complexity has a negative effect on adoption and this could only be dealt with through education (Mwangi *et al.,* 2015). However, fish farming being a more practical innovation imparted through practical training of doing and practicing other than complex innovation that would require scientific application, the farmers were more likely to adopt the technology with a lot of ease implying that the less educated were more practical and likely took up the innovation better than the more educated respondents.

Land size positively (β=0.502, P=0.002) influenced the willingness to adopt fish farming in Nyeri County (Table 4.5). This implies that the households who hold larger pieces of land were more likely to set aside small piece of land for the new technology on trial basis without compromising their regular flow of produce from the land. These findings agree with Amsalu & de Graaff (2007) who also found land size to be positive and significant, suggesting that farmers who hold large farms are more likely to invest in new innovations. This equally agrees that larger farms offer the owners flexibility in their decision-making, greater access to discretionary resources, more opportunity to use new practices on a trial basis and more ability to deal with risk (Mazvimavi & Twomlow, 2009; Zhang *et al.,* 2012).

Family size positively (β=0.971, P=0.005) influenced the willingness to adopt fish farming in Nyeri County. This implies that the will to adopt fish farming was high among the households whose family size was large. Since fish farming is a labour intensive agricultural practice, the larger family sizes were more likely to meet the labour demands with a lot of ease as compared to smaller families which agrees with He *et al.* (2007). According to He *et al*. (2008) larger family size is generally associated with a greater availability of labor and may positively influence the decision towards adopting new innovations. It could also imply that higher consumption pressure faced by their family (especially if large) may influence farmers' decisions to adopt innovations that solve some of their food and nutrients demands.

Group membership positively (β=3.28, P=0.001) influenced the willingness to adopt fish farming in Nyeri County. This implied that the will to adopt fish farming was high among the households that belonged to groups. It could also imply that the group provided the farmers with an avenue to share their experiences and therefore learn from each other. Groups are effective in persuading members to try new technologies and encourage sharing of knowledge and experiences among the members (Macharia *et al.,* 2014). According to Mwangi *et al*., (2015) groups are known for their multiplier effect among members, and therefore many change agents work in collaboration to implement their agendas.

Frequency of households' fish consumption positively (β=0.627, P=0.014) influenced the willingness to adopt fish farming in Nyeri County. This implied that the high the consumption of fish at the household level results to increased adoption of fish in

Nyeri County. This could be explained by the local demands for fish created at the family level which results to the families embracing these innovations to provide the necessary food demand for the family. This ends up promoting the chances of adoption of new innovations in the long run.

Training of the household heads prior to the ESP program positively influenced (β=0.087, P=0.043) adoption of fish farming in Nyeri County. This implies adoption of fish farming was more likely to take place among the farmers who had earlier been trained on fish farming. This agree with (Macharia *et al.* (2014) who noted that training is an important component of instilling skills and hence builds capacity of the target group and also acts as a vehicle by which profitable and resource conserving land management is locally promoted and widely adopted. Training overcomes constraints through providing appropriate knowledge and new skills and thus providing an understanding of what a technology entails and facilitates its efficient adoption and utilization (Daudu *et al.*, 2019).

4.5 The Effects of training to the adoption of small-scale commercial fish farming

4.5.1 Source on Information about the ESP fish farming program

Majority of the respondents (58%) got the information about fish farming from their area chiefs during chief *barazas*. Approximately 15.8% heard from the training officers who went around the farms recruiting farmers, 13.5% read about the program in newspapers while 10.8% heard about it from television sets and radio stations (Table 4.6).

Table 4.6: Source on Information about the ESP fish farming program

Source of Information	Frequency	Percent
Heard on TV/ Radio	24	11
Reading Newspapers	30	14
Word of mouth/ Chief's *Baraza*	128	58
Extension officers	35	16
All of the above	5	2
Total	222	100

Source: Field data, 2020

From the findings, government through the ministry of Agriculture employed a variety of strategies to reach to the potential fish farmers and inform them about the program. Word of mouth at Chief's *barazas* and from training officers convinced the larger percentage of fish farmers since they were able to explain to them the importance of fish farming on its income and food security benefits. This concurred with key informants' data on the methods they used to disseminate information about fish farming program and majority of them used word of mouth to pass the message concentrating mainly on the importance of fish farming. The word of mouth created a direct interaction with prospective farmers, explained the expected government support through the program and answered farmers' questions, fears and risks on fish farming. The key informants noted that the training officers and the chiefs jointly teamed up during the chief *barazas* to inform farmers on the fish farming program and its benefits to farmers and society (KI, K3, K4 interviewed, July, 2020).

4.5.2 Requirements for farmers to qualify for ESP support

All the respondents (100%) indicated that famers had to have more than half (½) acre of land and reliable water source from either a nearby river, taps or harvested from the house roofs. The key informants confirmed that, for one to qualify and benefit from the program as a fish farmer was required to own or have rented land and had reliable

supply of fresh water; since the two were major habitat components of fish. The government supported them with capital to construct fish ponds, provided initial fingerings and feeds and offered training services to the farmers.

4.5.3 Training methods

Recruited farmers were trained using different training methods. Most of the respondents (41%) identified class room training method as the most widely used method followed by practical method (40%) where models and demonstrations were used while 4% identified farm visits as methods of training used (Table 4.7).

Table 4.7: Training methods commonly used

Method	**Frequency**	**Percentage**
Classroom training (Formal lectures)	56	41
Practical and demonstrations	54	40
Sharing of information among through group discussions	20	15
Farm visit	5	4
Total	135	100

Source: Field data, 2020

Classroom method and demonstration were widely used because there were inadequate training officers and the program had definite training timelines. Therefore, the few trainers' chose to train with training methods that could suit to large group of trainees. They also chose a method they could cover a large content at a shorter time.

As reported by the key informants, training sessions were held before and after the recruitment of farmers. Training sessions before recruitment were organized and held during chief *barazas*. Farmers were sensitized on requirements, support to be given by

the program, importance and benefits of fish farming. After recruitment of farmers, training session continued on pond management skills.

4.5.4 Frequency of training sessions

Majority of the respondents (73%) indicated that trainings were held on weekly basis, 23% on fortnightly basis and 4% monthly (Figure 4.3).

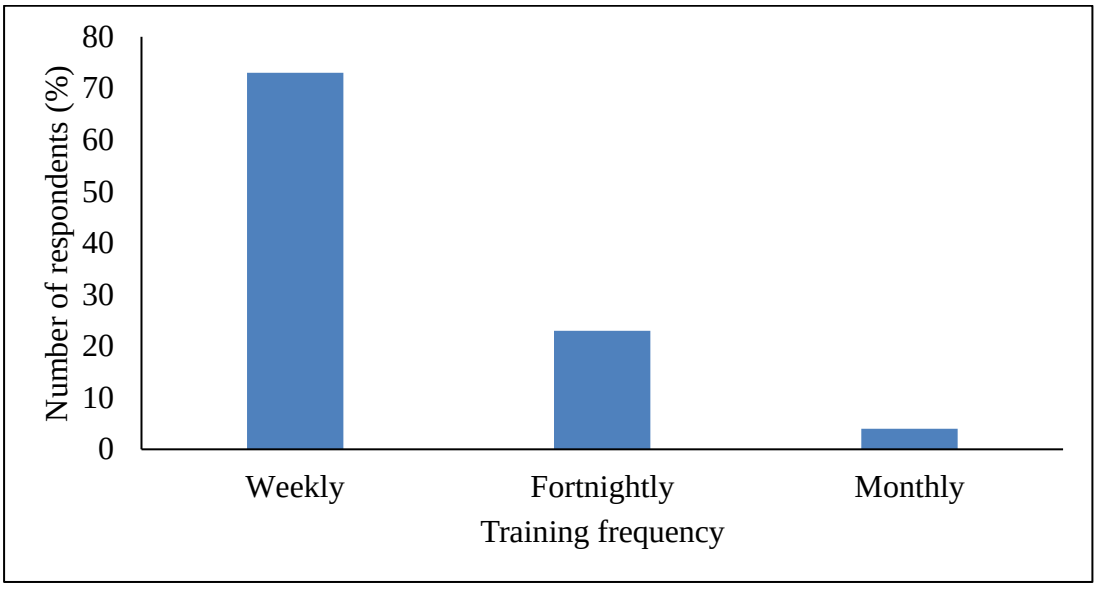

Figure 4.3: Frequency of training sessions
Source: Field data, 2020

4.5.5 Training areas under ESP influencing adoption of fish farming

The result revealed that there were regular training sessions since government had allocated training fund to the county fisheries department (K5, May 2020). Most (63%) of the respondents were influenced by the content on fish farming as business and the income benefit they could yield form fish farming, 15% by flexibility and ease on fish management, 14% by availability of fish market in local and urban market and 8% by construction of fish pond (Figure 4.4).

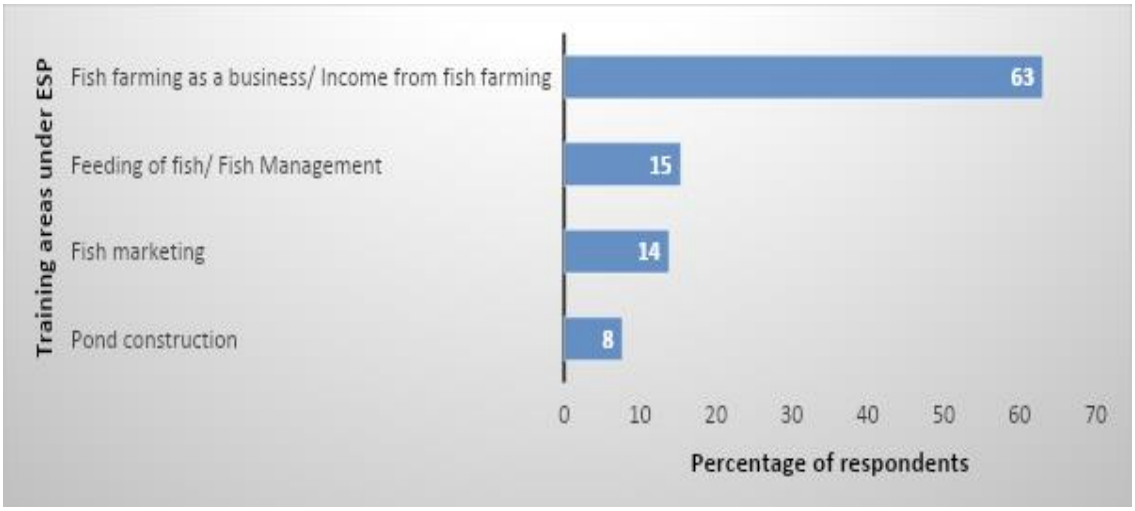

Figure 4.4: Training areas influencing adoption of fish farming
Source: Field data, 2020

The data reveals that much emphasis was on fish production and its benefits compared to other forms of agriculture practiced in the area, since trainers wanted to influence farmers to adopt the new practice of fish farming. This made farmers to believe that fish farming was easy and profitable business.

4.5.6 Frequency of follow-up training

The study sought on follow up training at the farms after the establishment of fish ponds. Majority (83%) of the respondent agreed that there were follow up in the farms while 12% said that there were no follow up training. The frequency of follow up training from the respondents who had indicated their presence were sought and categorized in weekly basis, fortnightly, monthly or on request, their responses were summarized in the figure 4.5 below.

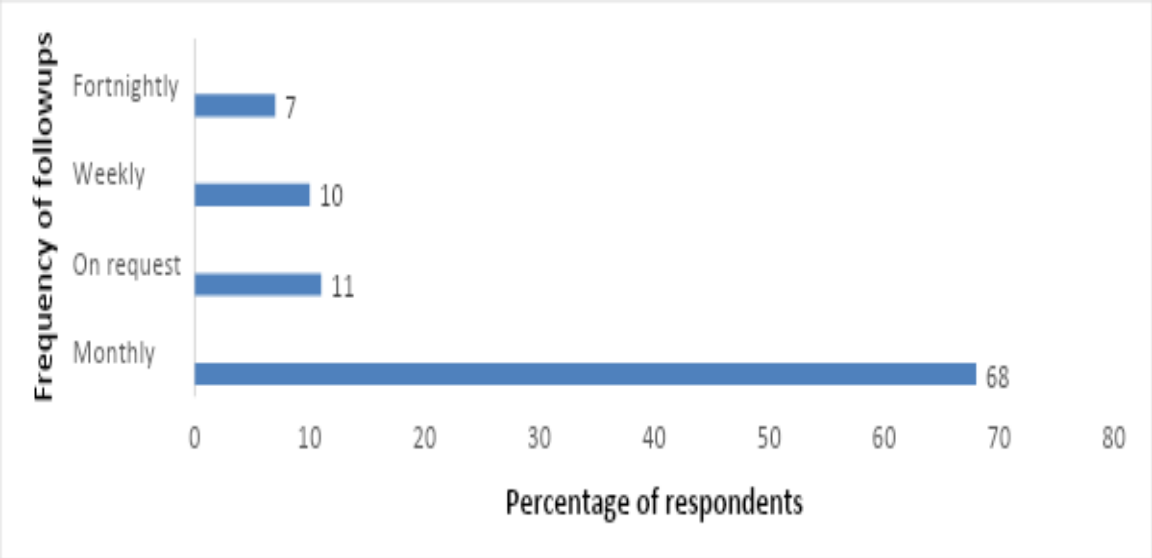

Figure 4.5: Frequency of carrying out follow-up in the fish farms
Source: Own data, 2020

Majority (68%) of the respondents had one follow-up training monthly, 11% had to request for a farm visit training, 10% were visited on weekly basis while 7% fortnightly. This indicated that the frequency of contact between trainers and farmers drastically reduced from weekly to monthly since the ratio of training personnel to that of farmers was high. This hampered the pond management practices and farmers relied on farmer to farmer consultation. This supported the observation by Oloo, (2011) that inadequate extension services made farmers take long to realize good returns from their ponds in the first years.

4.5.7 Training frequencies

Most (90%) of the respondents were trained on fish pond construction for example ponds depth and lining, 95% on identification of types fish, 91% on fish harvesting and 97% fish marketing and preparation (Table 4.8). Only 36% of the respondents were trained on fish diseases, parasites and predators control. Farmers were trained adequately on pond construction, types of fish since it was done practically during the

pond construction and stocking. Indeed, training on harvesting and fish marketing was emphasized to elicit farmers' interest to adopt fish farming.

Table 4.8: Frequencies of training on specific fish farming activities

Fish farming areas/ Training condition	Pond construction		Identifying of fish types		Fish feeding		Fish diseases, parasites and predators		Fish harvesting		Fish marketing and preparation	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Trained	220	99	211	95	191	86	79	36	201	91	216	97
Not trained	2	1	11	5	31	14	143	64	21	9	6	3
Total	222	100	222	100	222	100	222	100	222	100	222	100

Source: Field data, 2020

4.5.8 Shortcoming of fish farmers training

Majority (41%) of the respondent cited training methods to be the major training constraint, 23% the language used during training sessions hindered effective delivery of the content, 21% cited that funds to reimburse their fares and lunch, 10% and 5% cited lack of follow up farm trainings and training materials respectively (Table 4.9).

Table 4.9: Shortcoming of fish farmers training

Challenges	Frequency	Percentage
Ineffective training methods	91	41
Insufficient training funds	47	21
Training language barrier	51	23
Inadequate follow up trainings	22	10
Inadequate training materials	11	5
Total	222	100

Source: Field data, 2020

Methods of training were the major challenge cited during training because of the time constraints and few numbers of trainers. This was followed by language barrier since some trainers were from other ethnic communities and used the technical

language during the training sessions. Also there were limited follow up trainings in the farms to clarify and demonstrate training areas that were ambiguous. Further, training material like brochures were limited and farmers lacked reference materials in case of any problem. Data from key informants indicated that training sessions were hurried, follow up training were limited and inadequate of training material. This confirmed that there were shortcomings on methods of training, timeframe of farmers training and the number of training personnel. This made the training sessions to be hurried and adopt a classroom scenario with chalk board and manila displays. Further, they rated the attendance for the sessions to be good despite some complaints on reimbursement of fare and lunch which were given to participants in cash after the training sessions (KII, KIII and KIV interviewed, April, 2020).

4.5.9 Strategies of improving the training program

Most (74%) of the respondents wished trainer to slow down their speed and use demonstration method, which are friendly to the target participants, 13% opted for increasing follow-ups, 8% favored emphases on pond management practices and 5% for increased funding for the training program (Table 4.10).

Table 4.10: Strategies of improving the training program

Strategy	Frequency	Percent
Improve on the method of training by making it slower and employ demonstration method	145	74
Increase follow-ups	25	13
Emphasis on pond management and fish feeding	15	8
Funding	10	5
Total	195	100

Source: Field data, 2020

This indicated that additional number of trainers would increase the frequency of training and follow-up. Increased of contact hours between farmers and trainers help

farmers to acquire and inquire more on fish farming techniques and on solutions to the problems they face mainly on pond management practices.

4.5.10 Association between training and adoption of fish farming activity

The training offered to the farmers through the ESP was significantly associated with adoption of fish farming by the farmers (χ^2 = 98.571, P=0.001). Indeed prior fish farming training of household heads positively influenced adoption of fish farming in Nyeri County at (β=0.087, P=0.043) as indicated in logistic regression Table 4.4. This indicated that the training offered to farmers on pond construction, pond management, harvesting and marketing of fish influenced farmers to adopt fish farming. This is because farmers found fish farming to be simple after pond construction which was funded by the program, flexible with high yields in six months. Therefore, the hypothesis that training services had no positive contribution to adoption of ESP small-scale commercial fish farming in Nyeri County was therefore rejected.

4.6 Effect of Small-Scale Commercial Fish Farming on Farmers' Incomes

4.6.1 Source of market for fish products

Most of the respondents (45%) sold their fish to the fish factory located at Wamagana, 37% went to local buyers (vendors) at farm gate price, while 11% were sold at the roadside to pedestrians and motorists, 5% at the Sub-County coolers who were factory agents and 2% sell their fish products to schools (Figure 4.6).

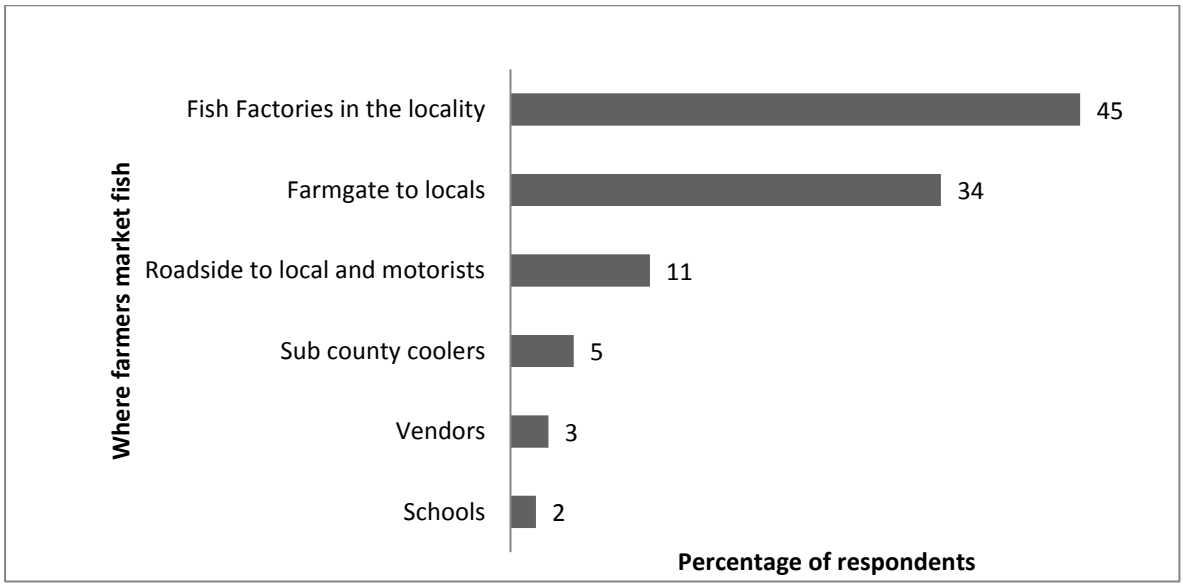

Figure 4.6: Where farmers market their fish products
Source: Field data, 2020

The results indicated that the farmers were able to access various market outlets where they sold their fish since there were ready markets for their produce. The markets were created by the program through putting up of fish processing factory in the county and sensitizing the public on importance of consuming fish. The key informants concurred that local demand for fish was on the rise and soon it will supersede the local supply of fish. They mentioned vendors, Wamagana fish factory and local community as the main market outlets; in addition, newly opened fish eateries in the nearby towns like Karatina and other shopping centers had widened the demand for fish as well promoting fish consumption in the area (KI, KII, KIII KIV and KV interviewed, April, 2020).

4.6.2 Fish farmers' associations

Most of the respondents (79%) indicated that they were members of fish farmers' organization, however, the organizations were not used to market farmers produce. Instead, about 82% of the respondents benefited by sharing experiences with other

members of the organization on pond management practices, challenges, deciding on fish pricing index and fish prices. The above observation supported Akinbile, (1998) observation that fish farmers who have membership in fish farming associations or co-operatives tend to be successful fish farmers through sharing their common challenges and setting the prices of their produce to eliminate competition and sustainability of their ventures.

4.6.3 Frequency of fish marketing

The study established that 61% of the respondents had regular commercial fish vendors who bought produce from farms and sold them at the local markets. Approximately 38% of the respondents had rare visit by fish vendors to buy fish from their farms, 33% were visited by the vendors fortnightly, 5% yearly and 8% each on monthly and weekly basis (Figure 4.7).

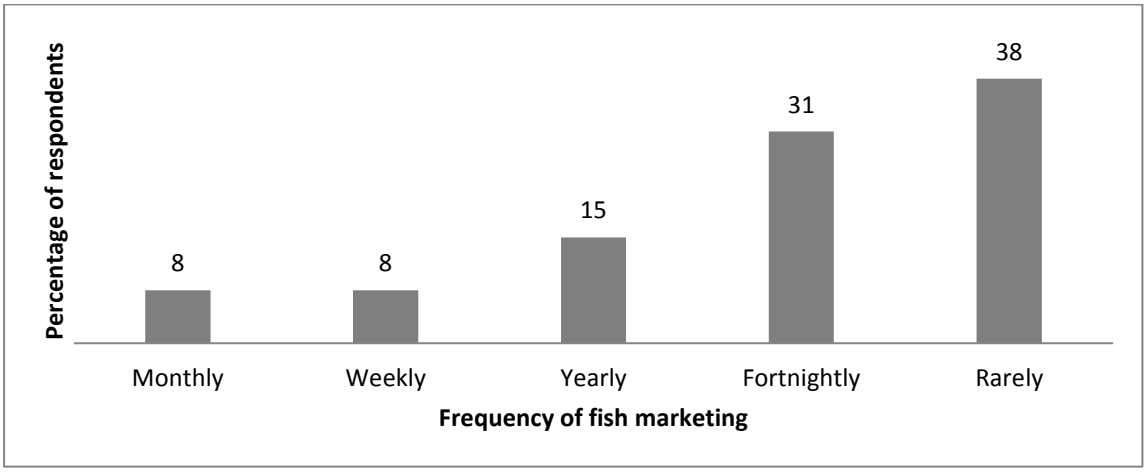

Figure 4.7: Frequency of fish vendors to fish farms
Source: Field data, 2020

This indicated that fish vendors visited the farms for purchase of fish, however their visits were rare since fish takes six months to mature and vendors bought where there was supply. They therefore inquired about farms with ready fish for harvesting before

visiting the farms. Therefore the study found that, there were many fish vendors who visited fish farms whenever there are ready fish for harvesting.

4.6.4 Number of fish vendors visiting farms

Most (72%) of the respondents had less than five vendors, 11% had 20 - 30 vendors, 6% each had 5 - 10 and 10 - 20 vendors and 5% of the farmers more than 30 fish vendors visiting their fish farms (Table 4.11).

Table 4.11: Number of vendors visiting fish farmers at the farms

Number of vendors	Frequency	Percent
Less than 5 vendors	160	72
5 -10 vendors	13	6
10 - 20 vendors	13	6
20 - 30 vendors	24	11
More than 30	11	5
Total	222	100.0

Source: Field data, 2020

This indicate that there were large numbers of fish vendors who visit the farms to buy fish, depicting that rare visits to the farms were as a results of low supply of fish from each farmer. Therefore, there was a large market for fish farmers from vendors apart from the processing factory and at no time there was lack of market for their produce. This guaranteed income to farmers on the quantity produced from the farm. Moreover, during the construction of fish ponds at the initial stages Gachucha *et al., (*2014) observed that it created employment to the youths who were involved in digging out the fish ponds.

4.6.5 Types of labour used in the fish farms

Majority (52.7%) of the respondents engaged casual labour depending on the labour needs, 45% used the family members to provide labour requirement in the fish farms and 2.3% of fish farm workers were permanent (Table 4.12).

Table 4.12: Types of labour used in the fish farms

Type of labour	Frequency	Percent
Permanent workers	5	2.3
Casual Laborers	117	52.7
Family employees	100	45.0
Total	222	100.0

Source: Field data, 2020

Fish farming created employment for family members and to other surrounding people. This increased family income since the family members engaged were rewarded in terms of salaries or shared profits from the fish farming.

4.6.6 Factors that determine fish price

Most(55%) of the respondents determined fish prices by the size and weight of the fish, 39% by fish species since different species had different prices per unit or size and 6% price of fish was driven by demand and supply forces (Table 4.13). The size, weight and species of fish were the major determining factors of the prices of fish since farmers invested in fish feeds and time to grow their fish to marketable sizes.

Table 4.13: Factors that determine fish price

Factor	Frequency	Percentage
Size and weight	122	55
Types	87	39
Market force demand	13	6
Total	222	100

Source: Field data, 2020

4.6.7: Market price of fish

The respondents sold their fish produce to the factory at Kenya shillings 350 per kilogram and Kenya shillings 250 for tilapia and catfish types respectively. They also sold at farm gate to the vendors, motorist, neighbours and pedestrian at Kenya shillings 300 for tilapia and Kemya shillings 200 for catfish. 97% of the farmers preferred selling their fish at farm gate (Table 4.14).

Table 4.14: Unit prices of fish

Type	Factory price per Kg	Farm gate price per Kg
Tilapia fish	350	300
Catfish	250	200

Source: Field data, 2020

This was because at farm gate the mode of payment was cash, unlike the factory which made payment after two weeks and sometimes after one month. More so, there were additional transport costs to farmers, since they had to transport their fish to the Sub-County coolers for collection by factory van. According to key informants K1 K11 and KV, the weight and size of fish ready for harvesting had to be above 250grams (table size fish) mainly achievable in six months depending on the size of the fingerings at stocking, temperature of ambient water and types of feeds and feeding management.

4.6.8 Quantities of fish production from each fish pond

Majority (57%) of the respondents harvested 600 – 650 pieces of tilapia fish in a 300m^2 fish pond, 18% 500 – 550 tilapia fish, 16% 650 – 700 pieces, 4% between 500 – 550 pieces and 3% and 2% below 500 and above 700 pieces (Table 4.15). This gives a mean production of 614 pieces of fish in 3000 cm^2 fish pond. The tilapia fish harvested weighed between 250grams and 550 grams, the mean weight according to informant KI and KII is 375 grams. Therefore, a fish pond produced approximately of 230.25kilograms of fish in six months. This translated to an average turnover of Kenya shillings 69,075.

Table 4.15: Quantities of fish production from each fish pond

Quantity/number of fish caught per 3000m^2	Frequency	Percentage
Below 500	7	3
500 – 550	9	4
550 – 600	39	18
600 – 650	126	57
650 – 700	36	16
Over 700	5	2
Total	222	100

Source: Field data, 2020

4.6.9 Economic returns from fish farming

Most (56.8%) of the respondents yielded between Kenya shillings 60,000 – 70,000 from one 3000cm^2 fish pond, 19.8% between Ksh50,000 – 60,000, 19.4% between Kenya shillings 70,000 – 80,000, 2.2% and 1.8% below Kenya shillings 50,000 and above Ksh80,000 respectively (Table 4.16). This indicated that 78% of farmers earned above Kenya shillings 60, 000 from one fish pond. The average expected earnings from one fish pond were Kenya shillings 69, 075, a farmer earning above Kenya shillings 60,000 made profits from fish farming investment. This indicated that 78% of the fish farmers earned profits from their fish farming.

Table 4.16: Return from a 3000m^2 fish pond in 6 months in Kenya shillings

Amount in Kenya shillings	Frequency	Percentage
0ver 80,000	4	1.8
70,000 – 80,000	43	19.4
60,000 – 70,000	126	56.8
50,000 – 60,000	44	19.8
Below 50,000	5	2.2
Total	222	100.0

Source: Field data, 2020

4.6.10 Benefits of fish farming

When asked whether there has been a significant change in their income since they started farming fish, 90% of the respondents reported an increase in household

income. They were able to finance their household financial need like paying their children school fees and buying family assets like television, radio and chairs. Most (25%) of the respondents used the income from fish farming to pay school fees, 18% to increase their fish farming investment, 18% on domestic uses such as buying foodstuffs and clothing, 15% to servicing loans, 15% to start other investment projects, 5% to boost their savings and 3% improved their family houses and acquire some assets. 61% of the farmers expressed interest to invest more on fish farming by constructing additional fishponds indicating that fish farming was profitable, 20% of the farmers had no plans for constructing more fish ponds and 19% of the farmers were not sure about whether they would invest more in fish farming (Figure 4.8).

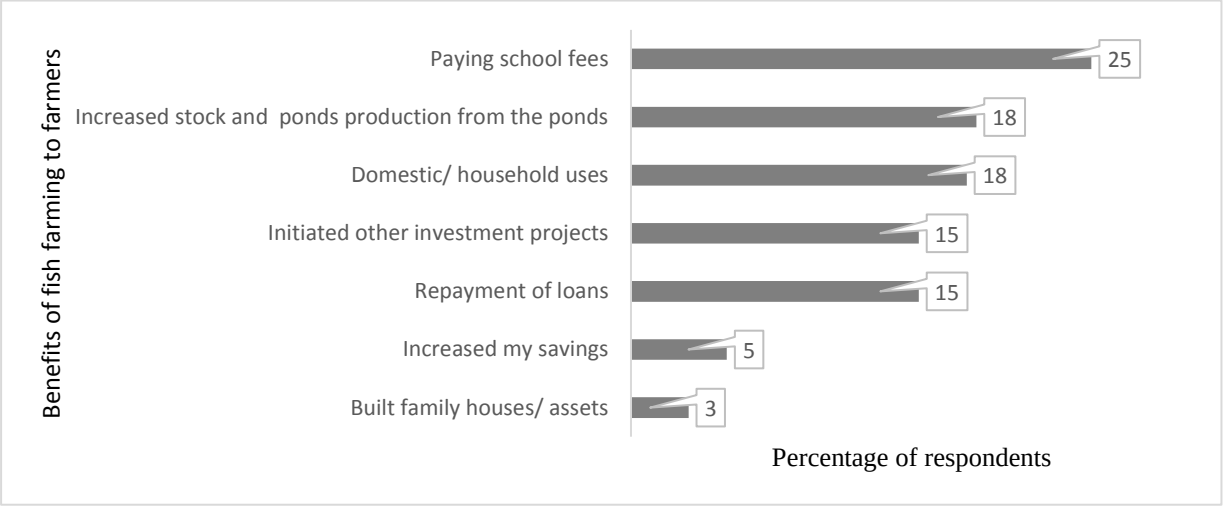

Figure 4.8: How farmers have benefited from the income from fish farming
Source: Own field data, 2020

4.6.11 Reasons for increased investment in fish farming

Majority (91%) of the respondent wished to increase fish productions and boost their household income, 6% wanted to rear different varieties of fish species like Gold fish, Koi carps and Mollies which are ornamental fish to diversify and modernize fish farming, 6% wanted to utilize knowledge obtained on fish farming by establishing

demonstration farms to train other farmers (Figure 4.9). Despite varied responses, farmers were focused on increasing production and diversify fish species to attract larger market and increase their income.

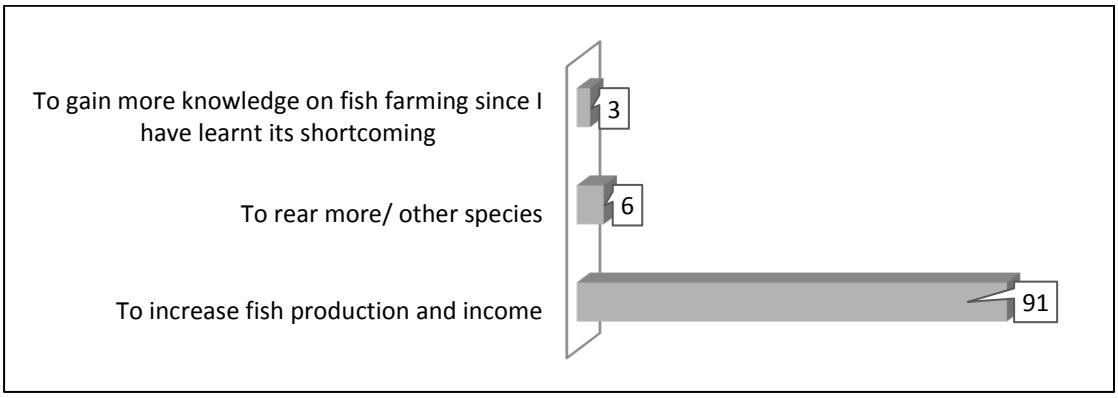

Figure 4.9: Reasons for increased investment in fish farming
Source: Field data, 2020

4.6.12 Association between adoption of ESP fish farming and Increase in farmers' income

There was a statistically significant association between the adoption of small-scale commercial farming under ESP and increase in farmers' incomes (χ^2 = 58.068, p=0.001). Consequently, the hypothesis that the adoption of ESP small-scale commercial fish farming had no significant increase on farmers' income in Nyeri County is rejected. Therefore, the adoption and establishment of fish farming have increased farmers' incomes enabling them to educate their children, improve their saving, meet their domestic financial needs and procure some household assets.

4.7 Effect of Small-Scale Commercial Fish Farming on Household Consumption Pattern

4.7.1 Frequency of family fish consumption

Most (54%) of the respondents fed their families with fish at least once in a week, 44% daily and 2% at least once in a month. This indicated that fish farmers' families fed on fish regularly because they were aware of their nutritional value supplementing other sources of proteins since they were available at their fish ponds and they were able to prepare them with ease (Figure 4.10).

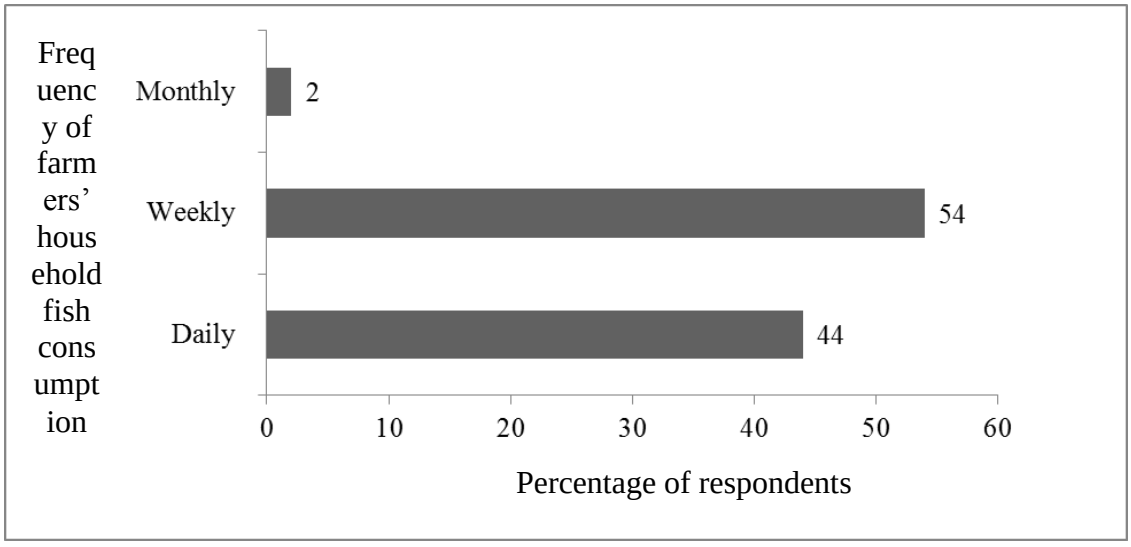

Figure 4.10: Frequencies of farmers' families' fish consumption
Source: Field data

4.7.2 Quantities of fish bought by the communities

Most (43%) of the respondents sold 1.5 – 2kg of fish to each member of the non-fish farmers or neighbour in single visit, 38% sold between 1 – 1.5kg of fish, 9% between 2 – 3kg, 7% between 3 – 4 kg and 3% below 1 kg of fish (Table 4.11).

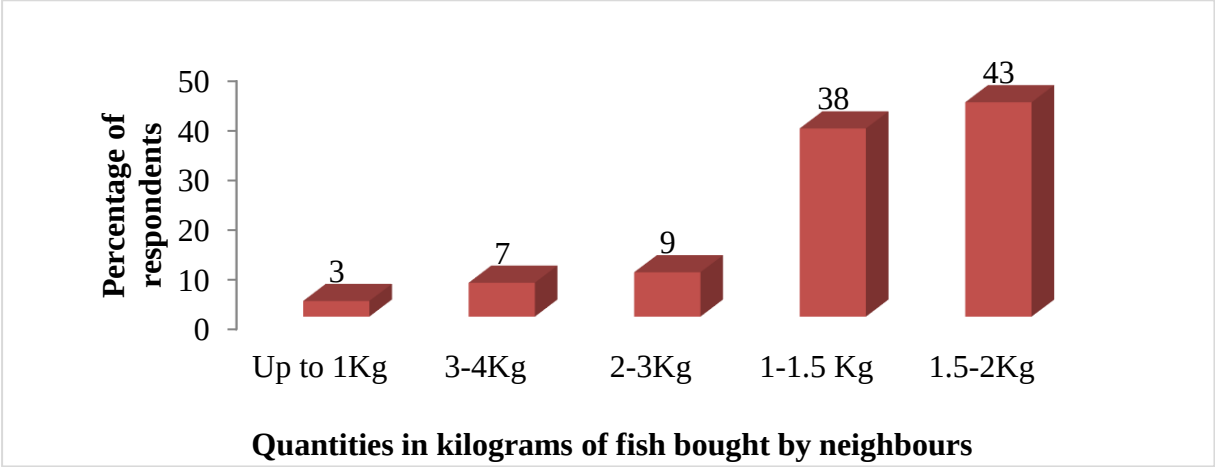

Figure 4.11: Quantities of fish bought by non-fish farmers/community members
Source: Field data, 2020

This revealed that varied quantities of fish were bought by local community members depending on their purchasing power and size of their families. Majority at 81% bought quantities ranging from 1 - 2kg, the range indicated that the amount bought were for their families' consumption and not for sale. This revealed that majority of the rural population consumed fish portion in their diet on daily or on weekly basis since it was cheap compared to other sources of meat protein portions and was readily available at the neighbourhood. This translated that fish farming influenced the uptake of fish by the members of the community and changed community consumption patterns. In addition, the key informants reported that the prevalence of fish consumption in the localities had increased in recent times supplementing the sources of white meat in the local market and eateries. This was because of enlarged local supply of fish from farmers' fish ponds, awareness of the fish nutritional value and improved methods of fish preparation in the area. (KI, KII and KV interviewed, April, 2020).

When asked whether the sales to the local market were increasing or decreasing, 90% of the respondent indicated that there was a notable increase in community sale volume of fish and 10% reported that sale volumes was constant. This indicated that community market for fish was widening by introduction of small-scale commercial farming.

4.7.3 Reasons behind increased fish consumption

Majority (61%) of the respondent attributed the increase in the sales volumes to the increased demand for fish due to the growing popularity of fish consumption by the old and the young population. About 23% to increased fish supply because of the improvement on pond management and fish production and 13% to affordable prices of fish. However, 4% did not know why there was an increase in the sales volumes in the local market (Figure 4.12). The above information revealed growth in awareness of nutritional value of fish by the local population and led to increased demand for fish from the community members.

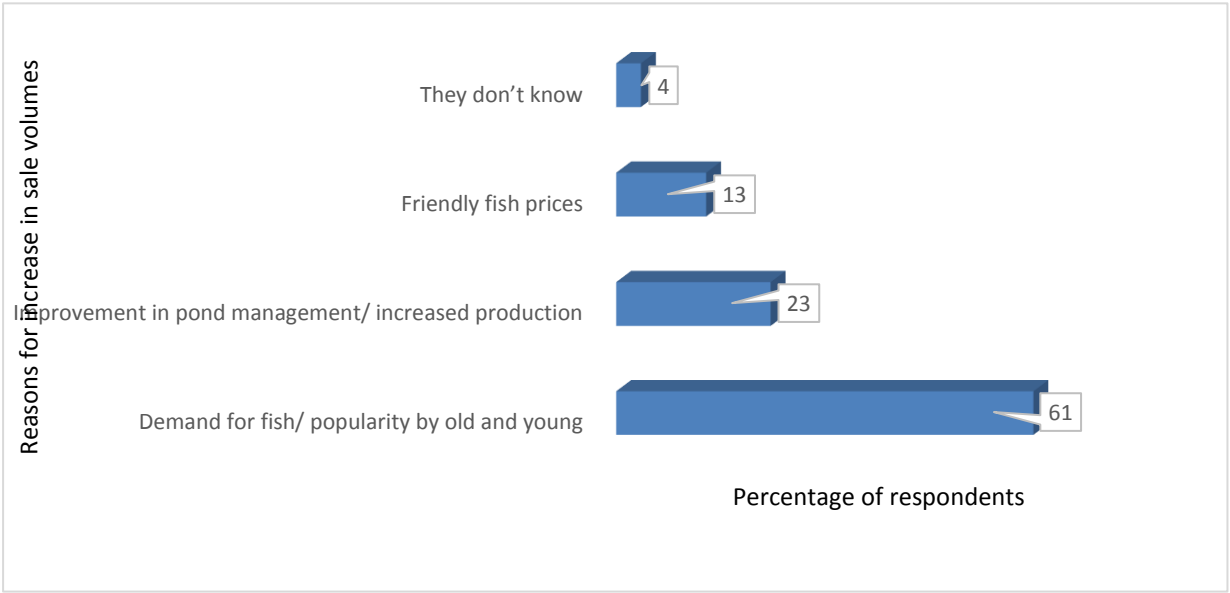

Figure 4.12: Reasons for the increase in sales volumes from the local markets
Source: Field data, 2020

This was because members of the community had information of the health gains from fish eating and had changed their attitude towards fish. Further, the study sought to establish whether the farmers were able to sufficiently satisfy the increased demand for fish by the community members. 59% of the respondent observed that their production sufficiently satisfied the demand and 41% of the respondents indicated that demand for fish was higher than the supply. This implied that fish consumption in the area was high and surpassing production from the farmers. The study identified that 95% of the respondents observed a positive change on the fish consumption by local community, most of the respondents (56%) attributed the positive change on fish consumption to increased awareness of health benefits of fish, 16% to fish affordability, 14% to tasty fish being produced, 12% to improved methods of cooking fish and 2% to improved fish availability as shown in fig. 4.12 above.

This revealed that the members of the community accepted fish in their diet since it was improving their health; it was available and had learnt cooking of tasty fish in their homes and at food eateries. For the farmers who reported that there was no positive trend in the consumption of fish 67% attributed it on production level that were low despite steady fish prices and 33% attributed it to inability to afford despite the will to buy for their family members. This implied that the community had changed it perception on fish consumption and fish was their preference when they can afford.

This above information indicated that fish farming and the consumption of fish had been accepted in the study area and there was need to increase fish production to meet the growing demand. There was a significant association between the adoption of small-scale commercial farming and increased fish consumption at ($\chi 2$ = 120.313,

p=0.001). Consequently, the hypothesis that the establishment of ESP small-scale commercial fish farming had no significant increase on household fish consumption in Nyeri County is rejected.

4.8 Challenges facing fish farming in Nyeri County

Most (88.7%) of the respondents were faced by low quality but highly priced fish feed, 86.5% received inadequate extension services and 80.2% lacked quality fingerings (Table 4.17).

Table 4.17: Frequencies of farmers facing technical challenges in fish farming

Technical challenge	Frequencies	Percentages
Inadequate follow up services	192	86.5
Poor quality fingerings	178	80.2
Low quality highly priced fish feeds	197	88.7

Source: Field data, 2020

The findings indicated inadequacy of fish feeds in the area, stockiest who had, sold them at high prices, while others mixed them with cattle feeds lowering their quality. Follow up extension services at farm were rare, being a new practice, fish farmers lacked timely consultation on emerging challenges at their farms. This was because the study constituency had only two fisheries officers with only one operational motorcycle which was to provide means of transport for the extension officers. The vastness of the constituencies and farmers' attention needs made one officer attend on average to three farms daily, the rest of the farmers consulted amongst them.

Farmers complained that the initial fingerings stocked to their fish ponds took long to mature, even after feeding them for more than six months they hardly attained 250grams. Other fish ponds were stocked with male and female fingerings unlike the

required mono-sex fingerings; hence they mated and overpopulated the ponds. This resulted to stunted growth.

On fish pond management challenges, the study further classified them into two categories; flooding of the ponds, fish predators and diseases. Majority (82.9%) of the fish ponds of the respondents were infested by fish predators and diseases in their fish ponds. 76.1% of the respondents, some of their stocked fingerings were swept by floods as a result of sudden heavy rainfall. The study found an interrelationship between the two challenges and attributed the challenge to inadequate pond management strategies and follow-up trainings to equip farmers of pond management skills. This was because farmers located their fish ponds away from their homesteads in fear of them becoming the breeding grounds. Those who placed them near the homesteads; they harvested rain waters from the roofs and drained them into fish ponds. When it rained, due to the gentle sloping terrain of their lands, surface runoff drained in to the fish ponds depositing silt and tadpoles to the ponds. Some ponds got flooded, washed away the fingerings, and deposited tadpoles that started to feed on the remaining fingerings, a predator that farmers were not aware for. Those who had harvested water from the roofs failed to disconnect the drain pipes; fish ponds got filled up and overflew sweeping off fingerings. The study found that 96.2% and 86.7% of the respondents were not aware that frogs and floods were great threats to fish farming. 97% of the respondents found rain season to be a blessing to help them curb the water challenge as emphasized during training sessions however, it turned to be a threat to their fish ponds. Therefore inadequacy of follow up training was found to be the main undoing of fish farming at initial stages of fish farming business. Similar to an observation by Oloo, (2014), that inadequate extension services led to

farmers not realize their profits in the first phase of fish farming program in Kisumu County.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter discusses the study results and presents the study conclusion. The results obtained from the statistical analysis and information collated from the content analysis formed the basis of this summary and conclusion. The chapter further provides policy recommendations and suggested areas for further research. The summary was structured per the study variables and analyzed within the framework of the research objectives.

5.2 Summary of the key findings

The study sought to determine the socio-economic factors influencing adoption of fish farming in Nyeri County. Results indicate that age of the household head, family size, membership to farmer groups/associations, frequency of fish consumption at the household and marital status positively influenced adoption of fish farming in Nyeri County. However, education level of the household heads negatively influenced adoption of small-scale commercial fish farming in Nyeri County.

The study sought to establish the influence of training to adoption of fish farming. The study found out that government through the ministry of Agriculture employed a variety of strategies to inform on fish farming program; they included sensitization meeting organized by the chiefs in their respective locations, advertisement on newspapers, radios and television programs. The Word of mouth at Chief's *Barazas* and from training officers created the greatest awareness on fish farming. They explained the expected gains from fish farming and government support through the program. Farmers who owned or rented land, had reliable source water and attended

the training sessions were selected to benefit from the program. Majority were selected during the sensitization meeting at chief's *Barazas*. They were later supported with capital to construct fish ponds, fingerlings, fish feeds and training.

The study observed that classroom and demonstration methods were widely used to train farmers by the training officers. This was because there were few training officers and set timeline for training, hence trainers used the suitable methods to large group of trainees in short period of time given. Training sessions were frequent; in most cases weekly since they were sponsored by government through the state department of fisheries. Farmers were trained on pond construction, fish species selection, fish feeds and feeding, fish pond management, fish harvesting and marketing. The study realized that much emphasis was put on profitability of fish farming and its benefits over other farming activities in the area and this greatly influenced farmers to adopt fish farming.

However, farmers training had various shortcomings; they included; technical language used during training sessions that hindered effective delivery of the content, insufficient funds to reimburse trainees fare, inadequate follow up farm trainings and inadequate training materials. Further, limited follow up training at farms because of inadequate training personnel resulted to farmers been poorly equipped on areas of fish diseases, parasites and predators control. Data obtained on effects of farmers' training on fish farming was subjected to Pearson Chi Square test whose results were (X^2=98.571, P = 0.001) and logit regression (B = 0.087, P = 0.043) indicating positive influence of prior training to adoption of fish farming in Nyeri county rejecting the null hypothesis that farmers training had no influence on adoption of fish farming in Nyeri County, Kenya.

The study sought to find the effects of fish farming on farmers' income. The study found that fish farmers marketed their produce through a number of market outlets. They included; farm gate to vendors and local community, at Wamagana fish factory and at the road side to pedestrian and motorists. The study found out presence of ready large local Market for their produce and resulted to improvement of fish farmers' household income. This enabled 25% of them to pay their children school fees, 18% to increase their fish stocks, 18% to meet their domestic financial needs, 15% to service their loans, 15% to initiate other investment project, 5% to increase their savings and 3% even to procure family assets. Fish farming sourced 41% of its labour from family members widening sources of family income. The increased income from fish farming inspired 61% of the farmers to expand their fish farming business. Others (6%) wanted to diversify fish species widening their market to further increase their income. The information obtained on farmers' income were subjected to Pearson chi square test whose results a significant association between fish farming adoption and increased farmers income at $X^2 = 58.068$, P=0.001 rejecting the null hypothesis that fish farming had no significant effects on farmers' household income in Nyeri County.

The study sought the frequency and quantities of fish bought by the non-fish farmers/neighbours and revealed that 90% of non-fish farmers frequented fish farms to buy fish weekly at a cumulative percent of 92%. A cumulative percent of 81% of frequent non-fish farmer customers bought between 1 – 2 kg of fish per visit. The study also found that some of those who bought at the farm gate did so with an intention of selling to the local markets. Further the study found that 90% of the farmers reported increased sales in volume to the local population, indicating

increased fish consumption by the local population which later increased the demand for fish from farmers. 61% of the farmers attributed the increased demand for fish to the growing popularity of fish among the old and the young due to its nutritional value, while others attributed it to improved supply and prevailing friendly fish prices. 95% of the farmers attributed the increased demand for fish to positive change of attitude towards fish eating, 56% to increased awareness of the fish nutritional value, 16% to affordable prices, 14% to taste, others to improved preparation method and accessibility of fish. By use of chi square the study realized an association of X^2 = 120.313, P=0.001 rejecting the null hypothesis that fish farming has no significant effects on farmers' household fish consumption in Nyeri County, Kenya.

The study found that farmers were faced by various challenges due to inadequate follow-up training, poor quality fingerings and highly priced low quality fish feeds. Inadequate follow-up was caused by inadequate number of extension officer with inadequate means of transport. This led to farmers' failures on predator and floods control in their fish ponds. The study further found that there were inadequate quality fish fingering and fish feeds. Farmers were therefore stocking their ponds with low quality multi-sex fingerings that overpopulated the ponds, hence stunted growth and death of some fingering. Moreover, the study noted that the quality of fish feeds stocked by the local stockiest were of low quality due their malpractice and inadequacy of quality fish feeds and fish feeds processing plant.

5.3 Conclusion

The study concludes that farmers' family size, land size, marital status membership to fish farmers organization are key socio-economic factors that influence the adoption

of fish farming in Nyeri County. These factors were enhanced by training offered to farmers' prior and after commencement of ESP commercial fish farming mainly on pond management and fish farming benefits. The study found that the introduction of ESP commercial fish farming to small-scale farmers increased their income empowering them to pay school fees, meet domestic needs, buy home assets as well as provided fish to their households and to the nearby community members. These greatly changed the attitude of residents of Nyeri County towards fish consumption through created awareness on nutrition value of fish, fish accessibility and affordability. Finally the study concludes that high prices of fish feeds, poor quality fingerlings and inadequate follow services were barriers towards successful adoption of fish farming technology in the County.

5.4.1Recommendations of the study

The study, recommends the following;

1. Development officers and government planners to always consider and incorporate recipient farmers' socio-economic characteristics when introducing new farming technologies.

2. The County government of Nyeri and donors to investment more on farmers' trainings by increasing training session and farmers' reimbursement to pull more farmers. These would equip fish farmers with more skills and increase awareness on fish farming benefits.

3. Department agriculture in the County government of Nyeri and Kenya Bureau of Standard, ascertain the production and stocking of quality fish feeds and fingerlings. Agriculture; been a devolved service, County government of

Nyeri to engage additional qualified fisheries extension officers to do follow-up with farmers' at their farms.

4. Government of Kenya to re-evaluate on of availability of affordable fish feeds by; reducing duty on imported fish feeds and or developing alternative sources of feeds like construction of fish feeds processing factory by investors or government.

5.4.2 Areas for further research

This study proposes the following areas for study

1. There is need to examine the influence of climate variability on fish production, yield and species in the county in reference to the unavailability of adequate water and its associated effect of the drying of the ponds.
2. There is need to examine on fish feeds available in Nyeri County, their quality and prices.

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Appendix I: Farmers survey questionnaire schedule

Date of interview ___ / ____/ 2020 GPS location of the fish farm …….

A. **Locational information**

No	Variable label	Variables	Skip rules, Information, Remarks
Identifying variables			
1	Sub county		
2	Ward	……	

B. General information of the respondent

3	Age		
4	Education levels.		
5	Number of Family members		
6	Main occupation		
7	Main agricultural activity		

C. Government supported training to ESP small scale commercial fish farmers?

8 a) How did you know about the supported fish farming program?

b) How were you identified to benefit from program?

c) What attracted you most on the program?

9 What type of support did you get from the ESP fish farming program?

10 a) Were there organized training before establishment of ponds?

b) If yes, how regular? Were the training sessions?

c) Which were the common training methods?

d) Which training areas mainly influenced you?

11 Were there training sessions after establishment of fish farming?

12 a) Were there farm follow-up training?

b) How regular?

c) How did these training sessions help you?

13 a) How can the training sessions be improved?

b) On your own opinion, what were the training shortcomings?

c) How can they be improved?

D. Benefits of fish farming

1.Income creation

14 Where do you sell your fish products?

15 a) Is there organized farmers' groups/ co-operative?

b) If yes are you a member?

c) If yes, what are the group benefits?

16 a) Do you have regular commercial fish vendors?

b) If yes, about how many?

(c) How regular are they?

17 a) Is there increase in your fish production?

b) If yes, why?

c) If no, have production decline?

d) If yes, why?

18 a) How do you determine fish price?

(b) What are the fish prices?

(c) Approximately how many fish per pond did you harvest last season?

19 a) Is there significant improvement in your household income?

b) If yes, could fish farming have contributed?

20 a) In what ways has derived income helped you?

21 a) Have / are you planning to constructed additional fish pond?

b) If yes, why?

c) If no, why?

22 How many people have you engaged in the fish farm?

Family ……

Permanent ……

Casuals …….

2. Local source of nutritious food to the rural household

23 (b) Does your family take fish?

(b) If yes, how regular? And why?

(c) If no, why?

24 a) Do neighbours buy fish for domestic consumption?

b) If yes, are there regular customers?

c) On average about how many kilograms per visit?

25 a) Are there local people, who buy fish to sell in local rural areas and markets?

b) How regular?

Daily

Weekly

specify …….

26 a) Are fish local sales increasing or decreasing?

b) If yes, why?

c) If no, why?

d) Do you satisfy all your fish customers throughout?

27 (a) Is there a positive change on fish consumption by local people?

b) If yes, why?

c) If no, why?

29. (a) Do you face challenges on pond management?

(b) Name them?

(d) How are you addressing the above challenges?

Appendix II: In-depth interview involving fish farming extension officers, County fisheries officer, chiefs, and Development officers in Nyeri County

Interview schedule for the key informants

Date of the interview _____/____/2020

Sub-county	Ward	Constituency

1. Highest education level attained.
2. Area of specialization.
3. What were the criterion to identify ESP
4. What were the farmers' requirements?
5. How and by whom was the supported fish farming disseminated to farmers?
6. How was the fish farming funding structured?
7. Which are the training methods were used and why?
8. Rate the attendance of farmers to the training sessions?

   1. **Very good** 2. **Good** 3. **Average**4.**Poor** 5.**Very poor**
9. Whish areas of training did farmers asked questions most?
10. What were the main training challenges reported by the farmers?
11. How do farmers market their produce?
12. Are there local fish buyers for home eating?
13. Are there local fish buyers' to sell/hawk fish nearby markets?
14. To your opinion, has ESP fish farming increased fish consumption in the area?

    Why?
15. (a) Are there farm follow-up training?

(b) How often?

(c) What are the follow-up challenges?

16. Is there sufficient income from fish farming?

17. To your opinion is there increase in fish consumption in area?

18. What are the main challenges do fish farmers face?

19. How can these challenges to resolved?

Thank you

Appendix III: GPS Co-ordinates of Sample Farms

Serial Number	GPS Co-ordinate		Serial numbers	GPS Coordinates	
1	0^0 28’ 26’’S	37^0 5’ 11’’E	37	$0^0$28 53’’S	$37^0$4’ 14’’E
2	0^0 28’ 25 ’’S	37^0 5’9’’E	38	0^0 28’ 55’’S	$37^0$4’ 11’’E
3	0^0 28’ 24’’S	37^0 5’ 8’’E	39	0^0 28’ 59’’S	$37^0$4’ 9’’E
4	0^0 28’ 25’’S	37^0 5’ 9’’E	40	$0^0$29’ 7’’S	$37^0$4’ 4’’E
5	0^0 28’ 25’’S	37^0 5’ 10’’E	41	$0^0$29’ 18’’S	$37^0$4’ 14’’E
6	0^0 28’ 26’’S	37^0 5’ 15’’E	42	$0^0$29’ 29’’S	$37^0$4’ 2’’E
7	0^0 28’ 20’’S	37^0 5’ 8’’E	43	$0^0$29’ 26’’S	$37^0$3’ 52’’E
8	0^0 27’ 0’’S	37^0 4’ 33’’E	44	$0^0$29’ 39’’S	$37^0$3’ 53’’E
9	0^{00} 27’ 59’’S	37^0 4’ 32’’E	45	$0^0$29’ 39’’S	$37^0$4’ 56’’E
10	0^0 27’ 59’’S	37^0 4’ 32’’E	46	$0^0$29’ 41’’S	$37^0$5’ 6’’E
11	0^0 28’ 3’’S	37^0 4’ 33’’E	47	0^0 30’ 5’’S	$37^0$5’ 7’’E
12	0^0 28’ 17’’S	37^0 4’ 33’’E	48	$0^0$29’39’’S	$37^0$5’ 6’’E
13	0^0 27’ 18’’S	37^0 3’ 54’’E	49	$0^0$29’ 10’’S	$37^0$5’ 6’’E
14	0^0 27’ 20’’S	37^0 3’ 45’’E	50	$0^0$29’ 8’’S	$37^0$5’ 8’’E
15	0^0 27’ 53’’S	37^0 3’ 46’’E	51	$0^0$29’ 0’’S	$37^0$4’ 46’’E
16	0^0 26’ 53’’S	37^0 3’ 37’’E	52	$0^0$29’ 34’’S	$37^0$4’ 50’’E
17	0^0 26’ 53’’S	37^0 4’ 1’’E	53	$0^0$29’ 35’’S	$37^0$4’ 52’’E
18	0^0 26’ 49’’S	37^0 3’ 58’’E	54	$0^0$29’ 32’’S	$37^0$5’ 16’’E
19	0^0 26’ 52’’S	37^0 3’ 48’’E	55	$0^0$30’34’’S	$37^0$5’ 9’’E
10	0^0 26’ 59’’S	37^0 3’ 50’’E	56	$0^0$30’20’’S	$37^0$5’ 14’’E
21	0^0 27’ 2’’S	37^0 3’ 45’’E	57	$0^0$30’59’’S	$37^0$5’ 18’’E
22	0^0 27’ 15’’S	37^0 3’ 43’’E	58	$0^0$30’57’’S	$37^0$5’ 59’’E
23	0^0 27’ 26’’S	37^0 4’ 8’’E	59	$0^0$30’3’’S	$37^0$5’ 43’’E
24	0^0 27’ 57’’S	37^0 4’ 7’’E	60	$0^0$29’10’’S	$37^0$5’ 42’’E
25	0^0 27’ 56’’S	37^0 4’ 16’’E	61	$0^0$29’0’’S	$37^0$5’ 16’’E
26	0^0 27’ 18’’S	37^0 4’ 20’’E	62	$0^0$28’58’’S	$37^0$5’ 20’’E
27	0^0 28’ 40’’S	37^0 5’54 ’’E	63	$0^0$29’4’’S	$37^0$5’ 24’’E
28	0^0 28’ 36’’S	37^0 5’ 54 ’’E	64	$0^0$29’6’’S	$37^0$5’ 22’’E
29	0^0 28’ 34’’S	37^0 5’ 55’’E	65	$0^0$29’ 13’’S	$37^0$5’ 30’’E
30	0^0 28’ 31’’S	$37^0$5’55’’E	66	$0^0$28’48’’S	$37^0$5’ 33’’E
31	0^0 27’ 7’’S	37^0 6’45’’E	67	$0^0$29’9’’S	$37^0$5’ 41’’E
32	0^0 26’ 24’’S	37^0 6’ 52 ’’E	68	$0^0$29’59’’S	$37^0$5’ 43’’E
33	0^0 26’35’’S	37^0 6’ 22 ’’E	69	$0^0$29’57’’S	$37^0$5’ 48’’E
34	0^0 26’55’’S	37^0 7’ 4 ’’E	70	$0^0$28’48’’S	$37^0$5’ 43’’E
35	0^0 25’47’’S	37^0 7’ 4 ’’E	71	$0^0$28’49’’S	$37^0$5’ 41’’E
36	0^0 25’52’’S	37^0 6’ 14 ’’E	72	$0^0$28’48’’S	$37^0$5’ 36’’E
73	0^0 25’57’’S	37^0 6’ 15 ’’E	116	$0^0$28’53’’S	$37^0$5’ 42’’E
74	0^0 26’39’’S	37^0 6’ 18 ’’E	117	$0^0$29’0’’S	$37^0$5’ 41’’E’

75	0^0 27’ 18’’S	$37^0$5’ 59’’E	118	$0^0$25’ 51’’S	$37^0$4’ 40 ’’E
76	0^0 27’ 32’’S	$37^0$5’‘35’’E	119	$0^0$27’ 53’’S	$37^0$4’ 48’’E
77	0^0 27’ 57’’S	$37^0$5’ 26 ’’E	120	$0^0$25’ 37’’S	$37^0$4’ 28’’E
78	0^0 27’ 25’’S	$37^0$5’ 27 ’’E	121	$0^0$25’ 28’’S	$37^0$4’ 25’’E
79	0^0 27’ 23’’S	$37^0$5’ 35 ’’E	122	$0^0$25’ 12 ’’S	37^0 4’ 38’’E
80	0^0 27’ 34’’S	$37^0$5’ 24 ’’E	123	$0^0$25’ 10 ’’S	$37^0$4’ 43’’E
81	0^0 25’ 54’’S	37^0 6’ 2 ’’E	124	$0^0$25’ 11’’S	$37^0$4’ 52’’E
82	0^0 25’ 54’’S	$37^0$5’ 7 ’’E	125	$0^0$25’ 11’’S	$37^0$4’ 53’’E
83	0^0 23’ 53 ’’S	$37^0$5’ 2 ’’E	126	0^0 25’ 10’’S	$37^0$4’ 47’’E
84	0^0 23’ 45’’S	$37^0$4’ 19’’E	127	0^0 25’ 10’’S	$37^0$4’ 44’’E
85	0^0 23’ 45’’S	$37^0$4’ 7’’E	128	0^0 25’ 9’’S	$37^0$4’ 45’’E
86	0^0 23’ 35’’S	$37^0$4’ 7’’E	129	0^0 25’ 10’’S	37^0 4’ 47’’E
87	0^0 23’ 21’’S	$37^0$3’ 56’’E	130	0^0 25’ 11’’S	37^0 4’ 49’’E
88	0^0 23’ 6’’S	$37^0$3’ 46 ’’E	131	0^0 22’ 3’’S	37^0 5’ 18’’E
89	0^0 23’ 12’’S	$37^0$3’ 38 ’’E	132	$0^0$23’ 0’’S	$37^0$3’ 26’’E
90	0^0 23’ 13’’S	$37^0$4’ 48 ’’E	133	$0^0$22’ 59’’S	$37^0$3’ 26’’E
91	0^0 23’ 31’’S	$37^0$4’ 52 ’’E	134	$0^0$23’ 28’’S	$37^0$3’ 28’’E
92	0^0 22’ 33’’S	$37^0$4’ 51’’E	135	$0^0$23’ 12’’S	37 3’ 27’’E
93	0^0 22’ 34’’S	$37^0$4’ 47’’E	136	$0^0$23’ 14’’S	$37^0$3’ 27’’E
94	0^0 22’ 44’’S	$37^0$4’ 45’’E	137	$0^0$23’ 36’’S	$37^0$3’ 4’’E
95	0^0 21’ 16’’S	$37^0$4’2 ’’E	138	$0^0$23’ 43’’S	$37^0$2’ 56’’E
96	0^0 21’ 52’’S	37^0 5’ 53’’E	139	$0^0$21’ 21’’S	$37^0$2’ 31’’E
97	0^0 20’ 51’’S	$37^0$5’ 50 ’’E	140	$0^0$24’ 43’’S	$37^0$2’ 45’’E
98	0^0 20’ 55’’S	$37^0$5’ 31’’E	141	$0^0$25’ 2’’S	$37^0$2’ 59’’E
99	0^0 20’ 6’’S	$37^0$5’ 41’’E	142	$0^0$25’ 0’’S	$37^0$3’ 1’’E
100	0^0 21’ 26’’S	$37^0$5’ 21’’E	143	$0^0$28’ 21’’S	$37^0$6’ 0’’E
101	0^0 21’ 32’’S	$37^0$4’ 48 ’’E	144	0^0 28’ 21’’S	$37^0$5’ 58’’E
102	0^0 21’ 21’’S	$37^0$4’ 55’’E	145	$0^0$28’ 22’’S	$37^0$6’ 12’’E
103	0^0 21’ 18’’S	$37^0$5’ 16’’E	146	$0^0$28’ 24’’S	$37^0$6’ 14’’E
104	0^0 21’ 26’’S	$37^0$5’ 18’’E	147	$0^0$28’ 20’’S	$37^0$5’ 32’’E
105	0^0 21’ 29’’S	$37^0$5’ 9’’E	148	$0^0$28’ 28’’S	$37^0$5’ 52’’E
106	0^0 21’ 29’’S	$37^0$5’ 12’’E	148	$0^0$28’ 36’’S	$37^0$5’ 55’’E
107	0^0 21’ 22’’S	37^0 5’ 4’’E	150	$0^0$28’ 11’’S	$37^0$6’ 26’’E
108	0^0 21’ 20’’S	37^0 5’ 14’’E	151	$0^0$27’ 47’’S	$37^0$6’ 34’’E
109	0^0 21’ 36’’S	$37^0$5’ 16’’E	152	$0^0$27’ 31’’S	37^0 6’ 34’’E
110	0^0 21’ 44’’S	$37^0$5’ 16’’E	153	$0^0$28’ 3’’S	$37^0$6’ 28’’E
111	0^0 21’ 42’’S	$37^0$5’ 12’’E	154	$0^0$28’ 6’’S	$37^0$6’ 25’’E
112	0^0 21’ 46’’S	$37^0$5’ 17 ’’E	155	$0^0$30’ 0’’S	$37^0$5’ 48’’E
113	0^0 22’ 0’’S	$37^0$5’ 19’’E	156	$0^0$29’ 54’’S	$37^0$5’ 49’’E
114	0^0 22’ 0’’S	$37^0$5’ 17’’E	157	$0^0$29’ 29’’S	37^0 5’ 48’’E
115	$0^0$22’ 1’’S	$37^0$5’ 18’’E	158	$0^0$29’ 52’’S	$37^0$5’ 51’’E
159	0^0 30’19’’S	$37^0$5’ 17’’E	202	0^0 27’ 16’’S	37^0 10’2’’E

160	0^0 29’ 9’’S	$37^0$6’ 5’’E	203	0^0 28’ 12’’S	37^0 10’16’’E
161	$0^0$32’ 11’’S	$37^0$7’ 2’’E	204	0^0 27’ 41’’S	37^0 10’2’’E
162	$0^0$30’ 20’’S	$37^0$9’ 3’’E	205	0^0 24’ 19’’S	37^0 7’26’’E
163	$0^0$31’ 35’’S	37^0 7’ 8’’E	206	0^0 24’37’’S	37^0 7’18’’E
164	$0^0$27’ 58’’S	37^0 7’ 3’’E	207	0^0 24’17’’S	37^0 7’21’’E
165	$0^0$24’ 13’’S	37^0 6’ 28’’E	208	0^0 24’24’’S	37^0 7’ 9’’E
166	$0^0$24’ 10’’S	$37^0$6’ 28’’E	209	0^0 26’13’’S	37^0 8’4’’E
167	$0^0$24’ 9’’S	$37^0$6’ 21’’E	210	$0^0$26’ 32’’S	37^0 8’ 14’’E
168	$0^0$25’ 47’’S	37^0 6’ 20’’E	211	$0^0$24’ 16’’S	$37^0$7’ 18’’E
169	$0^0$25’ 44’’S	$37^0$6’ 18’’E	212	$0^0$24’ 47’’S	$37^0$7’ 2’’E
170	$0^0$25’ 50’’S	$37^0$6’ 29’’E	213	$0^0$24’ 57’’S	$37^0$8’ 26’’E
171	$0^0$26’ 7’’S	$37^0$6’ 30’’E	214	$0^0$27’ 17’’S	$37^0$8’ 6’’E
172	$0^0$25’ 0’’S	$37^0$6’ 26’’E	215	$0^0$28’50’’S	37^0 8’ 49’’E
173	$0^0$24’ 47’’S	37^0 7’ 59’’E	216	$0^0$28’35’’S	$37^0$8’ 24’’E
174	$0^0$24’ 49’’S	$37^0$8’11’’E	217	$0^0$28’23’’S	$37^0$8’ 11’’E
175	$0^0$24’ 50’’S	$37^0$7’58’’E	218	$0^0$28’56’’S	$37^0$8’ 4’’E
176	$0^0$24’ 47’’S	37^0 7’58’’E	219	$0^0$28’ 16’’S	$37^0$7’ 14’’E
177	$0^0$24’ 58’’S	37^0 7’31’’E	220	$0^0$28’ 36’’S	$37^0$7’ 26’’E
178	$0^0$25’ 2’’S	$37^0$7’29’’E	221	$0^0$25’ 5’’S	$37^0$9’ 11’’E
179	$0^0$25’ 23’’S	$37^0$7’26’’E	222	0^0 25’ 11’’S	$37^0$9’ 17’’E
180	$0^0$25’ 30’’S	37^0 7’35’’E			
181	$0^0$23’ 29’’S	$37^0$7’47’’E			
182	$0^0$23’ 20’’S	$37^0$7’6’’E			
183	$0^0$24’ 57’’S	$37^0$7’32’’E			
184	0^0 24’ 39’’S	37 ^{0}7’35’’E			
185	$0^0$25’ 16’’S	$37^0$11’3’’E			
186	$0^0$25’ 35’’S	$37^0$11’11’’E			
187	$0^0$27’ 12’’S	$37^0$10’57’’E			
188	$0^0$29’ 11’’S	$37^0$10’2 ’’E			
189	$0^0$24’ 3’’S	$37^0$8’3 ’’E			
190	$0^0$23’ 59’’S	$37^0$6’7’’E			
191	$0^0$24’ 16’’S	$37^0$6’0 ’’E			
192	$0^0$29’ 13’’S	37^0 5’46 ’’E			
193	$0^0$28’ 18’’S	$37^0$8’14’’E			
194	$0^0$28’ 14’’S	$37^0$8’ 51’’E			
195	$0^0$27’ 36’’S	$37^0$8’ 53’’E			
196	$0^0$27’ 54’’S	$37^0$8’ 28’’E			
197	$0^0$28’ 23’’S	$37^0$8’ 3 ’’E			
198	$0^0$28’ 36’’S	$37^0$7’ 42’’E			
199	$0^0$28’ 42’’S	$37^0$7’ 37’’E			
200	$0^0$28’ 22’’S	$37^0$7’ 32’’E			
201	$0^0$27’ 42’’S	$37^0$7’ 41’’E			

Appendix VI: Farmers consent

Richard Kariuki Mwangi
Kenyatta University
M.A. Student
C50/CE/24890/2012
3/6/2020

To

Mathira West and East Fish Farmers Association

RE: CONSENT TO TAKE AND USE MEMBERS PHOTOGRAPHS FOR MY ACADEMIC PAPER.

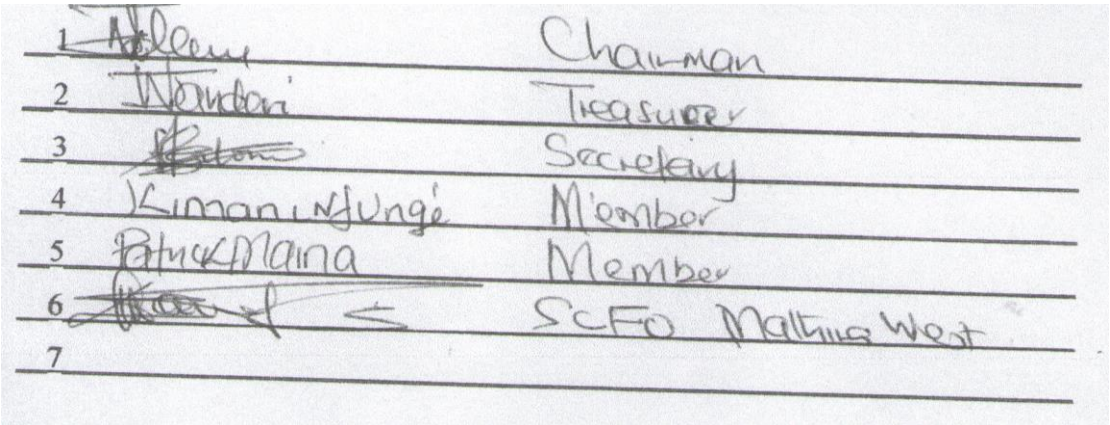
I write to seek your members consent to carry a academic paper where they are the main respondent, to take and use your members' photographs as evidence of fish farming activities in my academic paper.

I will be glad in permitted.

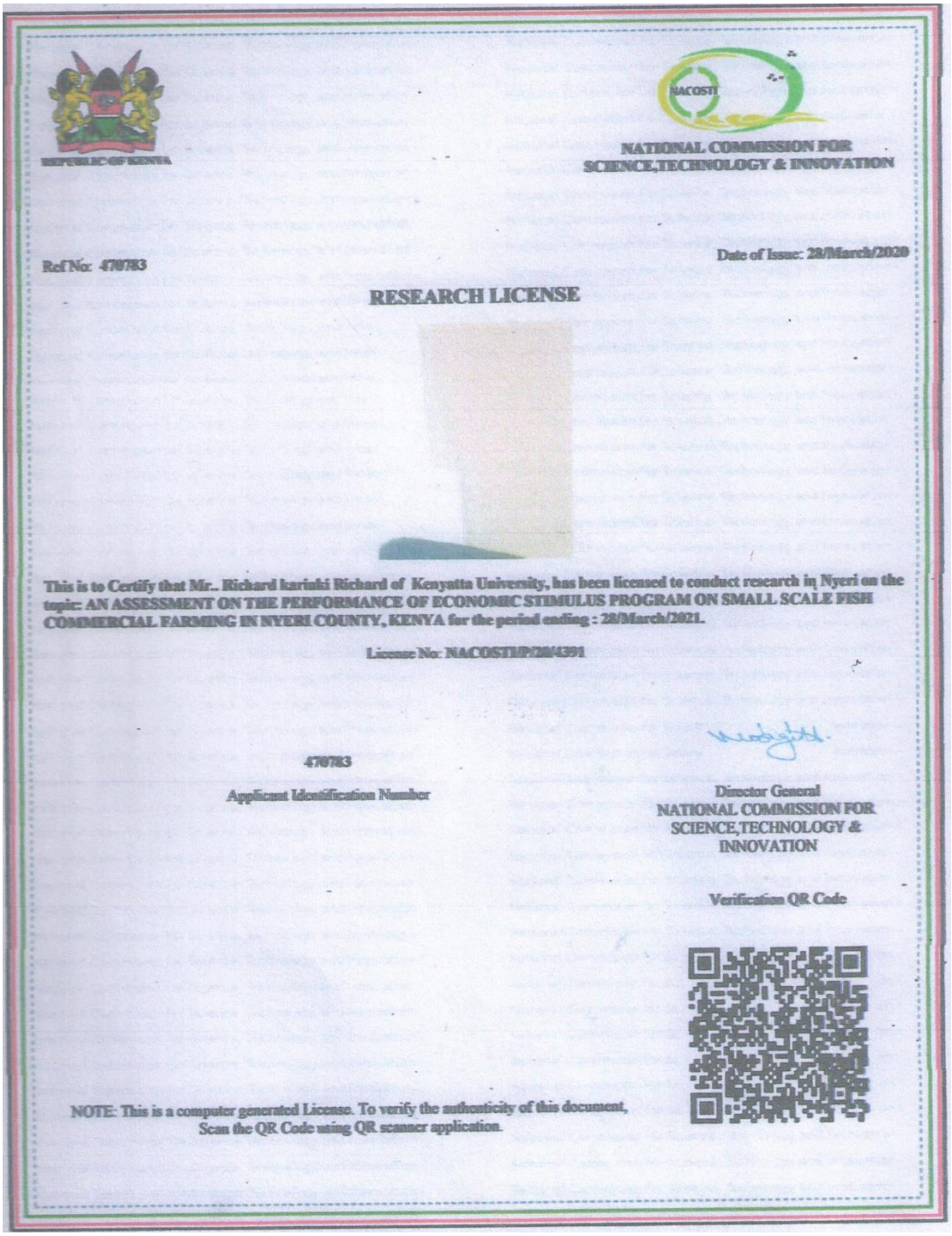
Yours

Richard K. Mwangi

If granted kindly sign in the spaces provided below



Appendix V: Authorization letter to carry research by NACOSTI



REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 470783

Date of Issue: 28/March/2020

RESEARCH LICENSE

This is to Certify that Mr.. Richard karinki Richard of Kenyatta University, has been licensed to conduct research in Nyeri on the topic: AN ASSESSMENT ON THE PERFORMANCE OF ECONOMIC STIMULUS PROGRAM ON SMALL SCALE FISH COMMERCIAL FARMING IN NYERI COUNTY, KENYA for the period ending : 28/March/2021.

License No: NACOSTI/P/20/4391

470783

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013

The Grant of Research Licenses is Guided by the Science, Technology and Innovation (Research Licensing) Regulations, 2014

CONDITIONS

1. The License is valid for the proposed research, location and specified period
2. The License any rights thereunder are non-transferable
3. The Licensee shall inform the relevant County Director of Education, County Commissioner and County Governor before commencement of the research
4. Excavation, filming and collection of specimens are subject to further necessary clearence from relevant Government Agencies
5. The License does not give authority to tranfer research materials
6. NACOSTI may monitor and evaluate the licensed research project
7. The Licensee shall submit one hard copy and upload a soft copy of their final report (thesis) within one of completion of the research
8. NACOSTI reserves the right to modify the conditions of the License including cancellation without prior notice

National Commission for Science, Technology and Innovation
off Waiyaki Way, Upper Kabete,
P. O. Box 30623, 00100 Nairobi, KENYA
Land line: 020 4007000, 020 2241349, 020 3310571, 020 8001077
Mobile: 0713 788 787 / 0735 404 245
E-mail: dg@nacosti.go.ke / registry@nacosti.go.ke
Website: www.nacosti.go.ke

Appendix VI: Authorization letter to carry research by the County Government of Nyeri

COUNTY GOVERNMENT OF NYERI

Town Hall – 2nd Floor
Along Kenyatta Road
P.O. Box 1112 – 10100
Telephone 061 2030700
NYERI

Email: nyericountysecretary@gmail.com

OFFICE OF THE COUNTY SECRETARY/HEAD OF COUNTY PUBLIC SERVICE

Our Ref: CGN/CS/ATT/I/100/43 **27th August, 2020**

Richard K. Mwangi
P.O. Box 187-10101
KARATINA

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on **"An Assessment on the Performance of Economic Stimulus Program on Small Scale Commercial Fish Farming in Nyeri County, Kenya"** in partial fulfillment of a Master's Degree in Geography, I am pleased to inform you that you have been authorized to undertake the research in Nyeri County for the period ending 28th March, 2021.

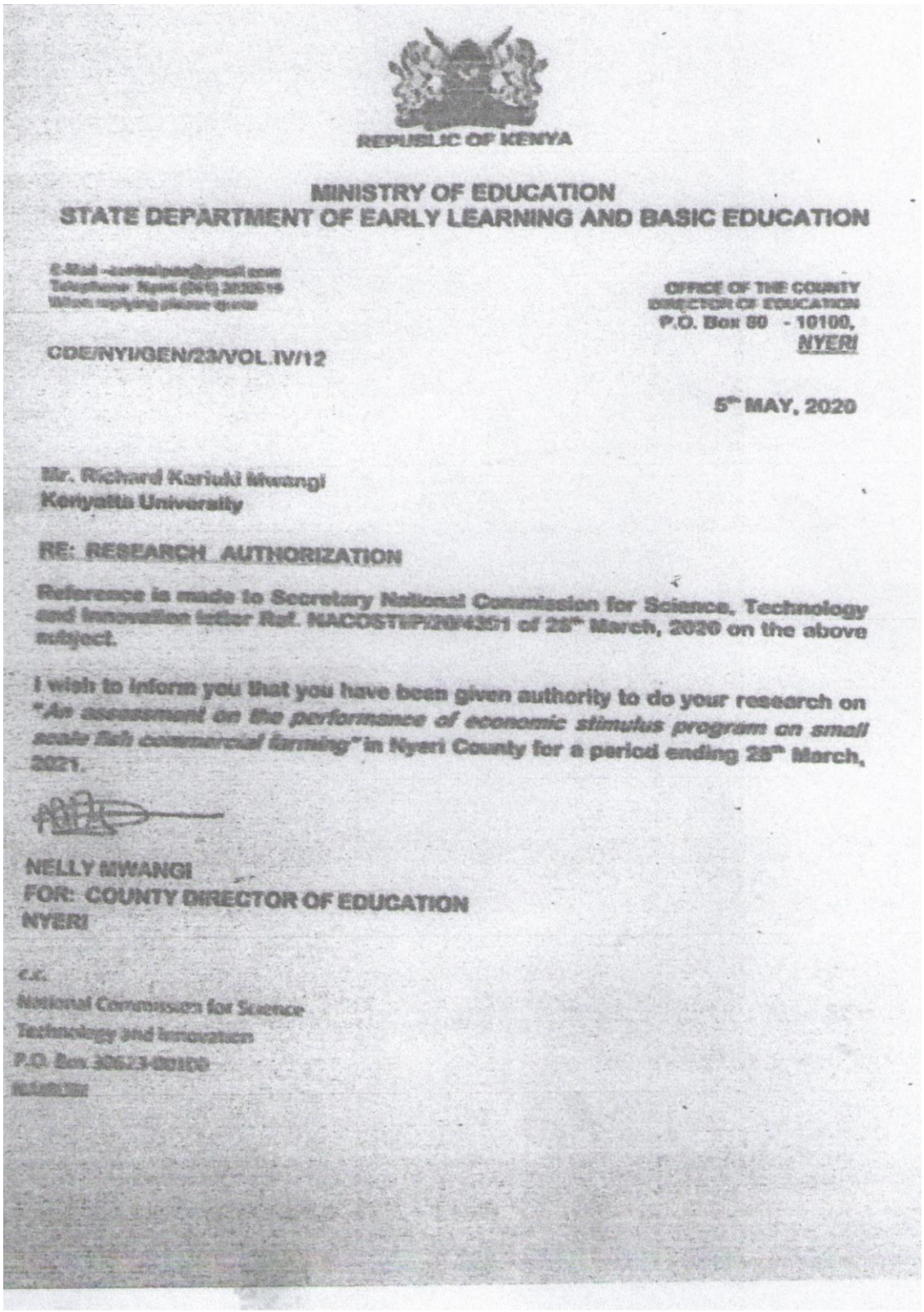
I wish you all the best in your study.

Benjamin W. Gachichio
COUNTY SECRETARY/HEAD OF COUNTY PUBLIC SERVICE

Copy to:

- **County Commissioner**
  Nyeri County

Appendix VII: Authorization letter from the Ministry of Education CDE Nyeri



REPUBLIC OF KENYA

MINISTRY OF EDUCATION
STATE DEPARTMENT OF EARLY LEARNING AND BASIC EDUCATION

E-Mail -
Telephone: Nyeri (061) 2030519
When replying please quote

OFFICE OF THE COUNTY
DIRECTOR OF EDUCATION
P.O. Box 60 - 10100,
NYERI

CDE/NYI/GEN/23/VOL.IV/12

5th MAY, 2020

Mr. Richard Kariuki Mwangi
Kenyatta University

RE: RESEARCH AUTHORIZATION

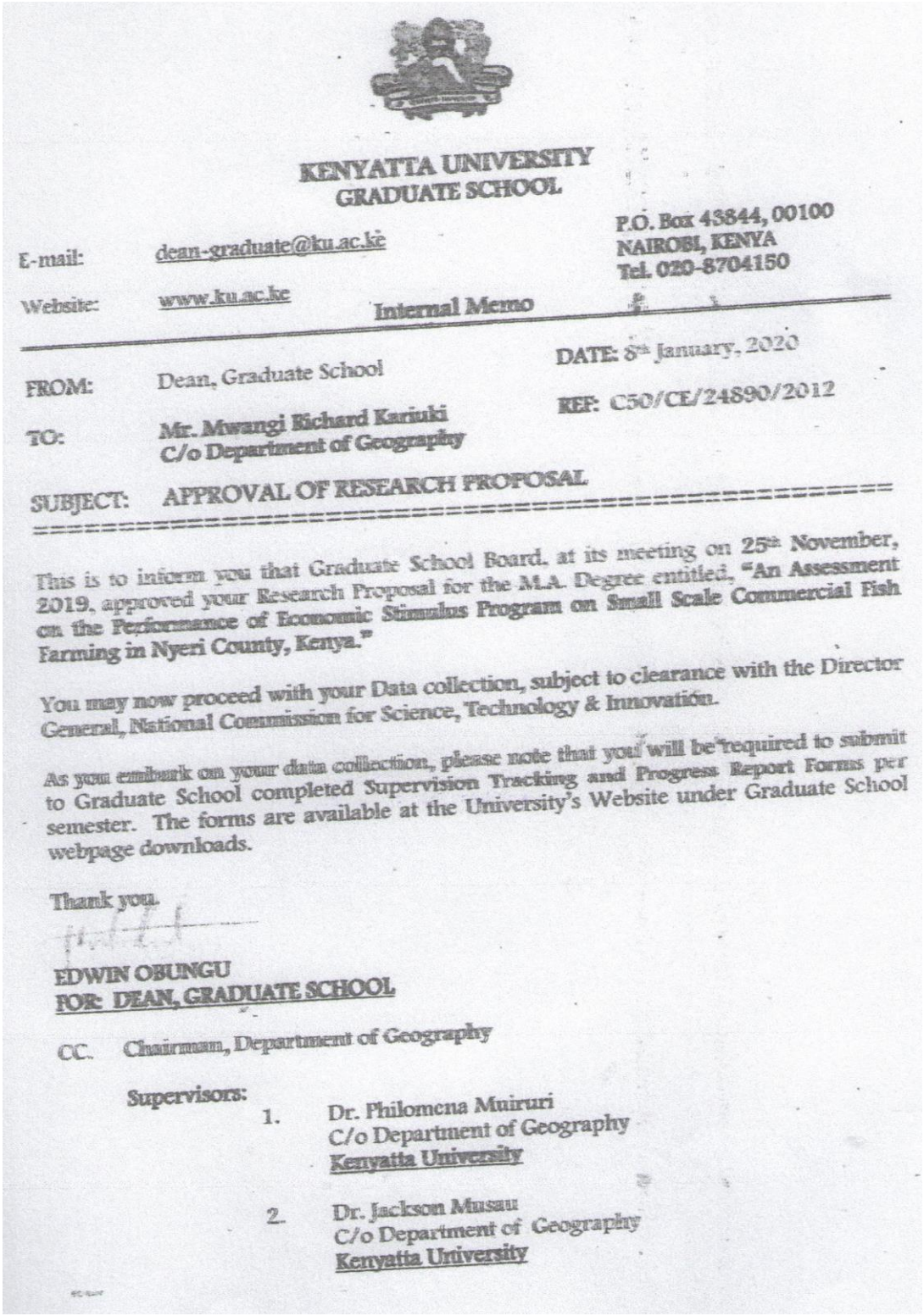
Reference is made to Secretary National Commission for Science, Technology and Innovation letter Ref. NACOSTI/P/20/4351 of 28th March, 2020 on the above subject.

I wish to inform you that you have been given authority to do your research on *"An assessment on the performance of economic stimulus program on small scale fish commercial farming"* in Nyeri County for a period ending 28th March, 2021.

NELLY MWANGI
FOR: COUNTY DIRECTOR OF EDUCATION
NYERI

c.c.
National Commission for Science
Technology and Innovation
P.O. Box 30623-00100
NAIROBI

Appendix VIII: Approval of Research Proposal



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Internal Memo

FROM: Dean, Graduate School

DATE: 8th January, 2020

REF: C50/CE/24890/2012

TO: Mr. Mwangi Richard Kariuki
C/o Department of Geography

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

This is to inform you that Graduate School Board, at its meeting on 25th November, 2019, approved your Research Proposal for the M.A. Degree entitled, "An Assessment on the Performance of Economic Stimulus Program on Small Scale Commercial Fish Farming in Nyeri County, Kenya."

You may now proceed with your Data collection, subject to clearance with the Director General, National Commission for Science, Technology & Innovation.

As you embark on your data collection, please note that you will be required to submit to Graduate School completed Supervision Tracking and Progress Report Forms per semester. The forms are available at the University's Website under Graduate School webpage downloads.

Thank you.

EDWIN OBUNGU
FOR: DEAN, GRADUATE SCHOOL

CC. Chairman, Department of Geography

Supervisors:

1. Dr. Philomena Muiruri
C/o Department of Geography
Kenyatta University

2. Dr. Jackson Musau
C/o Department of Geography
Kenyatta University