RELATIONSHIP BETWEEN FISH FARMING ENTERPRISE PRODUCTIVITY TRAINING PROGRAMME AND ADOPTION OF INLAND-BASED POND FISH FARMING IN MERU SOUTH SUB-COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented for an award of a degree or diploma in this or any other University.

Signature…… Date……

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Recommendation

This thesis has been submitted for examination with our approval as the UniversitySupervisors.

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DEDICATION

To my family and close friends who have been there to encourage and challenge me over the years.

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ABSTRACT

Inland-based fish farming in Kenya continues to draw enormous financial support by the Ministry of Agriculture, Livestock and Fisheries Development under the Economic Stimulus Programme. The Fish Farming Enterprise Productivity Programme (FFEPP) entails the production of fish in a managed environment in marine and freshwater systems for food and commercial purposes. In-land based pond fish farming has been hampered by low level of fish farming, abandonment of ponds, and inadequate training and extension services. Fish farmers in Meru South Sub-County have been slow in adopting inland- based pond fish farming despite the Kenya Government's efforts to promote fish farming through training. This study investigated the relationship between Fish Farming Enterprise Productivity Training Programme (FFEPTP) and adoption of inland-based pond fish farming in Meru South Sub-County, Kenya. The study employed survey design that targeted 400 pond fish farmers who had undergone FFEP training programme excluding those that abandoned their ponds, 22 extension officers and three ward fisheries officers. Purposive and stratified sampling was used to select the respondents. The total sample was 237 respondents comprising 212 farmers, 22 extension officers and three ward officers. The instruments for data collection were; a researcher administered questionnaire for farmers, and a self-administered questionnaire for fisheries and extension officers. Instruments were piloted in Maara Sub County with a sample of 24 respondents comprising of 21 farmers, two extension officers and one sub county fisheries officer. Face, construct and content validity of the research instruments were ascertained by a panel of experts in Agricultural Education. Cronbach's Alpha Coefficient was used to estimate the reliability of the questionnaires. A reliability coefficient of 0.72 and 0.70 for farmers and extension agents and fisheries officers' questionnaires were obtained. Data obtained was cleaned, coded and analyzed using SPSS version 21. Both descriptive statistics involving frequencies and means, and inferential statistics were used to analyze the data. The relationship between training and adoption of pond fish farming was assessed using relationship DID. The findings show that there was an increase in adoption rate of pond construction of 63.66 percent after training. This implies that FFEPTP had a positive impact on pond fish farming as evidenced by the significant number of ponds constructed after training. The study recommends that extension agents and ward fisheries officers should be proactive in providing farmers with technical support needed for pond establishment, fish production, marketing and harvesting.

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ABBREVIATIONS AND ACRONYMS

ACRSP	Aquaculture Collaborative Research Support Program
ERPARDP	Economic Recovery, Poverty Alleviation and Regional Development Programme
ESP	Economic Stimulus Programme
FAO	Food Agricultural Organization
FFEPP	Fish Farming Enterprise Productivity Programme
GOK	Government of Kenya
KAPP	Kenya Agricultural Productivity Programme
KMFRI	Kenya Marine and Fisheries Research Institute
MoFD	Ministry of Fisheries Development
OECD	Organization for Economic Cooperation and Development
UNDP	United Nations Development Programme
SPSS	Statistical Package for Social Sciences

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Millions of people all over the world depend on fish for their livelihoods (Food and Agriculture Organization [FAO], 2012). Fish is a source of protein to over one billion people and a source of food and employment to over 150 million people (FAO, 2012). Today countries world over are exploiting marine resources in what has come to be described as the marine blue economy (Ebarvina (2016). Blue economy deals with water bodies and the economic activities around them including fishing, marine transport, extraction of minerals under the sea, among many others (Wairimu & Khainga, 2017). Indeed, many countries have embraced the benefits of oceans, seas, lakes and rivers and are deploying them to drive economic growth, social progress and protection of the environment.

The United Nations Environment Programme estimates that half of the world's population lives within 60km of the sea, and three quarters of all large cities are located along the coast (FAO, 2017). According to the International Maritime Organization (IMO), up to 90 percent of the global trade facilitation by volume is seaborne and up to 70 percent of global trade facilitation by value is by the sea. With growing emphasis on blue economy, most developing countries are embracing this aspect of economic growth. Thus, there is relativism in pond fish farming and blue economy as the adaptation of the later as a practice of inland fish farming draws credence from this paradigm. The potential linkage between the blue economy, sustainable development and economic growth is recognized in the 2030 Agenda for Sustainable Development. Sustainable Development Goals (SDG) target 14.7 focuses on enhancing the economic benefits to Small Island Developing States (SIDS) and Least Developed Countries (LDCs) from the sustainable use of marine resources, including through the sustainable management of fisheries, aquaculture (Griggs, Stafford-Smith, Gaffney, Rockström, Öhman, Shyamsundar & Noble, 2013).

Consumption of fish and sea food products reached 14 kilograms per capital in developing countries in 2010 (Hempel, 2011). According to the FAO (2013), the amount of fish consumed on a global scale has increased from 45 $\times 10^9$ kg in 2009 to over 9 ×

10^{10} kg in 2013. Over this span, world per capital food fish consumption has also risen from 12kg /year to 16kg/year. China dominated aggregate consumption of fisheries products in 2009, with over 36 percent of global consumption, rising from only 11 percent in 2009. India and South East Asia together accounted for another 17 percent in .2009, with total consumption doubling since 2009.These increases have not been uniform across geographic or economic categories. Grow thin food fish consumption has primarily been a developing country phenomenon. The share of developing country fish consumption has risen from 45 percent in 2009 to 70 percent in 2013, mainly because of the rapid growth in population in these regions (FAO, 2013).

Aquaculture development and growth in Africa have been on low ebb despite the vast aquatic resources that abounds on the continent. Since the introduction of aquaculture to Africa, some decades ago, there have been a lot of innovations, technological advancement and progress in the areas of genetics, seed propagation, pond construction and farm management in general (Gabriel, Akinrotimi, Bekibele, Onunkwo & Anyanwu, 2007). Despite breakthroughs recorded in these areas most farmers in Africa still rely heavily on imported feed ingredients and fish feeds from European countries, which makes fish farming expensive as fish feed account for at least 60% of the total cost of production. This has contributed in no small measure to the slow pace at which aquaculture is advancing in Africa.

Countries in East Africa have hitherto not been left behind in the improvements of their economies leveraging on blue economy. In Uganda for example, a raft of measures are being undertaken to ensure sustainable use of marine resource through extension education. Uganda produces up to 15 000 tonnes of fish from aquaculture, including production from small-scale fish farmers, emerging commercial fish farmers and stocked community water reservoirs and minor lakes. There are an estimated 20 000 ponds throughout the country with an average surface area of 500 m² per pond (FAO, 2017) in the regions of Mayuge, Jinja, Bugiri, Busia, Mukono, Mpigi, Wakiso, Masaka, Rakai, Mbarara, Bushenyi, Ntungamo, Kasese, Hoima, Masindi, Nebbi, Gulu, Adjumani, Arua, Kamuli, Soroti, Lira, Iganga, Tororo, Pallisa, Mbale, Apac, Kabiramaido, Kabarole, Kamwenge and Kyenjojo. Some measures taken by the Ugandan government include better farming techniques, proactive shoreline and wetlands management, and more oversight on fishing. However Leveraging the blue

economy for sustainable development and inclusive growth in the Eastern Africa region faces challenges of illegal and unregulated fishing, piracy and maritime terrorism, Other challenges include degradation of marine ecosystems by dumping of toxic waste, destruction of coral reefs and coastal forests. Furthermore, Tanzania and Kenya are confronted with piracy in the Indian Ocean, while disputes on the lucrative Migingo fishing island exist between Kenya and Uganda (Wairimu & Khainga, 2017).

To achieve strong and sustainable economic growth, Kenya is diversifying her sources of growth by prioritizing the blue economy. Fisheries account for only about 0.5 per cent of the Gross Domestic Product (GDP) and generate employment for over two million Kenyans through fishing, boat building, equipment repair, fish processing, and other ancillary activities (Wairimu & Khainga, 2017). Therefore, the full economic potential of marine resources has not been exploited, yet Kenya has a maritime territory of 230,000 square kilometers and a distance of 200 nautical miles offshore. The blue economy has a great potential to contribute to higher and faster GDP growth in Kenya (Ebarvina, 2016). Innovation and growth in the coastal, marine and maritime sector could deliver food, energy, transport, among other products and services and serve as a foundation for sustainable development in Kenya (Government of Kenya, 2009). Diversifying the country's economy beyond land-based activities and along its coastal, marine and maritime sector is critical to achieving the Sustainable Development Goals (SDGs) and delivering smart, sustainable and inclusive growth. This is especially important in the context of the accelerated growth that the country is experiencing without any concomitant reduction in poverty. Furthermore, Kenya has tapped on the blue economy by providing training for fish farmers and carrying out educational campaigns to show the benefits of farmed fish over wild caught fish and to influence adoption of pond fish farming.

In 2009, the Kenyan Government initiated efforts to provide stimulus to the country's economy key of which were major agriculture sector improvement programmes through the Economic Stimulus Programme (ESP) (Government of Kenya, 2009). As a part the effort, the Ministry of Fisheries Development (MoFD) established the Fish Farming Enterprise Productivity Programme (FFEPP) in a bid to intensify efforts to equip fish farmers with knowledge and skills on modern fish farming technologies (MoFD, 2010). The Fish Farming Enterprise Productivity Programme under the Economic Stimulus

Programme is an initiative by the Government of Kenya to expand economic opportunities in rural areas for employment creation (MoFD, 2010). The intervention aim to improve nutrition, create employment and income opportunities. The construction of 200 fish ponds in each of the 140 constituencies was supposed to create 120,000 jobs and benefit more than 290,000 youth, as well as women, farmers, fishers.The programme was implemented in two phases funded by the Government of Kenya. Phase one of the project was funded under the Economic Stimulus Programme, while the second phase was funded under the Economic Recovery, Poverty Alleviation and Regional Development Programme (ERPARDP) (MoFD, 2010). The main objectives of the Project were to increase fish production, enhance food security, improve livelihoods of farmers, and provide employment for the youth (GOK, 2009).

In first phase of the project, KES1.12 billion was allocated for the construction of 28,000 fish ponds in 140 constituencies (GOK, 2009). In the second phase of the project, KES 2.72 billion were allocated for; the construction of additional 200 fish ponds in 20 other constituencies, construction of three shallow wells in each constituency, purchase of pond liners, fingerlings and fish feeds. Further support was provided for the construction of 80 mini fish processing and storage facilities (Republic of Kenya, 2010). In Tharaka Nithi County the Government allocated a total of KES1.2 million for the implementation of ESP in Meru South Sub-County that saw the establishment of 450 ponds (GOK, 2009). Under this framework, 200 farmers were selected and trained in 2010. The training focused on fish farming in Kenya, planning, design, construction, site selection, pond preparation, soil structure, pond size, depth and slope, stocking ponds, health, disease, predators, prevention, treatment, harvesting and marketing. The aim was to enhance farmers' competencies to facilitate the uptake of pond fish farming. Despite undergoing training, adoption of pond fish farming in Meru South Sub-County continues to be low.

A baseline survey conducted in year 2012 after the introduction of pond fish farming by Meru South Sub County Fisheries Department to establish the farmers' extent of adoption of the new technology of pond fish farming revealed that out of the 450 ponds that were established in the Sub-County, 270 have since been abandoned leaving only 180 functional. In addition, most of the male farmers had negative perception towards fish farming as it was seen as an activity for women and children. The baseline survey

also established that fish was less valued traditionally by the people of Meru South Sub-County because they rarely farmed or ate fish and this was a new experience for them. The implication therefore is that, farmers' required advocacy to change their perceptions about fish and enhance their knowledge and skills on pond fish farming. The foregoing suggests that for Kenya to leverage the blue economy for sustainable development and inclusive, thorough feasibility studies need to be conducted to quantify the opportunities of the blue economy and maximize returns from investments in the sector. The findings of these studies would assist in exploring the potential for public-private partnerships in areas such as research, product development, concept development, exchange of intellectual property, and financial and human resources development.

1.2 Statement of the Problem

Pond fish farming plays an important role in Kenya's national economic development, providing nutrition, employment and even earning foreign currency. The Kenyan Government has made efforts to build the capacity of farmers in pond fish farming through the Fish Farming Enterprise Productivity Training Programme. Despite the implementation of FFEPTP in Meru South Sub-County, the adoption of pond fish farming has been low, being characterized by low pond productivity and abandonment of fish ponds. This study therefore sought to investigate the relationship between FFEPTP and adoption of inland-based pond fish farming in Meru South Sub County Kenya.

1.3 Purpose of the Study

The purpose of this study was to determine the relationship between Fish Farming Enterprise Productivity Training Programme and adoption of inland-based pond fish farming in Meru South Sub County.

1.4 Objectives of the Study

This study was guided by the following objectives:

i) To establish the relationship between the demographic characteristics of farmers and adoption of pond fish farming before and after training Meru South Sub County
ii) To determine the relationship between the numbers of ponds constructed before and after FFEPTP training in Meru South Sub County.

iii) To determine the relationship between fish production methods used by farmers before and after FFEPTP training in Meru South Sub County.

iv) To determine the relationship between fish harvesting practices used by farmers before and after undergoing FFEPTP training in Meru South Sub County.

v) To determine the relationship between fish marketing strategies used by farmers before and after FFEPTP training in Meru South Sub County.

1.5 Research Hypotheses

The following hypotheses were tested:

$H0_1$ There is no statistically significant relationship between the demographic characteristics and adoption of pond fish farming before and after training in Meru South Sub county.

$H0_2$ There is no statistically significant relationship between the number of ponds constructed by farmers before and after FFEPTP training in Meru South Sub County.

$H0_3$ There is no statistically significant relationship between fish production methods used by farmers before and after FFEPTP training in Meru South Sub County

$H0_4$ There is no statistically significant relationship between fish harvesting practices used by the farmers before and after FFEPTP training in Meru South Sub County.

$H0_5$ There is no statistically significant relationship between fish marketing strategies used by farmers before and after FFEPTP training in Meru South Sub County.

1.6 Significance of the Study

The findings generated by this study may be utilized by the Ministry of Agriculture, Livestock and Fisheries Development in re-designing education programmes focusing on farmers regarding methods to enhance uptake of pond fish farming; this will have a multiplier effect in lowering the abandonment of ponds. Further, the Ministry of Agriculture, Livestock and Fisheries Development may use the findings to develop an improved curriculum for training pond fish farmers and finally increasing fish production. The findings of this study would also enable the Government to allocate enough funds to the Department of Fisheries to enable it provide adequate capacity

building to the farmers through education services and fish training programmes under the ESP as well as illuminating on areas that need improvement to make ESP realize its objectives of creating more employment and food security as envisaged in vision 2030 broad aims.

1.7 Scope of the Study

This study was limited in scope to pond fish farmers in Meru South Sub County. The study collected data to assess the relationship between of FFEPP training programme and farmers' adoption of inland-based pond fish farming. The study tested whether there was a statistically significant relationship between the number of ponds constructed, fish production methods and harvesting practices used by the farmers before and after FFEPTP training as well as marketing strategies used by farmers before and after FFEPTP training. The study involved Extension and Sub County Fisheries Officers. Fish Farming Enterprise Productivity Programme (FFEPP) was considered for the study as it was the most publicized and rolled out under the ESP to enable the government to realize its objectives of Kenya Vision 2030.

1.8 Limitations of the Study

Some respondents were almost reluctant to give information fearing that the information asked would have been used to paint a negative image about how they were adopting pond fish farming technologies. The researcher visited the farmers and explained the purpose of the study and assured the respondents of confidentiality of the information they gave. There was a problem in reaching some farms due to poor means of transport and communication. This was overcome by using a motorcycle that facilitated movement in the study area.

1.9 Assumptions of the Study

The study was based on the assumptions that:

i) The respondents would cooperative and would provide the required information.
ii) The respondents possessed adequate memory of what was learnt during the training since this was done in the year 2010.

1.10 Definition of Terms

The following terms were given operational definitions as follows:

Adoption of fish production technologies: Rogers (2003) defines adopting a new technology as the willingness to experience new idea and giving it a trial. In this study adoption refers to more farmers practicing pond fish farming, more ponds established, improved fish production methods, harvesting and marketing of fish.

Economic stimulus programme: Ringa, and Kyalo, (2013) defines economic stimulus programme (ESP) as aplan to boost the economy and achieve positive effects like increased job creation and securing the livelihoods of people through projects, such as fish farming. In this study economic stimulus programme referred to faming activities covered under the ESP which included, construction and stocking of fishponds with fingerlings and provision of aquaculture advisory services.

Extension agents: According to Food Agricultural Organization (2013) an extension agent is a trained person who develops and delivers educational programs to assist people in economic and community development, leadership, family issues, agriculture and environment. In this study an extension agent referred to persons employed by the ministry of agriculture, livestock and fisheries development to assist farmers in rural areas with methods of farming and educating them on new innovations in the field.

Fish farming enterprise productivity training programme: The Ministry of Agriculture, Livestock and Fisheries Development (2009) indicates that Fish Farming Enterprise Productivity Program (FFEPP) refers to the initiative by the Government of Kenya to expand economic opportunities in rural areas for employment creation through in-land fish farming. In this study, FFEPTP refers to a programme that farmers were educated on inland pond fish farming.

Farmers: Macmillan Dictionary defines a farmer as a person who owns or manages a farm. In this study the word farmer was used to refer to pond fish farmers.

Fish harvesting: Norah (2013) defines fish harvesting is the process of gathering a mature fish from the waters. In this study fish harvesting refers to gathering of mature fish for domestic and commercial purposes.

Fish marketing: Charo (2012) asserts that fish marketing is to make fish available to consumers at the right time and in the right place. In this study refers to finding appropriate market for fish produced through inland aquaculture.

Fish production: Munialo (2011) defines fish production as a complex process that involves interaction between various eco-biological factors such as soil, water, air, light, heat, micro-organisms, microflora and fauna, plants, animals and human beings. Basically it is a biomass production which takes place in a pond or aquatic ecosystem. In the fish production it is mainly the interaction between the fish reared and the pond ecosystem which is organized by human beings. In this study fish production refers to rearing of fish commercially in tanks or enclosures, usually for food.

Inland-based pond fish farming: According to Osure (2011), inland-based pond fish farming refers to controlled pond, artificial lake, or reservoir that is stocked with fish and is used in aquaculture for fish farming. In this study in land based pond fish farming refers to farming of fish by constructing ponds on dry land.

Pond establishment: Osure (2011) asserts that pond establishment is building a fish pond where fish are raised under controlled conditions. In this study, pond establishment refers to the act of constructing earthen fish holding facilities.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of literature under the following sub headings: Fish farming in Kenya, relationship between of training on farmers' competence in fish pond establishment, relationship between of training on farmers' competence in fish production, harvesting and marketing. The chapter also presents the theoretical and conceptual framework.

2.2 Importance of Aquaculture in Kenya

Aquaculture is a vital economic activity and livelihood component of rural communities living beside rivers and river flood plains in East Africa (Mbugua, 2008). It provides an alternative source of income for rural communities, particularly for women, since it can be carried out with minimal investment close to homesteads and can be integrated into existing farming systems (World Bank &FAO, 2010). Through aquaculture, the protein requirements and fish consumption needs of the populations can be adequately met (Nikon & Brummett, 2009). In Kenya, aquaculture contributes to an estimated two percent of the total fish produced and is practiced mainly under small holder mixed fang systems, where farmers grow crops and keep livestock in addition to fish farming(FAO, 2013). Small holder aquaculture farmers operate mainly in the medium to high agricultural potential areas, and tend to farm for households needs rather than purely economic objectives (MOFD, 2014). However, in order to raise incomes for rural small holders through aquaculture production a shift towards a more business oriented approach was required.

2.3 Fish Farming in Kenya

Fish farming in Kenya began in 1920 and until the mid-1990s; the activity followed a pattern similar to that observed in many African countries, characterized by small ponds, subsistence-level management, and very low levels of production (Osure, 2011). In 1960, the government helped increase the popularity of aquaculture through the "eat more fish" health promotion campaign. As a result, Tilapia fish farming expanded rapidly with the construction of many small ponds. Nonetheless, the initiative failed in the 1970's due to inadequate fish farming services, lack of quality fingerlings and insufficient training of fish farming workers.

By the 1990's there emerged small-scale fish farming (aquaculture) at different levels in Kenya for subsistence (Munialo, 2011). Since then, aquaculture in Kenya has taken many different forms, ranging from the small hand-dug 'kitchen ponds', to large earth ponds of 1000 m^2. Dam sand other impoundments used for storing water are often stocked with fish and the most common species farmed are tilapia, catfish, trout and goldfish. The different aquaculture systems used in Kenya vary considerably, according to technological advancement and the level of investment and management.

In Kenya aquaculture contributes to food security and social well-being of people (Lynch, Cooke, Deines, Bower, Bunnell, Cowx, & Rogers, 2016). Fish provides a good source of protein and essential micro nutrients and thus plays an important role in the prevention of many human diseases. Fish farming also reduces fishing pressure on our oceans, lakes and rivers (FAO, 2013). Overall, the Government of Kenya recognized that development of aquaculture could play a leading role in accelerating the Millennium Development Goals, particularly in poverty reduction and as a source of alternative fish, instead of relying on the natural ecosystem, which is in decline (GOK, 2014).

2.4 Implementation of FFEPP in Meru South Sub County

The Government of Kenya launched an Economic Stimulus Programme to improve the use of inland water resources for the adoption of commercial aquaculture. This was done through FFEPP. During the two weeks residential training participants underwent a one-week theory lessons and one week practical sessions. The training entailed selecting good pond sites, pond design and layout, pond construction, managing water and soil quality, preventing fish diseases and controlling predators, keeping fish farm records, integrating fish culture into the farm as a whole, fish harvesting techniques and marketing the practical training gave emphasis to site selection, pond construction, pond lining, feeding and harvesting.

Farmers were also taken on field observation to learn from practicing farmers. The duration of training may have been inadequate for farmers to fully get acquainted with the broad range of concepts needed to increase their competences for pond fish farming. Probably this could be due to low funding of the training activities by the Government and low investment by the private sector. The inadequacy in provision of extension services through training has been cited as being a major challenge to development of fish farming in Kenya. This situation results from lack of resources and technical staff

(MOFD, 2011). Inadequate outreach programmes and inefficiency in dissemination of technology to farmers may also impede the development of the fish industry.

The primary beneficiaries of the project were the unemployed young Kenyans. The activities under this program included the construction of 200 fish ponds in each of the 140 constituencies identified for the flagship of this project after training (MoALF, 2014). According to the MoALF, the Sub County Fisheries Officers were to identify and train a group of 10 youths from each constituency for the construction of the fish ponds. The specific objectives of training were to train participants on pond construction, stocking, pond management, fish breeding, feed formulation, fish harvesting and marketing, fish preservation and record keeping. In addition, farmers are provided with aquaculture advisory services during the training.

The facilitators involved in the training sessions used a variety of teaching methods, which included; lecture presentations, demonstrations, pair and group work, role-play, plenary discussions and case study exercises that provided a stimulus variation to the learning process. Sarma (2011) notes that is necessary for a trainer to vary the teaching methods used in order to keep the attention of the participants. The facilitators employed instructional resources such as, Power Point projector, video, overhead projector, flip chart and stand, and handouts. Interactive sessions containing exercises to complete from each taught lesson were adopted and answers to the exercises given in plenary.

After training the participants were expected to construct ponds and receive extension support on pond management, record keeping, fish harvesting and marketing. This study sought to investigate the relationship between training and adoption of pond fish farming. Further, the Constituency Program Tender Committee (CPTC) was to supply fingerlings and stockings of ponds, provide fish farming inputs and specialized equipment to farmers (MoALF, 2010).

2.5 FFEP Training Programme and Adoption of Pond Fish Farming

Training is a crucial and continuous requirement for agricultural development. The study investigated the relationship between fish farming enterprise productivity training programme and adoption of pond fish farming focusing on the topics covered during the training.

2.5.1 FFEP and Pond Establishment

Knowledge is an indispensable factor in agricultural practices and it is the basis of extension service delivery. It is defined by Osure (2011) as data that have been put into a meaningful and useful context which is communicated to recipient who uses it to make decision. Many farmers who go into fish farming without adequate skills have ended up with empty ponds and heavy losses (FAO, 2012). Fish farming requires that farmers undergo training and seek advice from fisheries experts on where to locate the ponds, fish stocking, feeding and general fish management practices such as breeding, pest and disease control as well as harvesting and marketing. Okwu and Ejembi (2010) assert that adequate course content that is relevant to the training needs of the participating farmers is one of the most important determinants of a successful training programme.

Aphunu and Ajayi (2010) conducted an assessment to farmers' views on the organization, content and duration of the Songhai delta training programme in Nigeria. The findings of this study revealed that the content was not fully relevant to address the fish farming problems faced by farmers. The respondents also reported that training duration was inadequate to allow room for in-training practice. Probably this would be an indication that the respondents were not satisfied with the training.

According to Munialo (2011) pond fish farmers require knowledge on pond construction and fish production. When the government initiated fish pond farming through the economic stimulus programme in Kenya, extension officers in the Ministry of Agriculture, Livestock and Fisheries Development were involved in disseminating the required knowledge to farmers to enable them actualize the programme. Similarly, Mamun-Ur-Rashid, Belton, Phillips and Rosentrater, 2013) found that farmers' knowledge and awareness of fish pond establishment before training was low. The knowledge of fish farming in Kenya may be acquired through undertaking a prescribed course in fish farming in schools, colleges and non-formal forums such as seminars and workshops (Fish Farming Enterprise and Productivity Report, 2010).

Arkorful (2013) asserts that the secondary school agriculture syllabus has inadequate content regarding inland fish farming technologies. Thus, people who have undergone through this syllabus have inadequate knowledge on this area which they would have used to empower farmers embracing fish pond farming under the ESP. Consequently

Shitote, Wakhungu and China (2012) present the view that the challenges facing farmers in fish pond establishment probably lies in inadequate knowledge which would have been acquired through inappropriate training programmes. This study established the relationship between of fish farming enterprise productivity training programme on adoption of inland-based pond fish farming in Meru South Sub- County, Kenya.

Mwangi (2011) contends that most of the farmers have not had practical exposure on pond establishment in Kenya. Therefore, farmers in Kenya need to be equipped with knowledge on pond construction. Majority of farmers who set up fish pond without consulting experts, have failed to turn them into successful enterprises due to lack of knowledge on how to construct fish ponds, selection of the right type of site, soil and size of fish to stock including general management (Osure, 2011). As a result, some of the farmers have abandoned pond fish farming altogether.

In trying to understand why farmers have abandoned pond fish farming, Shitote, et al, (2012) carried out a study of problems facing farmers in pond management in Western Kenya. The study established that the most prevalent problems facing pond fish farmers were drying up of ponds during drought, flooding and siltation. Oluwemimo and Damilola (2013) did assess the relationship between FFEP training programme and adoption of pond fish farming. A study of this nature was necessary to shed more light on the status of adoption of pond fish farming after knowledge and skills gain from FFEP training programme

2.5.2 FFEP and Fish Production Practices

Fish production involves rearing of fish for commercial and domestic use. The knowledge that agricultural officers have on fish production has a bearing on what knowledge the farmers have (Manyala, 2011). According to Manyala (2011), to optimize fish production, farmers require knowledge of pond design and construction, seed selection and stocking, general fish farm management, feeding and feed formulation, breeding, diseases and their control, harvesting, handling and processing all of which can be disseminated to farmers through education training programmes. Education of farmers, aquaculture professionals both in the public and private sector, require various levels of fundamental training in order to boost fish farming and management (Hino, 2011). Additionally, technically competent personnel have to be

available to provide specifically tailored courses for end users. Such training and education efforts can go a long way towards making farmers competent in their farming practices.

In a study of the experience of farmers in the then Lurambi Division (now Sub county) of Western Kenya by Andika and Marinda (2008), it was established that the expansion of fish pond farming was attributable to farmer exchange training programmes. The results from Andika and Marinda (2008) showed that less than a quarter of the fish farmers in Lurambi Division had attended fisheries related training. These training programmes were coordinated by the Kenya Fisheries Department. Fish farmers who attended training were educated on fish pond construction, pond feeding, pond manuring, fish propagation techniques, water quality management and post-harvest technology and handling in fish. According to FAO (2013b) training increased number of pond fish farmers in Western Kenya.

A study conducted by Okechi (2008) in Western Kenya aimed at establishing the effect of extension services on farmers' acquisition of improved fish production practices. Similarly, using regression analysis to determine the effect of knowledge transfer through extension, Ngugi (2010) established that the farmer's knowledge of fish production was associated with extension services. This shows that training enhances farmers' competences. In a study conducted by the government of Kenya by the Ministry of Fisheries Development, pond fish farmers were found to employ low pond management practices, which resulted in stagnation of fish farming leading to food insecurity in the study area (GOK, 2010). Francis (2011) also established that lack of knowledge on pond fish farming among farmers in Kakamega was an indicator of insufficient support on pond fish farming in terms of capacity building. This study therefore established whether a significant relationship exists between training and adoption of improved pond fish production practices in Meru South Sub County.

2.5.3 FFEP and Fish Harvesting

The final phase in the fish farming cycle is the harvest and possible sale of the fish. When most of the fish are big enough to be eaten or sold, harvesting can start. Good farming practices include regular harvesting of the fish to earn the farmer an income (Maina, 2009). The frequency of harvests and the quantities and returns realized are key

indicators of the economic viability of the enterprise (Maina, 2009). Mbugua (2009) postulated that many farmers lack fish harvesting skills such as use of appropriate nets and knowledge of timing of harvesting. Fish harvesting requires technical knowledge which farmers can acquire through training. Relevant information on fish harvesting may be obtained from various sources like extension agents, workshops and seminars and media. This knowledge will help farmers to harvest fish based on demand, carrying capacity and maturity hence increasing adoption.

2.5.4 FFEP and Fish Marketing

According to Kenya Marine and Fisheries Research Institute (KMFRI) (2012) fish farming has become one of the most profitable and fast growing enterprise to run and has been an alternative to agriculture which depends on seasonal rainfall. Fish farming is an all season's enterprise that provides nutritious food, constant income and can help alleviate poverty. However, the report identifies the fish market as one major factor hindering the prosperity of the venture. According to Alal (2012) marketing involves all the activities associated with getting fish to the consumers in the desired form, such as cleaning, processing, packaging, transporting and preservation. It is widely accepted that farmers' performance in fish farming is affected by their knowledge of market economy and demands (Ricdardson, 2010). Training has been an excellent avenue that can improve farmers' knowledge of marketing plans and marketing alternatives (FAO, 2013b). The goals of training include the transferring of knowledge from trainers to farmers, advising farmers on how to make better marketing decisions, adding value to fish products and observing sanitary standards (Alal, 2012).

According to Ngugi (2010) a farmer should conduct a market survey to help determine 1) type and size of fish preferred by consumers, 2) quantity of fish required by the market, 3) best time to market fish, 4) which other farmers are supplying fish and 5) prices at which fish are being sold before starting a fish farming enterprise. Mwangi (2008) noted that farmers had little knowledge of fish product diversification and value addition and recommends supporting farmers by building their capacity through organizing trade fairs, developing market information systems, promoting and facilitating value addition for fish products.

A study by Ugra (2009) in India revealed that pond fish farmers faced fish marketing challenges attributed to inadequate knowledge on customer requirements. Wamukota,

(2009) established that fish farmers in Kenya lacked marketing skills such as negotiation and communication skills, and feared that they will get a much lower price for their product if they would market it themselves. This study postulated that farmers' knowledge of fish marketing may be influenced by appropriate training. One of the main focuses of the current study is to establish how FFEP training programme relationship between farmers' knowledge for fish marketing in Meru South Sub County. In a study aimed at characterizing fish production and marketing practices under small holder farming systems found in the Eastern province of Kenya, Oyieng, Charo, Kahi and Ojango (2011) found that farmers tended to focus more on the production and management of fish than on issues related to the markets and marketing of fish.

There is need for development and strengthening of marketing of fish and fish products within Meru South Sub-County, if indeed pond fish farmers are to obtain better returns. Oyieng et al, (2011) established that most of the fish produced in small holder farms was sold directly within the local community, either to individuals or to the nearby markets. Traders in the local markets of Meru South Sub-County collect fish from several sources then transfer these to other larger urban trading centres for more profit. Most of the traders in the urban centres, however, obtained fish from Lake Victoria. A high fishing pressure on Lake Victoria due to demand from other parts of the country has been noted by the Fisheries Department in Kenya (Mbugua, 2008).

Ikiara (1999) also found that farmers tended to focus more on the production and management of fish than on issues related to the markets and marketing of fish. There was some misconception that the ESP that introduced the fish would also be a key supporter in the marketing of fish produced. A challenge for those implementing the ESP is to manage the expectations of communities targeted in development. There is also need for development and strengthening of fish markets and marketing of fish products within Meru South if indeed farmers are to obtain better incomes from aquaculture. Kenya, Omiti, Otieno, Nyanamba and Mc Cullough (2009) attempted to determine the factors influencing market participation and intensities among agricultural enterprises. For instance, Kenya, et al (2009) found that farmers in peri-urban areas sold higher proportions of their output than those in rural areas. They found that distance from farm to point of sale was a major constraint to the intensity of market participation while better output price and market information were key incentives for increased

sales. They therefore concluded that there was urgent need for Kenyan authorities to strengthen market information delivery systems, upgrade roads in both rural and peri-urban areas, encourage market integration initiatives and establish more retail outlets with improved market facilities in the remote rural villages in order to promote production and trade in high value commodities by rural farmers.

Komarek (2010) found that sub-county prices in Uganda had stronger relationship between on initial market entry decisions while quantities had a larger impact on volumes traded. It was also indicated that market information significantly relationship between market participation in the survey. This study sought to establish whether FFEP training programme has had any relationship between on farmers' knowledge of fish marketing in Meru South Sub -County. Bagumire (2009) also established that fishers with higher capacities had more potential to integrate in different markets while those without capacity to integrate different markets missed the opportunities for efficiency gains. This study therefore focused on establishing whether the farmers' aggregate fish marketing performance are relationship between by their training on the existing marketing channels, price spreads (marketing costs, price margins and profitability) among the different marketing activities and the level of market integration.

2.6 Theoretical Framework

The study was based on the Rogers Diffusion Model (2003). Rogers (2003) diffusion of innovations model seeks to explain how, why and at what rate new ideas and technology spread through a society. Rogers argues that diffusion is the process by which an innovation is communicated through certain channels over time among the participants in a social system. Rogers (2003) describes the innovation- decision process as an information-seeking and information-processing activity, where an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation. Rogers proposes four main elements that influence the spread and adoption of a new idea. These include: knowledge of the innovation, persuasion that shapes individual attitude for adoption, making the decision to adopt or reject the innovation, implementing the new innovation if a positive decision is made and confirmation where the person adopting the new technology evaluates the results of an innovation. Rogers' four main elements that persuade the spread and adoption of a new idea is shown in Figure1.

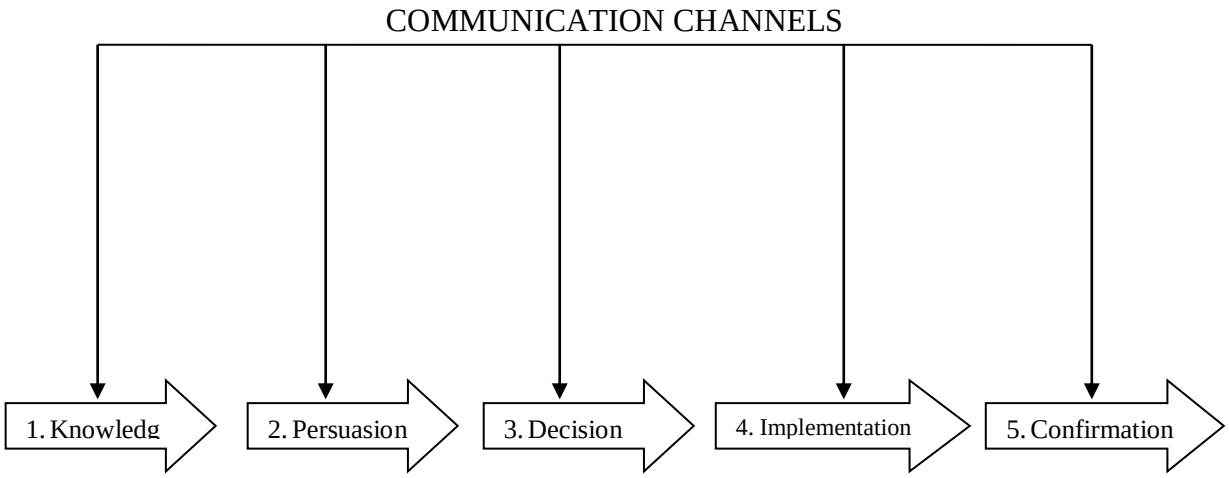

Figure 1: A Model of Rogers Five Stage In the Innovation-Decision Process

Source: Diffusion of Innovations, Fifth Edition by Rogers (2003)

In his theory, Rogers (2003) classifies people adopting a new technology into; innovators (those willing to experience new ideas and give it a trial), early adopters (people in leadership position that provide early adopters' impetus toward adopting the innovations) and early majority (are people who will adopt the innovation just before the other half of their peers adopts it. The proponent of diffusion model extended the classification to include late majority (include people in the society who wait until most of their peers adopt the innovation before they can make a decision to do the same. Laggards on the other hand are more skeptical about innovations and tend to make a decision whether or not to adopt a new technology after looking at whether the innovation is successfully adopted by other members of the social system in the past.

Figure 2 shows, adopters are in a normal distribution.

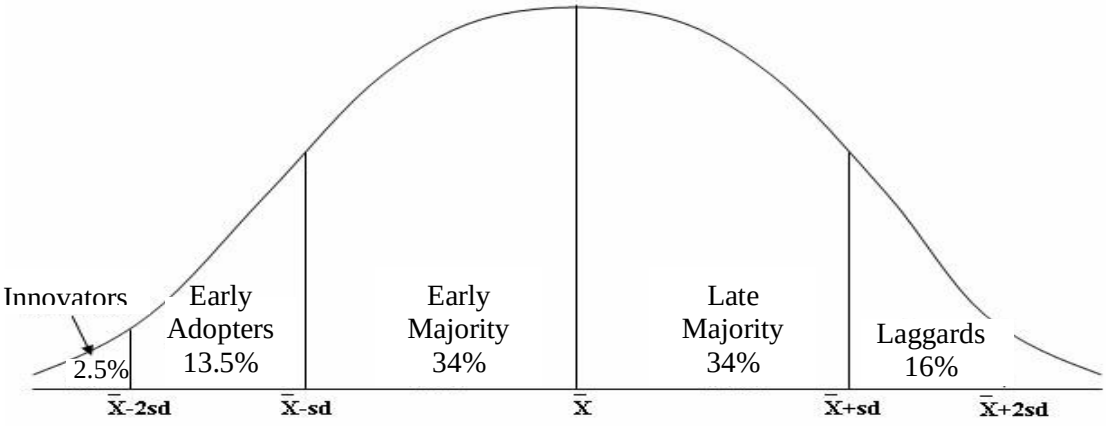

Figure 2: Adopter Categorization on the Basis of Innovativeness

Source: Diffusion of Innovations, fifth edition by Rogers (2003)

The Rogers (2003) diffusion of innovations model is relevant to this study in that it helps the current researcher to conceptualize that in order to increase fish farmers' adoption of pond fish farming farmers' needs training to overcome barriers such as lack of relevant knowledge in pond fish farming. Thus, the Rogers' diffusion of innovations model was found to be appropriate in guiding this study.

2.7 Conceptual Framework

The conceptual framework shows that the independent variable of the study was FFEP training programme, which was measured by the change in level of knowledge acquisition, in terms of fish production practices, fish harvesting methods and fish marketing strategies. The dependent variable was adoption of inland-based pond fish farming whose indicators were change in number of ponds established, fish production practices, fish harvesting methods and fish marketing strategies.

The intervening variables were; farmers' education level, gender and age. The intervening variables were controlled by assigning participants into different groups of different gender, age and level of education. The study did an analysis of farmers' demographic characteristics in order to establish if these were significantly correlated with the level of farmers' adoption of pond fish farming.

The conceptual framework that presents the relationship between study variables is shown in Figure 3

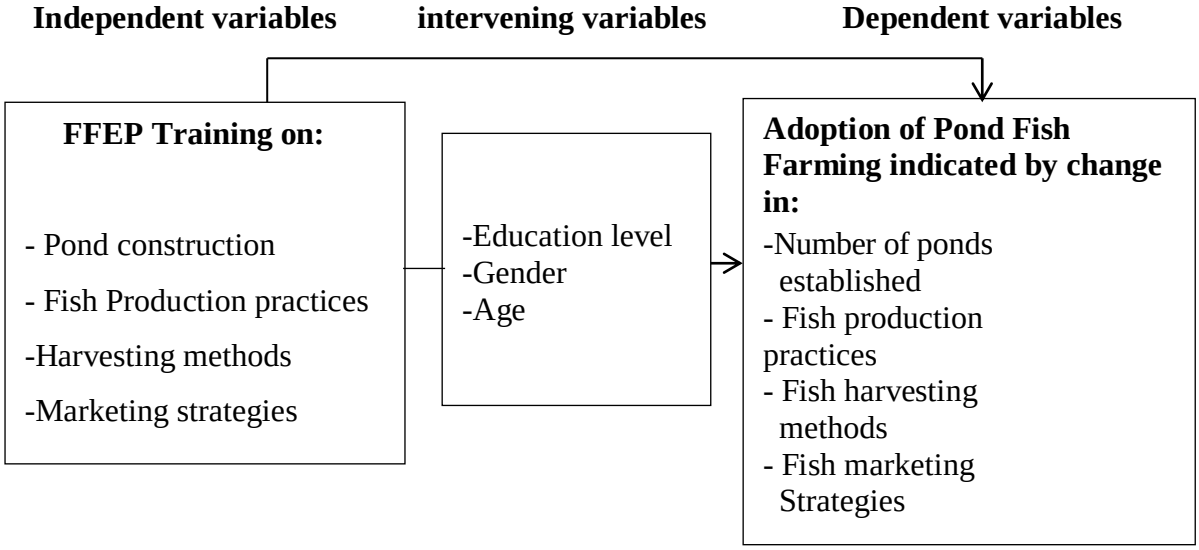

Figure 3: Relationship between FFEP Training and Adoption of Pond Fish Farming

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the methodology that was used in the study. It covers the research design, the target population, sampling procedures and sample size, research instruments, validity and reliability of the instruments, pilot study, data collection procedures, and data analysis.

3.2 Research Design

The study employed a research survey design. Survey research is an especially useful approach when a researcher aims to describe or explain features of a very large group or groups In this study data was collected from farmers in their respective farms. An observation schedule was utilized to collect data on the status of ponds and related fish production practices. The study made a series of observations more than once on members of the study population over a period of time. The researcher was able to collect and analyze data to establish the relationship between training and adoption of pond fish farming.

3.3 Location of the Study

The study was carried out in Meru South Sub-County in Tharaka-Nithi County. Meru South Sub-County is situated between Longitudes 3718’37” and 3728’33” East and Latitude 0007’23” and 0026’19” South. The total area of Meru South Sub-County is 443.89 km^2. The Sub County borders Meru Central to the North, Embu to the South, Tharaka and Mbeere to the East, Kirinyaga and Nyeri to the West at the peak of Mount Kenya (Huho & Kosonei, 2014). The Sub-County is divided into three administrative wardsnamely Chuka, Igambang’ombe and Magumoni wards.

The topography of Meru South Sub-County is influenced by the volcanic activity of Mount Kenya (Huho & Kosonei, 2014). Numerous rivers which originate from Mount Kenya Forest traverse the sub county and flow Eastwards at tributaries of Tana River, which discharge its water into the Indian Ocean. The soils of Meru South Sub-County are characterized by deep red loam. These soils are well drained and fairly fertile but require fertilizers to improve their fertility, as this has been lowered by continuous cultivation (Republic of Kenya, 2013).

The major economic activities engaged by the community in the study area were agriculture and livestock production specifically dairy, coffee and tea farming. People in the study area also engaged in sand harvesting and small scale industrial activities. These activities have however, been set various obstacles such as break down of institutional support systems, variations in weather and slow response to changing situations, among other factors. These have consequently bogged down the rural population in the vicious cycle of poverty due to persistence levels of subsistence (FAO, 2012).

According to Singleton and Straits (2010) an ideal reason for choosing a study site should be the existence of a problem that the researcher hopes to generate solutions for. Meru South Sub County was chosen because for two reasons; first, the Sub County was one of the beneficiaries of the Government of Kenya fish farming ESP; and historically people in Meru South Sub County have not been known to engage in fish farming until the introduction of the ESP. Pond fish farmers in Meru South Sub County have also reported lack of adequate support to fish farming development resulting in bad site selection, pond construction and management that have led to farmers realizing reduced fish yields (FAO, 2012). Furthermore, it is not clear whether farmers in Meru South Sub County were adequately trained to adopt inland-based pond fish farming.

3.4 Target Population

According to Meru South Sub-County Fisheries Officer, there were 400 farmers that benefited from the initial ESP Programme excluding those that abandoned their ponds, 22 extension officers and three Ward Fisheries Officers in Meru South Sub County. These formed the target population. The target population was distributed in 17 locations in Chuka, Igamba Ng'ombe and Magumoni as shown in Table 1.

Table 1

Distribution of the Target Population

Ward	Number of Locations	Target Population
Chuka	6	180
Igamba Ng'ombe	5	105
Magumoni	6	140
Total	**17**	**425**

Source: Meru South Sub- County Statistics Office, 2013

3.5 Sampling Procedure and Sample Size

Sampling was done by employing probability sampling method. The specific probability sampling method used was simple random sampling. Sampling started by identifying the study locale. Being among the Sub Counties that the government identified for the implementation of pond fish farming under the ESP programme in the first phase, Meru South Sub County was randomly selected among the 140 Sub Counties. Names of the 140 Sub Counties were inscribed onto a piece of paper that were folded and shuttled in a container. Since the study was to be carried out in one Sub County, one piece of paper was randomly picked from the pool of the 140 papers to select Meru South Sub County for the study.

After selecting Meru South Sub County as the study locale, sampling was further done by stratifying the study area into three Wards. To obtain the sample of pond fish farmers, the researcher employed the formula provided by Kothari (2004) to calculate the sample for the study.

$$n = \frac{Z^2.p.q.N}{e^2 (N-1) + Z^2 p.q}$$

Where;

N = Total population

n = Sample size

Z = Standard variate at a given confidence level (Z variate at 95% confidence level obtained from the table =2.05)

e = Acceptable margin of error 0.05

P = Sample proportion (in this case=0.5) Q =1-P

$$n = \frac{2.05^2 \text{ x } 0.5 \text{ x } 0.5 \text{ x } 400}{0.05^2 \text{ x } (400-1) + 2.05^2 \text{ x } 0.5\text{x } 0.5}$$

n = 205

Thus, a total of 205 out of the 400 fish farmers that benefited from the initial GOK ESP programme were selected from the three wards to form the sample. All the 22 extension officers were selected to participate in the study. Extension Officers were considered key informants as they were the ones that were used to disseminate knowledge on fish farming.

All the three Ward Fisheries Officers were purposively selected to participate in the study. Sub-County fisheries officers were considered key informants because they were the ones that were involved in implementing the ESP fish farming programme. The overall sample was 205 respondents. Table 2 shows the sampling frame.

Table 2

Sampling Frame

Category	Target Population	Sampling Procedure	Sample Size
Trained Farmers	400	Simple random	205
Extension Officers	22	Census	22
Ward Fisheries Officers	3	Census	3
Total	**425**		**230**

Source: Meru South Fisheries Department, 2013

3.6 Instrumentation

The data for this study was collected by using a questionnaire (Appendix A) that was administered to farmers in addition to observing their fish ponds using an observation schedule (Appendix C). The questionnaires comprised of five sections. Section A sought demographic information of the respondents; Section B gathered information on number of ponds before and after training and related practices, Section C gathered information regarding fish production methods employed before and after training, Section D sought information on harvesting practices employed by farmers before and after training while section E had questions on marketing strategies used before and after training. An interview guide for Extension Agents and Fisheries Officers (Appendix B) had questions on pond establishment, fish production, harvesting and marketing.

3.6.1 Validity

Validity refers to an instrument's ability to measure what it is supposed to measure. Validity therefore has to do with how accurate the data obtained in the study represents the variables of the study, (Cochran, 1993). To ascertain the content validity of the instruments, the researcher sought expert judgment from the research supervisors in the Department of Agricultural Education and extension of Egerton University. The experts examined the instruments individually and provided feedback. Their recommendations were incorporated in the final instruments.

3.6.2 Reliability

Reliability refers to the consistency of scores or answers from one administration of an instrument to another and from one set of items to another, (Patton, 2002) and the closer the value is to + 1.00, the stronger the congruence measure (Norman &Lincoln, 2005). A measure is considered reliable if a person's score on the same test given twice is similar. A pilot study was carried out in Maara Sub-County which involved 21 farmers, two Extension Officers and one Ward Fisheries Officer. Maara Sub County was chosen for the pilot study because the ESP programme was implemented in the Sub County. Cronbach Alpha Coefficient was computed to estimate the reliability of the instruments. Cronbach recommends a reliability coefficient of 0.70 and above is acceptable. The pilot test yielded reliability coefficient of 0.72 and 0.70 farmers and Extension Agents questionnaires respectively, and the instruments were therefore considered acceptable for use in the study.

3.7 Data Collection Procedures

There researcher obtained an introductory letter from Egerton University Graduate School, and a research permit from the National Commission for Science, Technology and Innovations (NACOSTI). The permit was presented to the Meru South Sub-County Fisheries Officer to be allowed to carry out the study in Meru South Sub-County. The researcher visited the farmers in the respective farms, introduced and explained the purpose of the study. The researcher booked appointments with the respondents and organized for the administration of the questionnaires to the farmers at their farms. The researcher was able to identify the farms with assistance from extension agents. Further, data from Ward Officers and Extension Agents was collected using a structured interview whereby the researcher engaged them orally and wrote their responses in a field note book.

3.8 Data Analysis

The data was cleaned, coded and then entered in the computer for analysis using the Statistical Package for the Social Sciences (SPSS) Version 21 for windows. Descriptive statistics included frequency counts and percentages. Hypotheses were tested using chi square. The relationship between training and adoption of pond fish farming was also assessed using Difference in Difference (DID) methodology. DID is a quasi-experimental design that makes use of cross-sectional or longitudinal data from post and

pre-treatment to obtain an appropriate counterfactual to estimate a causal effect. DID is typically used to estimate the effect of a specific intervention or treatment (such as training) by comparing the changes in outcomes over time between a population. The results of data analysis were presented in frequency tables. A summary of data analysis techniques used is presented in Table 3.

Table 3

Summary of Data Analysis

Hypothesis	Independent Variable	Dependent Variable	Method of Analysis
$H0_1$. There is no statistically significant relationship between the demographic characteristics and adoption of pond fish farming before and after training in Meru South Sub county	Demographic Characteristics	Adoption of pond fish farming	Regression Analysis
$H0_2$. There is no statistically significant relationship between the number of ponds constructed by farmers before and after training in Meru South Sub-County, Kenya.	FFEPTP Training	Number of ponds constructed	DID
$H0_3$. There is no statistically significant relationship between fish production methods used by farmers before and after FFEPTP training in Meru South Sub-County, Kenya	FFEPTP Training	Change in production methods	Regression and Pearson Analysis
$H0_4$. There is no statistically significant relationship between fish harvesting practices employed by the farmers before and after undergoing training in Meru South Sub-County, Kenya.	FFEPTP Training	Change in harvesting practices	Regression and Pearson Analysis
$H0_5$. There is no statistically significant relationship between fish marketing strategies before and after training in Meru South Sub-County, Kenya.	FFEPTP Training	Change in marketing strategies	Regression and Pearson Analysis

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

The findings of this study are presented using inferential statistics. The first section provides results obtained from respondents regarding general information pertaining to the study. The subsequent sections provide the results obtained from the respondents regarding pond construction and related practices, pond fish production methods, fish harvesting practices and marketing strategies adopted by farmers.

4.2 General Information of Respondents

In this section the general information of the respondents which include response rate, source of information on pond fish farming, farmers' evaluation of FFEPTP. General information provides data regarding research participants and is necessary for the determination of whether the individuals in a particular study are a representative sample of the target population for generalization purposes. The statistics and predictions resulting from demographic data can, for example, aid in the development of crucial interventions. No meaningful intervention can be effected without reference to general profile of the study population. The data for this study was collected using a questionnaire administered to the farmers while Extension Agents and Fisheries Officers were interviewed using structured interview guide. The data obtained is presented in tables, figures and text form.

4.2.1 Response Rate

Mugenda and Mugenda (2003) assert that since 100 % response rate is unlikely, and then the sample needs to be larger to ensure sufficient responses for the required margin of error. Therefore, there was need to obtain as high a response rate as possible to ensure that the sample was representative. Table 4 shows the response rate.

Table 4

Return Rate

Category of Participants	Sample	Response Rate	%	Instrument for Data Collection
Farmers	205	180	87.8	Questionnaire
Extension Agents	22	22	100	Interview Schedule
Ward Officers	3	3	100	Interview Schedule
Overall	**230**	**205**	**95.9**	

A total of 205 questionnaires were distributed to the farmers, and 22 Extension Agents and three Fisheries Officers were sought for oral interview. Out of the 205 questionnaires administered to the farmers 87.8 % were returned. Sixteen percent of extension agents and two percent Fisheries Officers were interviewed.

4.2.2 Source of Information about Pond Fish Farming

The respondents were asked to indicate their source of information about pond fish farming. The findings are presented in Table 5.

Table 5

Source of Information

Source of Information	Frequency	Percentage
Radio	25	14.0
Other farmers	47	26.0
Extension Agents or Fisheries Officers	72	40.0
Brochures	30	17.0
Newspapers	6	3.0
Total	**180**	**100.0**

The results indicate that majority (40%) of the farmers get information about pond fish farming from extension agents or fisheries officers. Sam, Osei, Dzandu and Atengble (2017) established that most farmers in Kenya use extension officers to receive information about fish farming. About 26% of the farmers reported that their source of information on fish farming was from other farmers, 17% from brochures, 14% from radio while 3% said they accessed information through reading of newspaper.

When asked to indicate whether the information on pond fish farming was acquired before or after undergoing FFEPTP, the responses shown in Figure 4 were obtained.

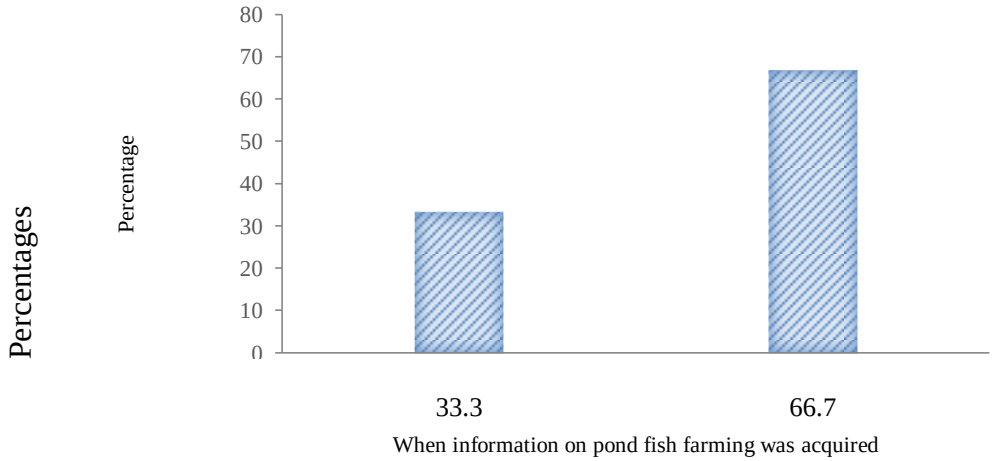

Figure 4: When Information about pond fish farming was acquired

The data in Figure 4 show that majority (66.7%) of the farmers indicated that they had acquired information about pond fish farming after the FFEPTP. This indicates that the training provided prerequisite knowledge to farmers on pond establishment and related practices. Farmers were also requested to indicate the type of support received from the Fisheries Department. The information gathered is shown in Table 6.

Table 6

Type of Support Offered to the Farmers from the Fisheries Department

Type of Support	Frequency	Percentage
Technical support	82	45.5
Provision of fingerlings	36	20.0
Provision of right feed materials	33	18.3
Provision of polythene liners	49	27.2
Total	**180**	**100.0**

The findings of the study indicate that a large number of the respondents (45.5%) received technical support on construction, equipping and maintenance of fishing vessels. This implies that the fisheries Department in Meru South Sub County is supporting pond fish farmers improve fish farming through provision of technical support, fingerlings, feed materials and polythene liners. This is consistent with Tutzman, Molnar, Atukunda and Walakira (2017) who argue that extension services offered to farmers include technical support and training among others.

4.2.3 Needs Assessment before Training

The study further sought to establish whether before training, farmers were contacted for needs assessment in order to establish the areas they needed training in. The needs assessment would be an important step in planning the appropriate interventions aiming at building farmers capacity and consequently have more farmers adopting pond fish farming technology. The responses given by the farmers are presented in Figure 5.

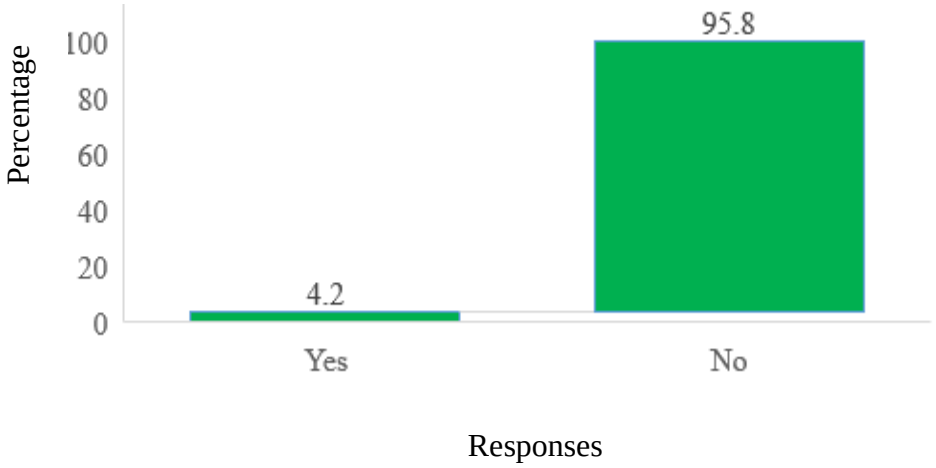

Figure 5: Needs Assessment before Training

The results indicate that the highest proportion (95.8%) of the respondents had not been consulted to map out their training needs before training. The findings clearly indicate that pond fish farmers were not consulted to establish their specific training needs. This could be a factor impeding a faster adoption of the technology in the study area. Effective training requires a clear picture of what the trainees need. This is consistent with Sarma, Talukdar and Mishra (2011) who notes that farmers training should be preceded by a needs assessment to establish the training needs.

4.2.4 Most Beneficial Areas of the Training

The study sought to know the areas that farmers found most beneficial after the FFEPTP. The results generated are presented in Table 7.

Table 7

Most Beneficial Areas in Training

Topics covered that were most beneficial to farmers	Frequency	Percentage
Record keeping	49	27.0
Stocking	36	20.0
Harvesting techniques	30	17.0
Marketing	65	36.0
Total	**180**	**100.0**

The findings of the study indicate that 36.0% of the respondents reported they found the topic on marketing most beneficial. Twenty-seven percent of the respondents found record keeping most useful, 20.0% found the topic on fish stocking very useful to them while 17.0% indicated they benefited much from the training on harvesting techniques.

4.2.5 Follow-up after Training

The study sought to establish whether the Fisheries Department made follow-ups after training the farmers to evaluate how the farmers were utilizing the knowledge and skills acquired during the training in pond establishment, production, harvesting and marketing. Farmers that were investigated gave the responses shown in Table 8.

Table 8

Follow-up after Training

Parameters	Frequency	Percentage
Yes follow-ups were done	31	17.2
Follow-ups were rarely done	99	55.0
No follow-ups were done	50	27.8
Total	**180**	**100.0**

A considerable number of pond fish farmers (55.0%) indicated that they were rarely visited by extension officers after the training while 27.8% reported that no follow-ups were done as opposed to 17.2 % that indicated that follow-ups were done. From the findings it can be adduced that extension agents did not conduct adequate surveillance/field visits after the training to enhance the diffusion of pond fish farming innovations. This could probably explain the farmers need for further training as indicated in the recommendation section in this study. Oloo (2011) found that the inadequacy in provision of extension services has been a major challenge to adoption of pond fish farming in Kenya.

4.3 Correlation between Demographic Characteristics and Adoption of Pond Fish Farming

The study was interested in identifying whether demographic characteristics of farmers that included gender, age and education level had any correlation with adoption of pond fish farming. These variables were cross-tabulated and subjected to a regression analysis to draw a statistical inference.

4.3.1 Gender Distribution of Farmers

The gender distribution of the farmers surveyed during this study was as shown in Table 9.

Table 9

Distribution of Farmers by Gender

Gender	Frequency	Percentage
Male	120	66.7
Female	60	33.3
Total	**180**	**100.0**

The results show that majority of the farmers 120(66.7%) were males compared with 60(33.3%) females. This is indicative of gender disparities in the sample of farmers engaged in pond fish farming in the study area in favour of men. Similar findings were obtained by Ngwili, Maina and Irungu (2015) in their study of characterization of fish farming systems in Kiambu and Machakos Counties, Kenya. The large percentage of men engaging in pond fish farming could be attributed to the aspect of ownership of land and tenure systems. Traditionally, females have less land ownership and therefore may not have access to this factor of production.

4.3.2 Age Distribution of Farmers

The distribution of farmers that took part in this study by age is as shown in Table 10.

Table 10

Distribution of Farmers by Age

Age Interval in Years	Frequency	Percentage
Below 20	15	8.33
21-30	35	19.44
31-40	40	22.22
41-50	60	33.33
51 and above	30	16.67
Total	**180**	**100.0**

The results show that majority 60(33.33%) of the farmers were in the age bracket of 41-50. The results further show that pond fish farming was practiced by a relatively large proportion of farmers below fifty years of age. Similar results were obtained by Ngwili, et al (2015) in their study of characterization of fish farming systems in Kiambu and Machakos Counties, Kenya. Wetengere (2009) reported that younger farmers in Tanzania were more likely to try new technologies and were capable of doing laborious activities like pond construction, pond repair and total harvest. This is also consistent with Roslina and Amir (2015) which stated that 63 per cent of brackish water pond farmers in Kedah were aged less than 50 years old. Dey *et al*. (2008) also found the average age of aquaculture farmers in Malaysia are in the age of 38 years to 50 years. These ages are the most productive age in terms of capital and energy to work optimally. Age factor has an important implication to the modernization of the aquaculture sub sector, since the elderly are quite difficult to accept the changes and they are more comfortable to conduct their activities in a traditional way.

4.3.3 Education Level of Farmers

This study sought to characterize farmers according to their level of education with the aim of cross-tabulating education level with adoption of pond fish farming. The results obtained are presented in Table 11.

Table 11

Distribution of Farmers by their Level of Education

Education Level	Frequency	Percentage
Primary level of Education	20	11.1
Secondary Level of Education	120	66.7
Tertiary/College Level of Education	40	22.2
Total	**180**	**100.0**

The results indicate that majority of the farmers 120(66.7%) had secondary level of education. This observation was in agreement with that of Kimenye (2005) who showed that most of the farmers who engage in fish farming in Kenya have at least a basic level of formal education which makes it easy for information dissemination during training.

4.3 Fish Pond Establishment Practices Before and After Training

The first study objective sought to determine if there was a significant relationship between in the number of ponds constructed by farmers before and after training in Meru South Sub-County, Kenya.

4.3.1 Construction of Fish Pond

Farmers were asked to indicate the number of ponds they had constructed before training and how many additional ones had they constructed after training. The results obtained are presented in Table 12.

Table 12

Number of Ponds constructed by Farmers before and after Training

Ward	Before Training in 2010	After Training in 2017
Chuka	23	130
Magumoni	9	70
Igamba Ng'ombe	2	25
Total	**34**	**225**

The results show that there were 34 ponds constructed before training with majority from Chuka ward. The results further show an increase in the number of ponds constructed by farmers after training from 34 to 225. In Nigeria Onuegbu (2010) found that majority of farmers who attended a fish farming training programmes had no ponds but adopted the practice after training. Wetengere (2010) concurs that despite high potentials that pond fish farming possesses. This indicates that farmers who have acquired knowledge on fish farming are more likely to adopt it than those who have not acquired the knowledge.

4.3.2 Pond Establishment

The study further explored the relationship between Fish Farming Enterprise and Productivity Training Program (FFEPTP) and pond establishment. The information sought was gathered using a questionnaire administered to farmers. The results obtained are shown in Table 13.

The responses were triangulated to enhance reliability and validity.

Table 13

Pond Establishment Practices before and after Training

Pond Establishment Practices	Before Training n = 180					After Training n = 180				
	N	R	S	O	A	N	R	S	O	A
Considered soil type before construction	90 (50%)	80 (44%)	10 (6%)	0	0	0	2 (1%)	60 (33%)	70 (39%)	48 (27%)
Constructed ponds near home to minimize predation	0	130 (72%)	50 (28%)	0	0	0	0	0	160 (89%)	20 (11%)
Constructed ponds close to a main water supply	0	0	0	160 (89%)	20 (11 %)	0	0	0	80 (44%)	100 (56%)
Constructed ponds away from trees which shed leaves	100 (56%)	70 (39%)	10 (6%)	0	0	0	0	15 (8%)	45 (25%)	120 (67%)
Ensured pond are exposed to sunlight	109 (61%)	11 (6%)	60 (33%)	0	0	0	0	35 (19%)	50 (28%)	95 (53%)
Constructed standard sized ponds	160 (89%)	0	20 (11%)	0	0	0	0	0	25 (14%)	155 (86%)
Erected dykes of required standard	149 (83%)	11 (6%)	20 (11%)	0	0	0	0	40 (22%)	15 (8%)	125 (70%)
Prevented soil erosion by planting grass and digging trenches around the pond	0	14 (8%)	26 (14%)	136 (76%)	4 (2%)	0	0	0	5 (3%)	175 (97%)
Constructed spillways	0	0	0	169 (94%)	11 (6%)	0	0	0	32 (18%)	148 (82%)
Used polythene liners to cover the pond	111 (62%)	56 (31%)	9 (5%)	4 (2%)	0	0	0	15 (8%)	45 (25%)	120 (67%)
Fenced ponds after construction	113 (50%)	47 (44%)	10 (6%)	10 (6%)	0	0	2 (1%)	58 (32%)	72 (40%)	48 (27%)

Key: N-Never; R-Rarely; S- Sometimes; O-Often; A-Always

The results in Table 13 show that, before training more than half of the farmers reported that they never or rarely considered soil type before constructing fish ponds. This could be interpreted to mean that before training farmers were not aware of the importance of considering soil type in the construction of ponds.

On further interrogation the respondents indicated they learnt that the soil type where a pond should be constructed should not be too sandy. Soil with too much sand or gravel in it will not hold water**.** In sandy soil the water will sink into the ground and there will not be enough water for your fish. The soil where you build your pond should have enough clay in it.

Clay soil holds water very well. In clay soil, very little water will sink into the ground, and banks of clay will be strong enough to hold the water in the pond. The results further show that after undergoing training, 39% of the farmers often considered soil type, and 48% always did while 33% sometimes considered soil type when constructing ponds. When interrogated further, the respondents stated that they learnt from the training that soils with good water retention ability are preferred.

The impact of training was also assessed by evaluating farmers' practices of considering security of fish from predators before and after training. The results show that after undergoing training, 89 percent of the farmers had constructed ponds near home to minimize predation as opposed to 72 percent who had their ponds constructed far from home before the training. The paradigm shift is primarily reflected in new knowledge gained through training. This implies that farmers were following the recommendations given by the extension agents on the issue of fish security. The findings seem to suggest that pond establishment practices are affected by skills and training. This concur with Shitote *et al*, (2012) who indicated that pond fish farming requires that farmers undergo training and seek advice from fisheries experts about pond establishment general fish management.

The study established the number of farmers that had constructed ponds away from trees which shed leaves before and after training. This aimed at measuring the knowledge and practice after training. The results show that slightly above half (56%) of the farmers had ponds constructed under tree canopy while after training two thirds (67%) of the farmers established their ponds away from trees that shed their leaves. This means that before training, most of the farmers constructed ponds under tree shades thinking that they are protecting fish from strong sunlight without the awareness that decomposition of leaves requires oxygen which is drawn from the pond water leaving oxygen debt for the fish leading death. Okuha, (2011) contend that adoption of best fish farming practices is more

likely to be relationship between by farmers' knowledge about design, construction and maintenance.

The results of this study show that before training more than three quarters (89%) of the farmers never constructed standard sized ponds. But after undergoing training, the results show that nearly all the farmers were constructing standard ponds. This means that farmers utilized knowledge gained from FFEPTP to change from constructing non-standardized to standardized ponds. Information given by extension agents showed that under the ESP programme farmers were taught and expected to construct earthen pond of size $300m^2$ and stock with 900 mono sex tilapia fingerlings.

The results in Table 13 show that before training more than three quarters of the farmers had not erected dykes of the required standard. This was different after the training as nearly all farmers had adopted the practice. Isyagi, Veverica, Asiimwe and Daniels (2009) notes that a fish pond should have standard dykes that are water-tight (impermeable), so the pond does not leak. The data in Table 10 show that before and after training, three quarters of the farmers were planting grass and digging trenches around the ponds to prevent soil erosion. This could be interpreted to mean that even before training, farmers were privy to the need of avoiding siltation. Isyagi et al, (2009) further posits that dykes or even grass is vital so that the silt has a chance to fall out of the water before that water goes into the pond.

The results shown in Table 13 further indicate that nearly all the farmers had not constructed spillways before training as opposed to the same after training. Most of the traditional ponds observed during the survey had no spillways that would allow for excess water to drain out of the ponds. Pandey and Kushwaha (2010) in their study noted that, spillways provide better regulation of the water supply, thus easier management of the pond.

As shown in Table 13, majority (62%) never used polythene liners to cover their ponds. After training, the practice was adopted by all farmers. Pond liners are useful in helping to curb water seepage. The results further indicate that more than three quarters of the farmers had their ponds not fenced before training unlike after training. This implies that prior to training famers did not have resources and prior knowledge of controlling predators. After training, the farmers were supported with materials and finances by the Ministry of Agriculture, Livestock and Fisheries Development that enabled them to

fence their ponds. The success in pond fish farming depends on how best one can utilize best practices in such a way that maximum production of fish takes place in a given pond system. The complex process in the fish production involving combinations of many practices results in unlimited variations in management.

When interviewed extension agents and agricultural officers stated that many of the farmers had limited knowledge on pond site selection prior to training. Extension Agents further stated that before training farmers' lacked requisite knowledge on selection of the right type of site, soil and size of fish to stock including general management. Munialo (2011) presents the view that the challenges facing farmers in fish pond establishment probably lies in inadequate knowledge which would have been acquired through inappropriate training programmes.

On further interrogation, agricultural officers and extension agents stated that after training farmers constructed ponds as per the required designs. However, the choice of a particular design depends on the kind of water supply available and the existing topography of the site. Regarding construction of standard sized ponds, the extension agents reported that many farmers had constructed non-standard ponds. Most of the ponds constructed before training had non-proportional dimensions and ranged from rectangular, trapezoid or square in shape. This information was collaborated through farm observations. Famers had constructed the recommended pond size because the extension agents provided technical support through after training follow-ups.

Regarding water circulators, the agricultural extension and fisheries officers interviewed indicated that farmers had regular water but no water circulators before and after training. Water circulators are ideal for creating directional water flow in the pond to prevent growth of unwanted algae and ensure there is vital oxygen. Using observation checklist, the study established that there was reliable water supply in most of the ponds observed.

Regarding management of water quality, the extension and ward fisheries officers interviewed were asked to indicate whether farmers managed pond water quality properly. An extension agent reported that water quality is the first most important limiting factor in pond fish production. It is also the most difficult production factor to understand, predict and manage. Its quality directly affects feed efficiency, growth rates, the fish's health and survival. Thus, the key water quality parameters for pond

production are temperature, Dissolved Oxygen, Turbidity, Nutrients, bacteria, PH, hardness, algae, metals and protozoan parasites. To some extent farmers have had experiences with water quality problems in their ponds, ranging from muddy water to fish kills. Unfortunately, most pond owners have never tested their ponds, and water quality problems are usually only detected after they cause a problem. Bhatnagar and Devi (2013) argue that water quality conditions in a pond are controlled by both natural processes and human activity. The effects of these activities can often be minimized through proper management and early detection of problems through testing. Concerns about pond water quality are directly related to the use(s) of the pond.

On further interrogation the ward fisheries officers indicated that majority of the farmers had not fenced their ponds. Observational data collaborated the reports by the ward fisheries officers. A typical response from one of the extension agents supports this finding. Most ponds in this area have not been secured. Fencing a pond is needed to prevent livestock from trampling pond banks, which causes pond shallowing, muddy water, and loss of fish. The results imply that farmers in the study area may not be leaping maximally from their ponds since some of the fish may be lost to predators. Bhatnagar and Devi (2013) assert that in order to control fish predators and prevent theft of fish/unauthorized fishing, farmers should fence round a pond edge.

4.4 Fish Production Methods Used Before and After Training

Objective two of the study was to determine the relationship between fish production methods applied by farmers before and after FFEP training programme in Meru South Sub-County, Kenya. In response, farmers were requested to provide responses rated on a five point Likert scale of 1-5 ranging from Never-1; Rarely-2; Sometimes-3; Often-4; and Always-5. The data captured from the farmers is presented in Table 14.

Table 14

Fish Production Methods used before and after Training

Fish Production methods	Before Training n = 180					After Training n = 180				
	N	R	S	O	A	N	R	S	O	A
Sort fingerlings by desired size &type	130 (72%)	50 (28%)	0	0	0	0	0	5 (3%)	55 (31%)	120 (66%)
Stock considering type or species	96 (53%)	74 (41%)	10 (6%)	0	0	0	0	9 (5%)	21 (12%)	150 (83%)
Feed fish using freshly manufactured feeds through broadcasting or sinking methods	163 (91%)	27 (9%)	0	0	0	0	2 (1%)	7 (4%)	23 (13%)	148 (82%)
Adjust feeding rates according to: species, size, fish density, stage in life cycle, water temperature and quality	180 (100%)	0	0	0	0	0	40 (22%)	120 (67%)	20 (11%)	0
Pests and diseases control through proper fencing, netting, removing dead weeds, use of scarecrows, use of medicated feeds , avoid water pollution and culling.	0	0	135 (75%)	30 (17%)	15 (8%)	0	0	0	89 (49%)	91 51%)
Fertilize ponds using inorganic(fertilizer) or organic(manure)	167 (93%)	13 (7%)	0	0	0	0	0	9 (5%)	121 (67%)	50 (28%)
Liming ponds regularly by applying liming materials over the water surface or draining before liming	171 (95%)	9 (5%)	0	0	0	0	0	74 (41%)	45 (25%)	51 (34%)
Keeping pond production records	175 (97%)	0	5 (3%)	0	0	0	0	0	86 (48%)	94 (52%)

Key: N-Never-1; R-Rarely-2; S- Sometimes-3; O-Often-4; A-Always-5

The results indicate that before training majority (72%) of the farmers were using methods such as sorting fingerlings by desired size and type. Nearly 28 % did it on rare occasions as opposed to 31 % that do it often and 66 % that does it always after undergoing training. This means that the change of practice was as a result of training or information gain. Sarma, Talukdar and Mishra (2011) posited that it is good to know the source of good quality fish seeds (fingerlings). Some stunted or sick fish may be sold as fingerlings. The bad quality fish cannot grow to acceptable market sizes and may not even be acceptable in the markets. Sourcing fingerlings from certified sources is important. Interview responses indicated that only few farmers selected quality fingerlings for stocking their ponds considering desired size and type. One Agricultural Officer affirms this by alluding that many farmers are yet to adopt the practice of selecting quality fingerlings. Most of them stock their ponds with any type of fingerlings without knowing their source and have less consideration for quality.

On interrogation regarding the criteria for selection of right species and fingerlings, most of the interviewed extension and agricultural officers indicated that temperature and water salinity were the main criteria for selecting fingerlings for pond stocking. This sentiment is captured in a verbatim report from one Extension Agent who indicated that: when it comes to production performance nothing will affect your end product more than the selection of the right fingerlings. The choice of species for stocking and rearing is governed by source, physical appearance and how they swim, temperature of the environment and level of water freshness and tolerance to a wide range of environmental conditions where the ponds are established.

Moehl, Brummett, Boniface and Coche (2006) compliment by asserting that, every farmer should be in position to assess the physical characteristics and physiological status of good fingerlings. Poor quality stock will give poor production performance regardless of other factors. Further, the results indicate that before training majority (53%) of the farmers reported that they never stocked ponds with right type and species while 41 % said they rarely practiced this. A paradigm shift is however noted after training as indicated by nearly three quarters (83%) farmers that were stocking their ponds with right species and density. This result can be interpreted to mean that training had relationship between farmers' production practices positively. This finding is in tandem with the findings of Sarma et al, (2011) who established that training has positive impacts on farmers' adoption of new technologies.

The responses obtained from farmers were qualified by the extension and agricultural officers that took part in the study. Interview responses from this category of respondents indicated that a standard pond (300 square metres) require 750 baby fish. This means 25 fish in $1m^2$. An Extension Agent reported that after training, more farmers were stocking ponds based on species one wanted to raise and which would do best in their ponds and the size of the ponds. It is important for farmers to observe stocking rules because stocking beyond certain number will cause competition for space, feed, oxygen, light and create aggressive interaction among the fish. Further there will be excessive accumulation of excretory matter in the pond. The results in Table 14 show that before training nearly 91 % of the farmers reported not to have been feeding fish using freshly manufactured feeds through broadcasting or sinking methods. This however changed after undergoing training as evidenced by 82% of the farmers who were always formulating the right feed material. This means that during training farmers learnt how to formulate right feed material and adopted the practice. In a study of the impact of farmer field schools on agricultural productivity and poverty in East Africa, Davis, Nkonya, Kato, Mekonnen and Odendo (2012) established that knowledge gained through training has a positive relationship between on farmers' practices.

When asked whether farmers feed fish using freshly manufactured feeds through broadcasting or sinking methods, the extension and agricultural officers reported that this was seldom done before training. An Agricultural Officer reported that before training many farmers had limited feed formulation and feeding knowledge. Therefore, they never feed fish using freshly manufactured feeds through broadcasting or sinking methods. On visiting the farms the researcher found that farmers fed fish considering fish species and density, size and stage in life cycle. Rajan *et al*., (2013) argues that ponds produce some natural food for fish but sometimes not enough to really get the fish you want. This could be the reason why supplemental feeding is required. As a result, farmers have to buy formulated feed material. Formulated fish feeds in pellet form are very common and available in a sinking or floating form. Fish feeds come in various forms like powder, pellets, marsh or granules. Farmers should always consult fish feeds experts for correct information.

Extension and agricultural officers were asked to explain how farmers stored the feed material to avoid spoilage. It was evident from the observation schedule that one of the most serious issues facing pond fish farmers in Meru South Sub County was poor

handling and storage of the feeds. Farmers lack the basic standards necessary for the storage and handling of feed materials to ensure feed freshness and minimize the exposure to contamination due to birds, rodents, insects and other environmental factors. In most cases feeds are exposed to direct sunlight, heat, moisture, and the prevailing weather conditions. These poor storage conditions certainly lead to poor feed quality. One Agricultural Officer reported that any farmers poorly store feed materials often leaving them open to the prevailing weather conditions for several weeks during which time the feed quality will almost certainly deteriorate.

The results further show that before training, none of the farmers adjusted feeding rates according to species, size, and population density; stage in life cycle, water temperature and quality. However, after training, it was now a common practice as reflected by 67 percent farmers that sometimes do fish sampling, 22% reported that they do it but occasionally and 11 % that do it often. In a study that sought to establish the impact of training on transfer of aquaculture technologies in some selected areas of Jamalpur, Bangladesh, Azad (2005) established that majority of the farmers were practicing feeding rates adjustment according to species, size, fish density, stage in life cycle, water temperature and quality.

The results of this study further show that before and after training farmers did control pest and diseases variedly. About three quarters did so occasionally before training 17 % did it sparingly and 8 % did it always. After training nearly half always practiced pest and disease control while 49 % often did it using methods such as proper fencing, netting, removing dead weeds, use of scarecrows, use of medicated feeds, avoid water pollution and culling. This is contrary to Azad (2005) findings that most farmers always practice skills leant in training programme. It was evident from the researcher observation that pest and disease control was not preserve of training. Farmers knew the value of pest and disease control even before training.

When asked to explain how farmers' controlled pests and diseases, before and after training, it was evident from the extension and agricultural officers that most common pest/predator control mechanisms employed by farmers before and after training included fencing, use of guard animals, frightening devices and double screens are usually installed at the main intake to ensure that pests and predators are prevented from entering the pond system. Disease control was done by removing fish found to be

floating in the pond and checking of fingerlings before stocking. A verbatim response captured from one agricultural officer shows that pest and diseases account for the majority of fish losses in pond fish farming, thus the importance of practicing preventative methods. Common control methods practiced by farmers include fencing, use of scaring devices, guard animals and culling of sick ones. It is important to note that when utilizing such methods, the target predator usually adapts to the tactics quickly and therefore these methods must be integrated with others to be effective.

From the results shown in Table 14, it can be deduced that nearly all 93percent of the farmers never fertilized their ponds either by using inorganic (fertilizer) or organic (manure) before training. After training, more than two thirds of them often fertilized their ponds. This implies that there was knowledge gained on pond fertilization after training. Training is thus vital for dissemination of critical information for the adoption of pond fish farming. Bhatnagar and Devi (2013) contend that water fertility determines ponds productivity. Pond fertilization stimulates the growth of microscopic plants that fish feed on. This can be done using compost made with animal manure and plant material. On interrogating the extension and agricultural officers it was found that majority of the farmers only fertilized their ponds prior to fish stocking; seldom afterwards before training. An Extension Agent supported this by asserting that farmers fertilize their ponds by adding manure and inorganic fertilizer. However, before training, many farmers were not knowledgeable about this practice.

Bhatnagar and Devi (2013) inform that fertilization stimulates the growth of the microscopic plants that feed the fish and shade out undesirable weeds. Large ponds should be fertilized regularly using either organic or inorganic fertilizers like urea, ammonium phosphate, or both, to maintain the plankton population in the pond. The fertilizers are either broadcasted over the pond water surface or kept in sacks suspended from poles staked at certain portions along the pond periphery. It is evident from the results that before training 95 percent of the farmers never limed their ponds regularly by applying liming materials over the water surface or draining before liming as compared with 34 % that always did so after training. This is a clear indication that before training farmers had no idea of pond liming. The findings of Sarma *et al*, (2011) that the knowledge level of farmers on pond liming before training was limited is supported by this finding. In addition to fertilization, ponds also need to be given regular doses of lime. Adding lime (finely crushed limestone) to a pond reduces acidity of bottom soils

and makes nutrients more available, increasing production of the microscopic plants and animals that start the food chain that feeds fish. Adding lime also has the added benefit of increasing the hardness (calcium, magnesium) of the water as well. When asked to indicate whether farmers limed their ponds, those interviewed reported that the practice was adopted after famers training. This is in tandem with the farmers' responses. An extension agent reported that none of the farmers used lime in their ponds before training

The results in Table 14 show that nearly all 97 percent farmers never kept pond production records before training as compared with about 52 % that always keep these records after training. This is in tandem with Osure (2011) findings that small scale farmers in rural areas rarely keep farms records. This means that farmers training were critical in enabling them to make production records. Records are important in fish farming because they help the farmer to control and monitor production and reproduction activities and to identify the results both technical and financial. When asked their opinion regarding farmers keeping of pond production records, nearly all the extension and agricultural officers interviewed sated that majority of the farmers did not have farms record. However, even after training nearly three quarters were not keeping accurate records. This means that record keeping is an area that should be focused into in future training programmes. A response from extension agent shows that very few farmers if any kept farm records before training. The situation is different after training because even though farmers keep these records, most of them are not satisfactory as the information given is sketchy.

Okwu and Ejembi (2010) assert that the prime objective of a farmer is to manage his farm in such a way that it is a continuing source of income. In order to achieve this, he/she needs to implement a set of good management measures and technical skills through good record keeping and administration. Osure (2011) notes that the main type of production records a fish farmer needs to keep includes identification, breeding and stocking, production, disease and treatment as well as financial records. This study explored the relationship between of the Fish Farming Enterprise and Productivity Program (FFEPP) on fish farming practices and production in Meru South Sub County. It is deciphered that training had a significant relationship between on fish production and management practices as there were relationship between in relation to selection of quality fingerlings, where farmers tended not to before training. There was also a relationship between in stocking ponds with the right species and density, making the

right feed material, sampling to adjust feeding rates and disease control, frequency of fertilizing ponds and in the type of fertilizers used, pond liming and record keeping. The results of this study therefore show that effective routine management practices include stocking, feeding, fertilization, controlling water levels, quality, pH, weeds, predators and diseases control.

4.5 Fish Harvesting Practices Before and After Training

Objective three of the study was to find out if there was a significant relationship between fish harvesting methods employed by the farmers before and after undergoing FFEP training programme in Meru South Sub-County. In response, farmers were requested to provide responses rated on a five point Likert scale of 1-5 ranging from Never-1; Rarely-2; Sometimes-3; Often-4 and Always-5. The data captured from the farmers is presented in Table 15.

Table 15
Fish Harvesting Practices used before and after Training

Harvesting Practices	Before Training n = 180					After Training n = 180				
	N	R	S	O	A	N	R	S	O	A
Harvest based on marketing plan/demand is high	12 (7%)	34 (19%)	110 (61%)	18 (10%)	6 (3%)	0	0	0	140 (78%)	40 (22%)
Harvest before pond carrying capacity	173 (96%)	7 (4%)	0	0	0	0	40 (23%)	34 (19%)	67 (37%)	39 (21%)
Use recommended nets	40 (23%)	17 (9%)	57 (32%)	45 (25%)	21 (11%)	0	0	0	162 (90%)	18 (10%)
Harvest when fish are mature	0	0	98 (54%)	76 (42%)	6 (4%)	0	0	0	150 (83%)	30 (17%)
Harvest early in the morning	57 (32%)	49 (27%)	74 (41%)	0	0	0	0	62 (34%)	54 (30%)	64 (36%)
Clean harvested fish	0	0	0	138 (77%)	42 (23%)	0	0	0	0	180 (100%)
Stop feeding fish two days before harvesting	0	0	0	0	0	0	0	0	104 (58%)	76 (42%)
Stop applying fertilizer 1-2 weeks before harvesting	0	0	0	0	0	0	0	0	121 (67%)	59 (33%)
Keep harvesting records	178 (99%)	2 (1%)	0	0	0	0	0	58 (36%)	62 (34%)	62 (34%)

Key: N-Never; R-Rarely; S- Sometimes; O-Often; A-Always

The results show that before training majority 61 percent of the farmers sometimes harvested fish based on marketing plan or when demand was high as compared with majority (78%) that practice this quite often after training. This could be interpreted to mean that there was a change in practice after training. Olaoye, Ashley-Dejo and Adelaja (2014) found that training promotes knowledge and skill development which in turn may strengthen a force for rapid adoption of innovations. This was supported by an agricultural extension officer who reported that:

> *"Over the years many farmers have been harvesting fish without a proper market survey of consumer preferences, demand, comparing current market channels and exploring potential markets. Therefore, a fish farmer does not encounter a market with many buyers but rather a situation in which he meets more fellow sellers than buyers. More often than not, they don't get value for their fish".*

Similarly, a ward fisheries officer said that:

> *"When fish are to be harvested for market, farmers should ensure that the market has been arranged first and is ready to take the fish".*

With regard to whether farmers harvested market size fish, about three quarters of the agricultural extension agents and officers interviewed reported that:

> *"Majority of farmers were not attaining the desirable marketable size. This can be explained by the fact that most of the ponds had reached their maximum carrying capacity or there was stunted growth of the fish. During training farmers were sensitized on harvesting fish when they reached market size".*

In respect to farmers practicing harvest before the pond carrying capacity, the study results show that before training nearly all 96 percent of the farmers said they never practiced this as compared with 37 % and 21 % that often and always did this after training. This suggested that the farmers actually had benefited from the training courses they attended and as such majority of them were able to practice harvesting before reaching the pond carrying capacity at their farm fields. This implies that the change of practice was as result of knowledge gained through training.

The responses from one of the extension agents indicate that before training, majority of the farmers had little knowledge of harvesting before reaching pond carrying capacity. Thus, majority would in many occasions harvest fish after ponds had reached to their carrying capacity. When this is not done there will be overpopulation and the pond becomes overcrowded. As a result, the space fish occupies shrinks correspondingly. With a limited living space, the growth of fish will be in turn impaired. In support of this, an agricultural officer who also took part in the survey indicated that there were few

farmers who knew the importance of harvesting fish before they got overpopulated before training. With regard to use of recommended nets, the results in Table 15 show that before training majority 32 percent indicated they sometimes did when compared with 90% that quite often used recommended nets after training. This again could be interpreted to mean that training had a relationship between on farmers harvesting with respect to use of right tools. During interview with one of the extension agent that participated in the study it was established that before training most farmers used poor fishing gears such as mosquito nets and wire mesh to harvest fish and this could have led to injury of fish. This is in conformity with Ngwili (2016) whose study on market characterization and consumption of farmed fish in Kiambu and Machakos Counties, Kenya observed that most farmers in the two counties used poor fishing gears such as mosquito nets and wire mesh to harvest fish and this could have led to injury of fish. It could have also resulted in harvesting under-sized fish and contamination of the pond water by the chemicals contained in the mosquito nets.

The results further show that before training 54 percent of the pond fish farmers that were surveyed sometimes harvested mature fish in contrast with 42 % that often did. A paradigm shift is seen after training where 83 % report that they often harvest mature fish. This could be interpreted to mean that the paradigm shift noted was as a result of training. Farmers with no skills and know-how about certain improved husbandry practices have less probability of adopting new technologies that are introduced. In support of this, one extension agent reported that indeed farmers harvest mature fish most of the time because consumers like mature and big fish. The findings are congruent with Gupta and Acosta's (2004) arguments that consumers in Kenya prefer large sized whole fish to smaller fish. Size is mainly relationship between by management practices used especially species stocked, feeding and aeration of ponds.

The study results show that before training majority (32%) of the farmers said they had never harvested fish early in the morning or late in the evening as compared with 27 % that indicated they did it but rarely. After training, it is found that 36 % of the farmers reported that they often harvested fish either early in the morning or late in the evening. The best practice is that harvesting should be done early in the morning or late in the evening when fish are not very active (Tynsong, & Tiwari, 2008). Generally, knowledge and practical skills provision through farmers' training is thought to have created a

favorable mental attitude for the acceptance of improved practices especially of management-intensive practices like harvesting. The foregoing implies that training is vital to enable farmers acquire knowledge and skills necessary to enable then adopt pond fish farming technology. The results further show that even before training, majority (77%) of the farmers' often cleaned fish after harvesting. Kiaya (2014) recommend that once harvested, fish should be handled with care and transported to the market while still fresh and clean. Where the fish are not destined for immediate sale, simple processing at the farm level can greatly reduce post-harvest losses. Interviewed extension agents and agricultural officers responded in the affirmative that it is a common procedure for farmers to clean harvested fish. This practice does not need one to have undergone any training to do so. Emphasis on careful handling, cleaning, processing, packaging and transport are important post-harvest practices.

The results of this study show that before training, all (100%) farmers never stopped to feeding fish at least two days before harvesting. However, after training it was established that majority 58 percent of the farmers often stops feeding fish some few days before harvesting. This is vital to allow the gut of fish time to empty which aids gutting and cleaning of the fish before marketing (Kiaya, 2014). A similar trend was established regarding farmers not stopping to apply fertilizer 1-2 weeks before harvesting. But after training a change in practice is observed. It can be inferred that farmers' training equipped them with improved practices, which helped them to adopt and practice effectively what was learnt. The skills acquired through training helped the farmers to carry out an improved practice effectively. If farmers are well trained in new practices, they may need minimal technical advice and outside backup support.

Regarding farmers keeping harvest records, the results show that 99 percent of the farmers never kept harvest records before training. During farmer visits and data collection stage, one farmer indeed remarked that an extension officer made him discover that the records he kept were not adequate to provide useful information. The farmer attested to acquiring a lot of knowledge on pond fish farming from the training and technical advice from extension officers who visited his farm. This farmer reported that after training and receiving support from the extension agents he had kept records on quantities of fish harvested per every harvest.

4.6 Fish Marketing Strategies Used Before and After Training

The fourth objective of the study was to determine whether there was a significant relationship between fish marketing strategies employed by pond fish farmers before and after training. In response, farmers were requested to provide responses rated on a five point Likert scale ranging Never-1; Rarely-2; Sometimes-3; Often-4 and Always-5. The data captured from the farmers is presented in Table 16.

Table 16

Marketing Strategies used before and after Training

Marketing practices used	Before Training n =180					After Training n =180				
	N	R	S	O	A	N	R	S	O	A
Conducts a market survey before selling	160 (89.9%)	20 (11.1%)	0	0	0	0	0	40 (22.2%)	110 (61.1%)	30 (16.7%)
Sell when prices are high	0	60 (33.3%)	55 (30.6%)	65 (36.1%)	0	0	0	0	10 (5.6%)	170 (94.4%)
Sell through cooperatives or marketing groups	166 (92.2%)	14 (7.8%)	0	0	0	0	5 (2.8%)	29 (16.1%)	130 (72.2%)	16 (8.9%)
Sells fish while fresh	42 (23.3%)	39 (21.7%)	99 (55.0%)	0	0	0	0	0	8 (4.4%)	172 (95.6%)
Advertises	154 (86.0%)	26 (14.0%)	0	0	0	138 (76.7%)	42 (23.3%)	0	0	0
Packages fish	178 (98.9%)	2 (1.1%)	0	0	0	153 (85%)	15 (8.3%)	12 (6.7%)	0	0
Avoids fish brokers	0	0	0	0	180 (100%)					180 (100%)

The results in Table 16 show that before training majority (89.9%) of the farmers never made any market survey to know the kind of fish required and customer preferences as compared with 61.1 % who after training indicated they often conducted a market survey before harvesting their fish. This means that such farmers do not receive any marketing information and are thus unaware of any standards to be maintained. Wetengere (2008) notes, many farmers have limited market information regarding pricing policy and targets. Training coupled with extension services could be effective tools for transfer of

market information to farmers. Extension agents and agricultural officers interviewed mentioned that fish harvesting must be timed and tailored to meet the local supply and demand patterns. The time lapse between fish harvest and purchase by customers is critical for fresh fish because fresh fish cannot be held for long periods of time without serious losses. The price of fish is fixed neither by the government nor by the fisheries cooperatives, nor even by the trade associations. However, the price is relationship between by the price at which the farmers want to sell their fish and the amount of profit they intend to gain and it is fixed through supply and demand interaction.

The results further show that before training, 36.1 percent of the farmers that took part in the study reported that they do not always sell fish when prices are high. Results of observation schedule revealed that farmers do not always sell their fish when prices are high. This could be attributed to farmers' lack of knowledge on fish prices. However, it is evident that after training nearly all farmers (94.4%) indicated that ensured they timed their harvest when fish availability in the market was low to leap higher income. Extension agents that were interviewed mentioned several things that were essential in the determination of fish prices. Perhaps the most critical factors identified were the quality of the fish, availability and purchasing power of the customer. This was supported by nearly three quarters of the extension agents who reported that many farmers do not observe this probably due to the need for immediate cash income. It can be difficult in some way to predict the prices of fish, because they constantly vary based on differing factors. Farmers need to take into account many things when deciding what price to charge on the fish harvested. That is availability in the market, quality, and purchasing power of the customer. Proper timing is also critical because prices are generally lowest during fish harvest, and rise as supplies diminish.

The responses from extension agents and agricultural officers resonate with Namisi (2005) findings that the major factors identified to relationship between the prices of fish in the market include, quality of fish and location of the customers. Knowing the factors that affect fish prices can help the producer develop selling strategies. Analysis of interview responses showed that farmers were trained on issues related to pricing mechanisms. The results of this study also show that not many farmers sold their fish through cooperatives or marketing groups before training. Out of the 180 pond fish farmers surveyed, 166 (92.2%) reported never selling their fish through cooperatives or

marketing groups while 14 (7.8%) did so but on rare occasions. This was however different after training as nearly three quarters of the farmers were more often than not using cooperatives or marketing groups to sell their fish. This means that the training provided to farmers has not only helped them improve their marketing strategies but also enabled them to join cooperative societies that can help them with soft loans to acquire inputs. When asked whether pond fish farmers in Meru South Sub County marketed their fish through cooperatives, interviewed extension and agricultural officers said that initially farmers were not members of cooperatives or marketing groups. Each sold their fish individually. Since the quantity of fish produced was low, they sold it in the local market. However, after adopting large scale fish farming after training, most of the farmers were now members of certain cooperatives that acted as an outlet for fish marketing. Analysis of interview responses showed that farmers have been trained in issues related to marketing channels.

The results shown in Table16 indicate that before training majority 55.0 percent of the farmers sometimes sold fresh fish. However 95.6% of the farmers reported they always sold fresh fish after training. This finding was supported by agricultural officers and extension agents who arguably said that the selling of fresh fish was due to the fact that fish cannot be held for long periods of time without going bad or deteriorating in quality. In addition, fresh fish, especially live, are highly preferred by consumers. This finding is in tandem with Sarma, Talukda and Mishra (2011) who contends that selling fresh fish demands an expedited process because fish is highly perishable. Results from surveyed farmers further show that before training, majority (86%) of the farmers had never advertised their product. This probably suggests that farmers had limited knowledge on marketing and related business skills before training. Failure to advertise contributes to lack of awareness of fish and fish products by the consumers. Advertising is thus a powerful marketing communication tool.

The results further show that nearly all (98.9%) and 85% of the farmers have never packaged fish for sale before and after training respectively. This was confirmed by extension agents who indicated that farmers transport fresh fish in water buckets or in baskets. In addition, many farmers do not have equipment for storing or packaging fish to keep them for long periods without affecting their quality. According to the responses received from extension agents and agricultural officers, this aspect is not influenced by

farmers training whatsoever. Through training farmers acquired knowledge on packaging and realized that there was need to package their fish. The study findings show that fish selling business is dominated by farmers themselves. This is reflected by reports from an overwhelming majority (100%) that indicated that they always avoided selling through intermediaries before and after training. This means that all farmers that took part in the study do not prefer using fish brokers to sell their fish. Training therefore helped farmers to realize that fish brokers reduces their profitability by acting as cartels who collude to exploit farmers by fixing prices to compel consumers to have no other choice but to buy from them.

4.7 Hypotheses Testing

The following hypotheses were tested:

$H0_1$ There is no statistically significant relationship between the demographic Characteristics and adoption of pond fish farming before and after training in Meru South Sub County

$H0_2$ There is no statistically significant relationship between the number of ponds constructed by farmers before and after FFEPTP training in Meru South Sub County

$H0_3$ There is no statistically significant relationship between fish production methods used by farmers before and after FFEPTP training in Meru South Sub County

$H0_4$ There is no statistically significant relationship between fish harvesting practices used by the farmers before and after FFEPTP training in Meru South Sub County

$H0_5$ There is no statistically significant relationship between fish marketing strategies used by farmers before and after FFEPTP training in Meru South Sub County

4.7.1 Relationship between Farmers Demographic Characteristics and Adoption of Pond Fish Farming

This study tested the hypothesis that there is no statistically significant relationship between the demographic characteristics and adoption of pond fish farming before and after training in Meru South Sub County. First, the demographic characteristics of farmers (gender, age and education level) were cross-tabulated to differentiate their adoption segregated by these variables. The results of cross-tabulation of gender, age and education level of farmers and adoption of pond fish farming is presented in Table 17.

Table 171
Cross-Tabulation of Gender, Age and Education Level of Farmers and Adoption of Pond Fish Farming

Variable	Number of ponds constructed n=180		Adoption Rate = $\frac{Ponds\ after - \text{Ponds before}}{Total\ Number\ of\ Farmers} x100$
	Before training	After training	
Male	21	185	91.0%
Female	13	40	15.0%
Below 20 years	2	8	3.3%
21-30	6	15	5.0%
31-40	10	60	27.8%
41-50	12	102	50.0%
51 and above years	4	40	20.0%
Primary level of education	6	25	10.6%
Secondary level	18	125	59.4%
Tertiary/college	10	75	36.1%

The results show that there was a higher rate of adoption among male farmers at 91 percent, 50.0% among farmers in the 41-50 age bracket and 59.4% among farmers whose education level was secondary. Similar findings were obtained by Ngwili, *et al.* (2015) in their study of characterization of fish farming systems in Kiambu and Machakos Counties, Kenya. The higher rate of pond fish farming among the males in the study population could be attributed to factors such as land ownership, gender stereotyping which places farming roles to men in the study area while females are socialized to up family roles such as child caretaking and related household chores.With reference to age, the results show that there was a higher rate (50.0%) of adoption among those aged between 41 and 50 years. This is in agreement with Ngwili *et al*. (2015) findings that farmers of middle age are more vibrant and have the stamina to engage in farming than the aged folk. In a similar vein, Wetengere (2009) reported that middle aged farmers in Tanzania were more capable of doing laborious activities like pond construction, pond repair and total harvest.

The results also indicate that farmers with secondary school level of education had a higher rate (59.4%) of adoption compared to others in the study population. This observation was in agreement with that of Kimenye (2005) who showed that most of the farmers who engage in fish farming in Kenya have at least a secondary level of education. The fact that a greater number ponds were found among farmers who had secondary level of education imply that dissemination of information on fish farming was likely to yield positive results in terms of better management and improved

productivity. Indeed, farmers that were trained by the government under Fish Enterprise Productivity Programme had minimum of primary level of education. Using multiple regression analysis, the study analyzed the relationship between demographic characteristics (gender, age, level of education) and the level of farmers' adoption of pond fish farming. The linear regression model is as follows:

$Y = \alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + U$

Y = Level of pond fish farming adoption
X_1= Gender (Male, Female)
X_2= Age (Years)
X_3= Education level (Primary, Secondary and Tertiary/College)
U = Error term
The results obtained are shown in Table 18.

Table 18
Multiple Regression Results of relationship between Demographic Characteristics and Adoption of Pond Fish Farming

Variable	Regression coefficient					
	Unstandardized Coefficients			Standardized Coefficients		
	B	Std. Error	Sig.	Beta	t	Sig.
Constant	80.49	10.18	0.000	-4.107	-0.267	0.790
Gender	-0.067	-3.060	0.761	-1.050	-0.349	0.729
Age	0.075	0.591	0.557	0.408	2.732	0.009
Education	-5.551	-2.391	0.020	3.535	1.856	0.069
	R square = 0.161; adjusted R square = 0.098 F-value = 2.584; $p \leq 0.05$			R square = 0.248; adjusted R square = 0.190 F-value = 4.286; $p \leq 0.05$		

The regression results in Table 18 show that gender, age and education level had a positive relationship with the level of adoption of pond fish farming. The results show a weak positive relationship between gender of the farmers and adoption of pond fish farming ($p<0.729$). The study found that women adopting fish farming is low. One possible explanation given by Ogbonna et al (2015) is that the labor requirement in the construction of fish ponds and harvesting of fish is intensive and most people rely on family labour. The results further indicate a significant positive relationship between age and adoption of fish farming ($p<0.009$). In the study the majority of farmers who adopted pond fish farming were in the age of between 41 and 50 years. It has been observed that relatively younger people for example 41-50 years are risk takers relative to older people

(Solomon & Karere, 2013). According to Solomon *et al*. (2013) young people are more exposed than old people and can easily adopt new technology. On the other hand, although older farmers may be less inclined to try new farm practices, they have more access to land, income and other resources.

Further, the results show that the level of education of farmers has a positive significant relationship on the level of adoption ($p<0.069$). Pond fish farmers with secondary level of education in this study have higher adoption level compared with low and higher education. According to Ifejika *et al*. (2007); Ali *et al*. (2010); Solomon and Kerere (2013), education can have an impact on the modernization of the techniques of fish farming where it will help farmers to obtain and understand information about a technology that is often changed. In term of technology adoption, Uematsu & Mishra (2010), proffer that formal education can be a barrier to technology adoption, where education can increases farmer's human capital and gives them more lucrative incentives for employment opportunities off the farm. This situation makes the highly educated to shun the farm for white collar jobs.

4.7.2 Relationship between the Number of Ponds Constructed by Farmers before and After Training

This study tested the hypothesis that there is no statistically significant relationship between the number of ponds constructed by farmers before and after FFEPTP training in Meru South Sub County. To determine if there was a significant relationship between number of ponds constructed before and after training, a Difference-in-Difference (DID) statistical technique was used to study the differential effect of a treatment. The results are shown in Table 19.

Table 19

Difference in Difference to Determine Rate of Change in Pond Construction

Wards	Before training	After training	Change
Chuka	23	130	107
Magumoni	9	70	61
IgambaNg'ombe	2	25	23
Total	34	225	191
DID (Mean) change	**11.33**	**75**	**63.66**

The results show that there was an adoption rate of 63.66 percent after FFEPTP training. This implies that training had a positive link to an increase in pond construction as evidenced by the significant number of ponds constructed after training.

4.7.3 Relationship between Training and Fish Production Methods

The study tested the null hypothesis that there is no statistically significant relationship between in fish production methods practiced by farmers before and after FFEPTP training in Meru South Sub-County, Kenya. The data in Table 20 shows the descriptive statistics with regard to fish production methods.

Table 20

Descriptive Statistics on Fish Production Methods

Fish Production Methods	Descriptive Statistics					
	Before Training			After Training		
	N	Mean	Std. Dev	N	Mean	Std. Dev
Sort fingerlings by desired size & type	180	1.278	0.020	180	4.639	0.151
Stock considering type or species	180	1.522	0.011	180	4.783	0.284
Feed fish by broadcasting or sinking methods	180	1.206	0.045	180	4.761	0.261
Adjust feeding rates	180	1.000	0.176	180	2.889	1.852
Pests and diseases control	180	3.167	3.056	180	4.506	0.066
Fertilize ponds using inorganic (fertilizer) or organic(manure)	180	1.072	0.120	180	4.228	0.005
Liming ponds regularly	180	1.050	0.136	180	3.650	0.360
Keeping pond production records	180	1.056	0.132	180	4.550	0.090
Mean		**1.419**			**4.250**	

The results show that before training the mean responses was 1.419 that corresponds to never on the Likert scale. This implies that before training most of the farmers never practiced the required fish production methods. However, after training the mean responses was 4.250 that correspond to often on the Likert scale implying that most of the farmers utilized required fish production methods. Using regression analysis, the study established the fish production methods practiced by farmers before and after FFEPTP. The results obtained are shown in Table 21.

Table 21

Regression Coefficients of Fish Production Methods Practiced by Farmers before and after Training

Fish Production Methods	Regression Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
Constant	1.197	0.228		5.241	0.000
Sort fingerlings by desired size & type	0.057	0.099	0.039	0.573	0.567
Stock considering type or species	0.086	0.048	0.123	1.785	0.076
Feed fish by broadcasting or sinking methods	0.002	0.050	0.003	0.039	0.969
Adjust feeding rates	0.031	0.043	0.050	0.716	0.475
Pests and diseases control	0.002	0.023	0.005	0.069	0.945
Fertilize ponds using inorganic (fertilizer) or organic(manure)	0.012	0.049	0.017	0.253	0.800
Liming ponds regularly	0.057	0.099	0.039	0.573	0.567
Keeping pond production records	0.047	0.078	0.036	0.543	0.550

Stock considering type or species was the method highly practiced by farmers in the study area ($\beta = 0.123$; $t = 1.785$; $p = 0.076$). A Pearson Correlation analysis was done to establish the degree of association between fish production methods practiced by farmers before and after FFEPTP training. The results detail and calculation of Pearson Correlation Coefficient on training and fish production methods is shown in Table 22.

Table 22
Results of Pearson Correlation Analysis on the Relationship between Fish Production Methods employed before and after training

x	Y	X – Mx	Y – My	(X - Mx)2	(Y - My)2	(X - Mx)(Y - My)
1.278	4.639	-0.141	0.388	0.020	0.283	-0.055
1.522	4.783	0.103	0.532	0.011	0.260	0.055
1.206	4.761	-0.213	0.510	0.045	1.854	-0.109
1.000	2.889	-0.419	-1.362	0.175	0.065	0.570
3.167	4.506	1.748	0.255	3.056	0.001	0.446
1.072	4.228	-0.347	-0.023	0.120	0.361	0.008
1.05	3.65	-0.369	-0.601	0.136	0.090	0.222
1.056	4.55	-0.363	0.299	0.132	0.283	-0.109
		Mx: 1.419	My: 4.251	Sum: 3.695	Sum: 3.065	Sum: 1.029

The value of R^2, the coefficient of determination, is 0.0935.

Key

X: X Values

Y: Y Values

Mx: Mean of X Values

My: Mean of Y Values

X - Mx & Y - My: Deviation scores

$(X - Mx)^2$ & $(Y - My)^2$: Deviation Squared

(X - Mx)(Y - My): Product of Deviation Scores

XValues $\sum$=11.351; Mean= 1.419; $\sum(X - Mx)^2 = SSx = 3.695$

YValues $\sum$=34.006; Mean= 4.251; $\sum(Y - My)^2 = SSy = 3.065$

$r = \sum((X - My)(Y - Mx)) / \sqrt{((SSx)(SSy))}$

$r = 1.029 / \sqrt{((3.695)(3.065))} = 0.3058$

r = 0.3058

From the tabulation, we note that (r=0.3058; p=0.05). Although technically a positive correlation, the relationship between the study variables is weak (the nearer the value is to zero, the weaker the relationship). Thus, the null hypothesis is therefore rejected. This therefore implies that training had a weak positive correlation on fish production methods employed by pond fish farmers in Meru South Sub County.

4.7.3 Relationship between Training and Harvesting Practices

The study tested the null hypothesis that there was no significant relationship between training and harvesting practices employed by the farmers before and after training in Meru South Sub-County, Kenya. The data in Table 23 shows the descriptive statistics with regard to fish production methods.

Table 23

Descriptive Statistics on Fish Harvesting Practices

Fish Harvesting Practices	Descriptive Statistics					
	Before Training			After Training		
	N	Mean	Std. Dev	N	Mean	Std. Dev
Harvest based on marketing plan/demand is high	180	2.844	0.778	180	4.222	0.0001
Harvest before pond carrying capacity	180	1.039	0.852	180	3.580	0.398
Use recommended nets	180	2.944	0.964	180	4.100	0.012
Harvest when fish are mature	180	3.490	2.335	180	4.167	0.002
Harvest early in the morning	180	2.094	0.017	180	4.011	0.040
Clean harvested fish	180	4.233	5.157	180	5.000	0.623
Stop feeding fish two days before harvesting	180	0	3.849	180	4.422	0.045
Stop applying fertilizer 1-2 weeks before harvesting	180	0	3.849	180	4.328	0.014
Keep harvesting records	180	1.011	0.904	180	4.067	0.021
Mean		**1.962**			**4.211**	

The results show that before training the mean responses was 1.962 that corresponds to rarely on the Likert scale. This implies that before training most of the farmers rarely practiced the required fish production methods. However, after training the mean responses was 4.211that correspond to often on the Likert scale implying that most of the farmers utilized required fish production methods.

Using regression analysis, the study established the harvesting practiced used more by farmers before and after FFEPTP training. The result obtained in Table 24.

Table 24

Regression Coefficients of Harvesting Practices before and after Training

Fish Harvesting Practices	Regression Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
Constant	1.169	0.205		5.702	0.000
Harvest based on marketing plan/demand is high	0.051	0.040	0.084	1.297	0.196
Harvest before pond carrying capacity	0.007	0.022	0.021	0.033	0.742
Use recommended nets	0.080	0.040	0.125	1.988	0.048
Harvest when fish are mature	-0.269	0.082	0.210	-3.267	0.001
Harvest early in the morning	-0.029	0.035	0.052	-0.823	0.412
Clean harvested fish	0.147	0.041	0.234	3.622	0.000
Stop feeding fish two days before harvesting	0.087	0.051	0.110	1.700	0.091
Stop applying fertilizer 1-2 weeks before harvesting	0.073	0.057	0.083	1.823	0.201
Keep harvesting records	0.107	0.058	0.188	1.854	0.065

The data on Table 24 shows that cleaning of fish after harvesting was the most common practice employed by farmers ($\beta = 0.234$; $t = 3.622$; $p = 0.000$).

A Pearson Correlation analysis was done to establish the degree of association between fish production methods practiced by farmers before and after FFEPTP training. The results detail and calculation of Pearson Correlation Coefficient on training and fish production methods is shown in Table 25.

Table 25
Results of Pearson Correlation Analysis on the Relationship between Fish Harvesting Practices Employed Before and After Training

x	Y	X - Mx	Y – My	(X - Mx)2	(Y - My)2	(X - Mx)(Y - My)
2.844	4.222	0.882	0.011	0.779	0.000	0.582
1.039	3.580	-0.923	-0.631	0.851	0.398	-0.109
2.944	4.100	0.982	-0.111	0.965	0.012	-0.067
3.490	4.167	1.528	-0.044	2.336	0.002	-0.026
2.094	4.011	0.132	-0.200	0.018	0.040	1.793
4.233	5.000	2.271	0.789	5.159	0.623	-0.414
0	4.422	-1.962	0.211	3.848	0.045	-0.230
0	4.328	-1.962	0.117	3.848	0.014	0.137
1.011	4.067	-0.951	-0.144	0.904	0.021	0.582
		Mx: 1.962	My: 4.211	Sum: 18.707	Sum: 1.154	Sum: 1.675

The value of R^2, the coefficient of determination, is 0.1299.

Key

X: X Values

Y: Y Values

Mx: Mean of X Values

My: Mean of Y Values

X - Mx & Y - My: Deviation scores

$(X - Mx)^2$ & $(Y - My)^2$: Deviation Squared

(X - Mx)(Y - My): Product of Deviation Scores

X Values $\sum$ = 17.655; Mean = 1.962; $\sum$(X - Mx)2 = SSx = 18.707

Y Values $\sum$ = 37.897; Mean = 4.211; $\sum$(Y - My)2 = SSy = 1.154

X and Y Combined (N = 9; $\sum$(X - Mx)(Y - My) = 1.675)

$r = \sum((X - My)(Y - Mx)) / \sqrt{((SSx)(SSy))}$

$r = 1.675 / \sqrt{((18.707)(1.154))} = 0.3604$

r = 0.3604

From the tabulation, we note that (r=0.3604; p=0.05). This therefore implies that although training had a positive impact on farmers' knowledge of fish harvesting and related practices in Meru South Sub County, the association was weak. Thus, the null

hypothesis is rejected. This therefore implies that training had a weak positive correlation on fish production methods employed by pond fish farmers in Meru South Sub County

4.7.4 Relationship between Training and Fish Marketing Strategies

The study tested the null hypothesis that there was no significant relationship between in fish marketing strategies adopted by farmers before and after training in Meru South Sub-County, Kenya. The data in Table 26 shows the descriptive statistics with regard to fish marketing strategies.

Table 26

Descriptive Statistics on Fish Marketing Strategies

Fish Marketing Strategies	Descriptive Statistics					
	Before Training			After Training		
	N	Mean	Std. Dev	N	Mean	Std. Dev
Conducts a market survey before selling	180	1.111	0.600	180	3.944	0.122
Sell when prices are high	180	3.028	1.304	180	4.944	1.820
Sell through cooperatives or marketing groups	180	1.078	0.653	180	3.872	0.077
Sells fish while fresh	180	0.836	1.103	180	4.956	1.852
Advertises	180	1.144	0.551	180	1.233	5.580
Packages fish	180	1.011	0.766	180	1.217	5.655
Avoids fish brokers	180	5.000	9.700	180	5.00	1.974
Mean		**1.886**			**3.595**	

The results in Table 26 show that before training the mean responses was 1.886 that corresponds to never on the Likert scale. This implies that before training most of the farmers rarely used the required fish marketing strategies. However, after training the mean responses was 3.595 that correspond to often on the Likert scale implying that most of the farmers often use the required fish marketing strategies. Using regression analysis, the study established the marketing strategies used more by farmers before and after FFEPTP training. The results obtained are shown in Table 27.

Table 27
Regression Coefficients of Marketing Strategies before and after Training

Fish Marketing Strategies	Regression Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
Constant	1.282	0.222		5.785	0.000
Conducts a market survey before selling	-0.019	0.038	0.034	-0.059	0.604
Sell when prices are high	0.071	0.043	0.110	1.649	0.100
Sell through cooperatives or marketing groups	0.012	0.024	0.033	0.507	0.613
Sells fish while fresh	0.047	0.043	0.071	1.084	0.279
Advertises	-0.263	0.089	-0.197	-2.954	0.003
Packages fish	0.242	0.154	0.017	0.254	0.706
Avoids fish brokers	0.084	0.044	0.128	1.912	0.057

From the results, it is evident that the most practiced marketing strategy is avoiding fish brokers ($\beta = 0.128$; $t = 1.912$; $p = 0.057$). A Pearson Correlation analysis was done to establish the degree of association between training and marketing strategies employed by farmers. The tabulation of Pearson Correlation Coefficient is shown in Table 28.

Table 28
Results of Pearson Correlation Analysis on the Relationship between Fish Marketing Strategies Employed Before and After Training

x	Y	X - Mx	Y – My	(X - Mx)2	(Y - My)2	(X - Mx)(Y - My)
1.111	3.944	1.141	0.349	0.602	0.122	-0.271
3.028	4.944	-0.809	1.349	1.302	1.819	1.539
1.078	3.872	-1.051	0.277	0.654	0.077	-0.224
0.836	4.956	-0.743	1.361	1.104	1.852	-1.430
1.144	1.233	-0.876	-2.362	0.552	5.580	1.755
1.011	1.217	3.113	-2.378	0.767	5.656	2.083
5.000	5.00	1.141	1.405	9.692	1.974	4.374
		Mx: 1.887	My: 3.595	Sum: 14.673	Sum: 17.079	Sum: 7.826

The value of R^2, the coefficient of determination, is 0.2444.

Key

X: X Values

Y: Y Values

Mx: Mean of X Values

My: Mean of Y Values

X - Mx & Y - My: Deviation scores

$(X - Mx)^2$ & $(Y - My)^2$: Deviation Squared

(X - Mx)(Y - My): Product of Deviation Scores

X Values ∑ = 13.208; Mean = 1.887; ∑(X - Mx)2 = SSx = 14.673

Y Values ∑ = 25.166; Mean = 3.595; ∑(Y - My)2 = SSy = 17.079

X and Y Combined (N = 7; ∑(X - Mx)(Y - My) = 7.826)

r = ∑((X - My)(Y - Mx)) / √((SSx)(SSy))

r = 7.826 / √((14.673)(17.079)) = 0.4944

r = 0.4944

From the tabulation, we note that (r=0.4944; p=0.05). This therefore implies that although training had a positive impact on farmers' knowledge of fish marketing strategies in Meru South Sub County, the association was weak. Thus, the null hypothesis is rejected. This therefore implies that training had a weak positive correlation on fish marketing strategies employed by pond fish farmers in Meru South Sub County.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter gives the summary, conclusions, recommendations and suggestions for further research.

5.2 Summary of the Study

This study determined the relationship between the number of ponds constructed by farmers before and after training. The results show that there was an adoption rate of 63.66 percent after FFEPTP training. This implies that training had a positive link to an increase in pond construction as evidenced by the significant number of ponds constructed after training.

The study tested the null hypothesis that there is no statistically significant relationship between in fish production methods practiced by farmers before and after FFEPTP training in Meru South Sub-County, Kenya. A Pearson Correlation analysis was done to establish the degree of association between fish production methods practiced by farmers before and after FFEPTP training. A weak positive correlation, was established ($r=0.3058$; $p=0.05$). This therefore implies that training had a weak positive correlation on fish production methods employed by pond fish farmers in Meru South Sub County.

The study further tested the null hypothesis that there was no significant relationship between training and harvesting practices employed by the farmers before and after training in Meru South Sub-County, Kenya. The results show that before training the mean responses was 1.962 that corresponds to rarely on the Likert scale. This implies that before training most of the farmers rarely practiced the required fish production methods. However, after training the mean responses was 4.211that correspond to often on the Likert scale implying that most of the farmers utilized required fish production methods.

A Pearson Correlation analysis was done to establish the degree of association between fish production methods practiced by farmers before and after FFEPTP training. From the tabulation ($r=0.3604$; $p=0.05$). This therefore implies that although training had a positive impact on farmers' knowledge of fish harvesting and related practices in Meru South Sub County, the association was weak. This therefore implies that training had a

weak positive correlation on fish harvesting methods employed by pond fish farmers in Meru South Sub County.

The study tested the null hypothesis that there was no significant relationship between fish marketing strategies adopted by farmers before and after training in Meru South Sub-County, Kenya. It is observed from the tabulation, that (r=0.4944; p=0.05). This therefore implies that although training had a positive impact on farmers' knowledge of fish marketing strategies in Meru South Sub County, the association was weak. Thus, the null hypothesis is rejected. This therefore implies that training had a weak positive correlation on fish marketing strategies employed by pond fish farmers in Meru South Sub County.

5.3 Conclusions

Based on the objectives of this study, the following conclusions are made:

i) There was a positive relationship between the training and the numbers of ponds constructed after FFEPTP training. An adoption rate of 63.66% was registered after FFEPTP training. Thus, training had a positive influence in pond construction as evidenced by the significant increase in number of ponds constructed after training.

ii) The FFEPTP has a positive influence on pond production methods since there was a mean of 1.4 before training and 4.25 after training. Therefore there is a positive relationship between fish production methods used by farmers before and after FFEPTP training.

iii) There is a positive relationship between fish harvesting practices used by farmers before and after undergoing FFEPTP training This is evidenced by the fact that before training the mean was 1.962 as compared to 4.211obtained after training..

iv) There is a positive relationship between fish marketing strategies used by farmers before and after FFEPTP training. Before training a mean of 1.886 farmers never carried out proper marketing strategies as compared to 3.595 who often practice it.

5.4 Recommendations of the Study

Basing on the findings and conclusions of the study, the following recommendations are made:

i) That extension agents and ward fisheries officers should be proactive in providing farmers with technical support needed for pond establishment. They should also conduct a needs assessment before executing a training programme to enable in the mapping of knowledge gaps to address during training. They should also scale up follow-ups after training to ensure farmers were following through on the new skills.

ii) Extension Agents and Ward Fisheries Officers should emphasis on disseminating unsophisticated, low-cost improved practices, and teaching farmers to make best use of available resources in construction of ponds.

iii) That Extension Agents and Ward Officers should put more effort in reaching fish farmers that have not had contact with them so as to pass useful information about fish production methods. Farmers too should also be eager to receive the extension agents and should always search for their help.

iv) That there is need to for the Extension Agents and Ward Fisheries Officers to constantly remind the farmers on appropriate harvesting methods. In these situations, much investment in training, demonstration, and infrastructure development is necessary to support the introduction and spread of aquaculture as a farm enterprise.

v) That farmers training should focus on fish marketing strategies such as online marketing.

5.5 Suggestions for Further Research

The following are suggestions for further research:

i) The extent to which farmers know how to produce fish is constrained by technical, economic, social and environmental variables. There is need to conduct a study to identify these variables and design local farming systems to improve the yields.

ii) A study should be carried out to determine the role of the fish pond system in the farming system and others activities.

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APPENDIX A

QUESTIONNAIRE FOR POND FISH FARMERS

Introduction

I am William N. Mbiuki, a Masters Student in the Department of Agricultural Education and extension in Egerton University. I am interested in investigating the relationship between of fish farming enterprise productivity training programme on the adoption of inland-based pond fish farming in Meru South Sub-County, Tharaka-Nithi County, Kenya. I kindly request you to answer the questions below to the best of your knowledge. The information provided will be treated with utmost confidentiality and will only be used for the intended purpose.

Section A: Demographic Information

Provide your responses to the following questions by ticking in the appropriate box.

1. What is your gender? i) Male ( ) ii) Female ( )
2. Where did you get information about fish farming from?

……

3. Have you ever undergone FFEPTP?

……

4. a) Did you get the information before or after (FFEPTP)

……

b) If after, did you get any support from the Fisheries Department?

……..

5. Are they still providing the same support to you?

…….

6. Were you contacted for needs assessment before training?

……

7. Did the fisheries, department make a follow up after training

…….

8. Were you provided with reference materials after training?

……

If yes what reference materials were provided with?

Brochures……..

Handouts ……..

Booklets …….

Books…….

9. During the training what areas benefitted you most?

.....

10. Which areas were covered well?

……

11. Do you require further training?

……..

12. Were you trained on record keeping?

……..

If yes what records do you keep?

…….

Section B: Fish Pond Establishment Practices

I: Construction

13. Kindly indicate the number of ponds you had constructed before training and how many additional ones you constructed after training.

Number of ponds constructed before training	Number of ponds constructed after training

II: Establishment

14. How often have you engaged in the following pond establishment practices? Use the scale provided: N-Never = 1; R-Rarely = 2; S- Sometimes = 3; O-Often = 4; A-Always = 5 to give your responses. Tick appropriately.

Pond Establishment Practices	Before Training					After Training				
	N	R	S	O	A	N	R	S	O	A
Considering soil type before construction										
Construct ponds near home to minimize predation										
Construct ponds close to a main water supply										
Construct ponds away from trees which shed leaves										
Ensure pond are exposed to sunlight										
Construct standard sized ponds										
Erect dykes of required standard										
Prevent soil erosion by planting grass and digging trenches around the pond										
Construct spillways										
Use polythene liners to cover the pond										
Fence ponds after construction										

Section C: Fish Production Methods

15 How often have you engaged in the following fish production methods? Kindly Use the scale provided: Never-1; Rarely-2; Sometimes-3; Often-4; and Always-5 to give your responses. Tick appropriately.

Fish Production methods	Before Training					After Training				
	N	R	S	O	A	N	R	S	O	A
Sort fingerlings by desired size & type										
Stock considering type or species										
Feed fish using freshly manufactured feeds through broadcasting or sinking methods										
Adjust feeding rates according to: species, size, fish density, stage in life cycle, water temperature and quality										
Pests and diseases control through proper fencing, netting, removing dead weeds, use of scarecrows, use of medicated feeds, avoid water pollution and culling.										
Fertilize ponds using inorganic(fertilizer) or organic(manure)										
Liming ponds regularly by applying liming materials over the water surface or draining before liming										
Keep pond production records										

Section D: Fish Harvesting Practices

16. How often have you engaged in the following fish harvesting practices? Use the five point Likert scale of 1-5 ranging from Never-1; Rarely-2; Sometimes-3; Often-4 and Always-5 to give your responses. Tick appropriately.

Harvesting Practices	Before Training					After Training				
	N	R	S	O	A	N	R	S	O	A
Harvest based on marketing plan/demand is high										
Harvest before pond carrying capacity										
Use recommended nets										
Harvest when fish are mature										
Harvest early in the morning										
Clean harvested fish										
Stop feeding fish two days before harvesting										
Stop applying fertilizer 1-2 weeks before harvesting										
Keep harvesting records										

Fish Marketing Strategies

17. How often have you engaged in the following fish marketing strategies? Use the five point Likert scale of 1-5 ranging from Never-1; Rarely-2; Sometimes-3; Often-4 and Always-5 to give your responses. Tick appropriately.

Marketing practices used	Before Training					After Training				
	N	R	S	O	A	N	R	S	O	A
Conducts a market survey before selling										
Sell when prices are high										
Sell through cooperatives or marketing groups										
Sells fish while fresh										
Advertises										
Packages fish										
Avoids fish brokers										

APPENDIX B

INTERVIEW GUIDE FOR EXTENSION AGENTS AND FISHERIES OFFICERS

Name of Interviewee : ……

Organization : ……..**.....**

Position Held :……

Name of Interviewer :……..

Date of Interview :……..

Hello. My name is Njeru Mbiuki. I am conducting a survey across Meru South Sub County on Inland-Based Pond Fish Farming. Your contribution will be of great importance. I appreciate your participation in survey.

The interview will last about 30 minutes. There is no right or wrong answers to the questions; I would like to learn about your personal thoughts and attitudes. If you don't understand a question, please tell me and you can add further information at any stage. Your answers will be kept strictly confidential.

May I begin the interview now? YES ☐ NO ☐

Pond Construction and Establishment

The interviewer asks the interviewee questions related to the following and probe to generate in-depth information

Areas of focus	Ask and probe
Soil type	i) What is the best soil type for establishing a fish pond? ii) In your view, have farmers been considering soil type before pond construction? iii) Probe to understand whether training had any knowledge impact on soil type
Proximity to homestead	i) How have the farmers embraced the practice of establishing ponds near home to minimize predation? ii) Probe to understand whether there is any difference in the practice before and after training

Water supply	i) How would you explain the regularity of water supply to fish ponds in Meru South Sub County? ii) Have farmers constructed ponds near a main water supply? Explain. iii) During the FFEP training, were the benefits of constructing ponds near a main water supply taught to the farmers?
Trees which shed leaves	i) During your farms visits, have you noticed ponds constructed away from trees which shed leaves? If yes, what advice did you give? ii) Were the farmers aware of the importance of doing this before training? Explain.
Exposure to sunlight	i) To what extent have farmers constructed fish ponds exposed to sunlight? ii) Give your general observation on the situation of ponds exposed to sunlight before and after training
Size	i) Generally, when would you say farmers had ponds constructed to the approved standards by the MoAFD? ii) Is it before or after training? Explain.
Dykes	What would you give as your comment on the situation of dykes constructed on ponds before and after farmers training?
Soil erosion	i) Which methods of soil erosion control are recommended for fish ponds? ii) Which methods did farmers use before training?
Spillways	Have you come across ponds without spillways after training? Probe to find out whether the situation was the same before training
Polythene liners	When would you say farmers used polythene liners in their fish ponds? Is it before or after training? Explain.
Security	i) Which methods have farmers been using to avoid predation before training? ii) What additional methods were taught to farmers during training? iii) Which methods do farmers prefer most? Explain

Fish Production Methods

Areas of Focus	Ask and Probe
Fingerlings	i) How have farmers been ascertaining the quality of fingerlings before training? ii) Has there been any change in these practices after training?
Pond Stocking	Which methods have farmers been using to stock their ponds? Explain in light of before and after training.
Fish Feeding	What differences have you noticed before and after training with regard to the fish feeding methods used by the farmers?
Adjusting Feed Rates	i) What factors do farmers consider when adjusting feed rates? ii) Which methods were predominant before training?
Pests and Diseases Control	What methods of pest and disease control have farmers been using before and after training? Justify.
Pond Fertilization	Have farmers been fertilizing ponds before training? If yes which methods have they been using?
Pond Liming	i) Are there recommended methods of pond liming? ii) In your opinion what would you say are pond liming methods used by farmers before and after training?
Production Records	i) Which production records should farmers who engage in pond fish farming keep and maintain? ii) Which among them have you found during farm visits before and after training?

Fish Harvesting Practices

Areas of Focus	Ask and Probe
Harvesting Plan	i) What considerations do farmers make before harvesting their fish? ii) What would you recommend as the best practice? iii) Have farmers embraced harvesting based on marketing plan or harvesting when demand is high or when fish is mature? If yes, were farmers aware and practicing these before training?
Pond Carrying Capacity and Harvesting	i) To what extent have farmers harvested fish before the ponds could reach their carrying capacity? ii) Were the farmers aware of the benefits of doing so before training?
Nets	What is your comment on the net size used by farmers before and after training?
Harvest Time	i) What time of the day do most of the farmers harvest fish in this region? ii) What in your opinion is the best time to harvest fish and why?
Harvesting Hygiene	What methods of ensuring fish hygiene during harvesting have farmers been practicing before and after training?
Withdraw Feeding	Are there farmers who knew the importance of stopping to feed fish two days prior to harvesting before training?
Withdraw Pond Fertilization	What about stopping to apply fertilizer 1-2 weeks before harvesting?
Harvesting Records	What are the differences in the harvesting records kept by farmers before and after training?

Fish Marketing Strategies

Areas of Focus	Ask and Probe
Market Survey	i) Have farmers been conducting a market survey before deciding to sell fish? ii) Have they been involved in doing so before and after training? Probe to get-in-depth information about the similarity and differences before and after training.

Pricing and Selling	Did farmers require training to know the value of selling fish when prices are high and fresh? Explain.
Market Outlets	When have farmers engaged cooperatives and marketing groups more? Is it before or after training? Explain.
Advertising	Explain whether farmers have been advertising their fish and fish products? Probe to find out the advertising situation before and after training
Packaging	What about packaging?
Fish Brokers	What has been the farmers' perception of involving fish brokers in marketing of fish before and after training?

APPENDIX C

OBSERVATION SCHEDULE

Farm ……..

Date of Observation……..

Location…….

Number of active ponds found…….

Pond Establishment

Areas of Focus	**Observation**
Soil type	Sand( ) Clay ( ) Loam ( )
Proximity to homestead	Near ( ) Far ( )
Water supply	Within the proximity of a reliable source of water supply ( ); far from water supply( )
Trees which shed leaves	Ponds established away ( ); Under ( )
Exposure to sunlight	Ponds exposed ( ) Not exposed ( )
Size	Small ( ), Large ( ) Recommended ( )
Dykes	Erected ( ); Not erected ( )
Soil erosion control methods	Done ( ): Not done ( )
Spillways	Available ( ); Not available
Polythene liners	Applied ( ); Not Applied
Security	Provided ( ); Not Provided

Fish Production Methods

Areas of Focus	**Observation**
Pond Stocking	Type: Tilapia ( ); Mud fish ( ); Others( ) Size : Small ( ); Medium ( )
Fish Feeding Methods	Broadcasting ( ); Sinking ( )
Adjusting Feed Rates according to:	Species ( ), size ( ), fish density ( ), stage in life cycle ( ), water temperature ( ), Water quality ( )
Pests and Diseases Control measures observed	Fencing ( ), Netting ( ), Removing dead weeds ( ), Use of scarecrows ( ), Use of medicated feeds ( ), Use of non-polluted water ( ), culling ( ).
Fertilizer used	Inorganic( ), Organic( )
Liming	Done regularly ( ), Not Done at all ( )
Production Records	Kept ( ), Not Kept ( )

Fish Harvesting Practices

Areas of Focus	**Observation**
Harvesting Plan	Available ( ) Not available ( )
Considers pond carrying capacity	Always ( ) Rarely ( ) Not at all ( )
Nets used	Standard ( ), Non-standard ( )
Harvest Time	Morning ( ), Mid-morning ( ), Late Afternoon ( )

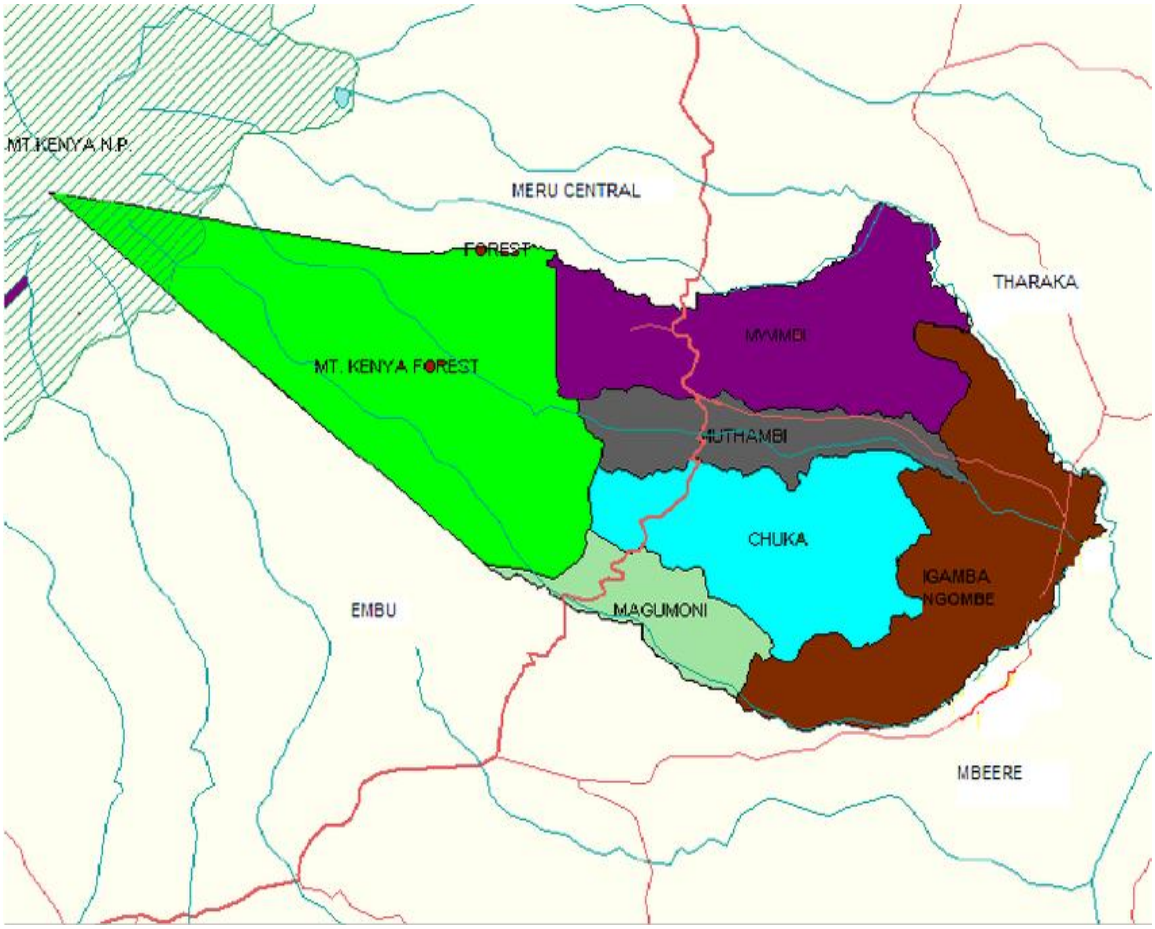
Harvesting Hygiene	Observed ( ), Not Observed ( )
Withdraw Feeding	Done two days before harvesting ( ) Not done ( )
Withdraw Pond Fertilization	Stopped 1-2 weeks before harvesting ( ) Not stopped ( )
Harvesting Records	Available ( ), Not Available ( )

Fish Marketing Strategies

Areas of Focus	Observation
Market Survey	Done ( ), Not done ( )
Pricing	Done when prices are high ( ), Not Considered ( )
Through	Cooperatives ( ) Marketing Groups ( ), Individual buyers ( )
Advertising	Done ( ), Not Done ( )
Packaging	Done ( ), Not Done ( )
Fish Brokers	Engaged ( ), Not Engaged ( )

APPENDIX D

MAP OF MERU SOUTH SUB COUNTY



Source: Central Bureau of Statistics

APPENDIX E

RESEARCH AUTHORIZATION

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: 020 400 7000,
0713 788787,0735404245
Fax: +254-20-318245,318249
Email: dg@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/18/44334/20661** Date: **4th January, 2018**

Mbiuki William Njeru
Egerton University
P.O. Box 536-20115
EGERTON.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Influence of fish farming enterprise productivity training program on adoption of inland-based pond fish farming in Meru South Sub-County, Kenya"*** I am pleased to inform you that you have been authorized to undertake research in **Tharaka-Nithi County** for the period ending **4th January, 2019.**

You are advised to report to **the County Commissioner and the County Director of Education, Tharaka-Nithi County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

BONIFACE WANYAMA.
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Tharaka-Nithi County.

The County Director of Education
Tharaka-Nithi County.