# AN ANALYSIS OF FACTORS INFLUENCING DEMAND FOR POULTRY AND FISH FEEDS IN KENYA

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## DECLARATION AND APPROVAL

### DECLARATION

This thesis is my original work and has not been presented for the award of degree in any university.

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## DEDICATION

I would like to dedicate this thesis to my loving mother Milkah Njeri Macharia, for her efforts in ensuring I get a decent education.

## ACKNOWLEDGMENTS

I wish to express my gratitude to Dr John Busienei, Dr Kimpei Munei and Dr Gracious Diiro for their tireless efforts to guide me throughout this work. Their support through ideas and insight, made this work a success. My sincere gratitude also extends to my classmates for their encouragement and positive criticisms. I would also like to thank the Africa Economic Research Consortium (AERC) for their financial support, both in coursework and in fieldwork.

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# ACRONYMS AND ABBREVIATIONS

3SLS - Three Stage Least Square

AERC - Africa Economic Research Consortium

CES - Constant Elasticity of Substitution

FAO - Food and Agriculture Organisation

FAOSTAT - Food and Agriculture Organisation Statistics

FGLS - Feasible Generalized Least Squares

KNBS - Kenya National Bureau of Statistics

SUR - Seemingly Unrelated Regression

VIF- Variance Inflation Factor

## ABSTRACT

Poultry and fish are important sub-sectors in Kenya providing rural farmer households with income and contributing to their food and nutritional security. Although ownership of these enterprises is not gender specific women are the ones mostly involved in taking care of them. The study was therefore set to analyze the factors that influence the demand for poultry and fish feeds in Kenya. The objectives were; 1) to estimate the quantity of fish and poultry feed demanded by smallholder farmer households in Kenya. 2) to estimate the own and cross price elasticities of demand for poultry and fish feed among smallholder farmers in Kenya and 3) to estimate the own and cross price elasticities of demand for poultry feed among households headed by male and female in Kenya. In order to address the three objectives, three hypotheses were also put in place and were as follows; 1) that there are no significant differences in the quantity of feed demanded by smallholder fish and poultry farmers in Kenya. 2) That the own price and cross price elasticities of demand for poultry and fish feed types are positive and 3) that the own price and cross price elasticities of demand for poultry feed types between households headed by males and those headed by females are positive. The study utilized cross-section data from a sample of 386 poultry farmers and 278 fish farmers randomly selected from three counties which are Nakuru, Kisii and Kirinyaga Counties. The feed demand for both poultry and fish enterprises were analyzed by estimating translog cost functions and a system of cost share functions for the major feed types used for poultry and fish feeding in Kenya. Major feed types for poultry included grains, vegetables, and mixed feed while for fish they included own made feed, mash and floating pellets. Descriptive results shows that quantities of poultry feed demanded by an average farmer were 55.47 kilograms of grains, 48.37 kilograms of vegetables and 71 kilograms of mixed feed. Results for fish production analysis show that quantities of fish

feed demanded by an average farmer were 42.6 kilograms of own made feed, 42.36 kilograms of mash and 62.76 kilograms of floating pellets. Econometric results show that poultry and fish feeds are generally price inelastic and price elasticities tend to decrease with rising expenditure level. The study found out that most of the poultry feeds have complementary relationships. In addition fish feeds also exhibited both complimentary and substitutionary relationships. For instance, in poultry production, grain and mixed feed pair, and vegetable and mixed feed pair all exhibited a complementary relationship. In fish production, own made feed and mash feed pair, own made feed and pellet pair and mash and pellets pair exhibit a complementary relationship for the whole sample, but in Kirinyaga own made feed and pellet pair exhibit a substitutionary relationship. In poultry production female headed households were found to have a higher own price elasticity in absolute terms than male headed households for vegetables and mixed feed. The study, therefore, recommends that policy makers develop policies aimed at reducing the prices of feed especially manufactured poultry and fish feed through the adoption of alternative protein ingredients, the most important and expensive component, in feed manufacture. Policy makers should also develop policies that are aimed at reducing the prices of other non-protein ingredients in poultry and fish feed manufacture to reduce the cost per unit and thus lower feed prices. Strategies such as training on poultry production and management to promote efficient use of available resources should be targeted towards female headed households and female farmers as they are in most instances the owners and managers of poultry enterprises. Future research should focus on disaggregating analysis by gender for fish farmers and analysis non-price incentives such as trainings that influence feed consumption.

**KEYWORDS; Demand, translog cost, elasticity,**

# CHAPTER ONE: INTRODUCTION

## 1.1 Background of the study

Development of the livestock sector is viewed as one of the important pathways for reducing poverty and improving food security in many households in developing countries (Thornton, 2010). In Kenya the sector accounts for about 12% and 40% of national Gross Domestic Product (GDP) and agricultural GDP, respectively (Government of Kenya, 2012), and is a source of food and cash income for over 10 million people in both the rural and urban areas (Omiti and Okuthe, 2009). From 2007 to 2014 the national value of marketed output from the sector grew from Kshs. 33.49 billion to over Kshs. 97 billion (Kenya National Bureau of Statistics, 2015). Among the important subsectors within the Kenyan livestock sector are poultry and fish with the former accounting for about 55% of the livestock sector's GDP (Omiti and Okuthe, 2009).

### 1.1.1 Significance of the Poultry Subsector in Kenya

The poultry subsector accounts for about 30percent of Kenya's Agricultural GDP and about 7.8 percent of the total GDP, and offers food, employment and income to rural and urban households (Omiti and Okuthe, 2009). The subsector contributes income to rural households and improves nutrition by providing households with eggs and meat (Kimani, 2006; Mbugua, 2014). Poultry production in Kenya is produced by both the small scale and large scale farmers. Small scale production is mainly for subsistence with excess sold to supplement income. In rural areas, small scale poultry farming is mainly dominated by women farmers (Kitalyi 1998; Okitoi et al 2007). Women's integral role in farming households of bearing most of the responsibilities for household food security and income places them at a pivotal position to play a great role in meeting food demand (Jensen and Dolberg, 2003). Although its income is small, it is controlled

by women and, it can provide positive spiral effects that will lead the women and rural households out of poverty (Jensen and Dolberg, 2003).

Statistics show that the subsector has exhibited a stagnant growth over the past decade. For instance the national production of poultry meat in Kenya has stagnated at 22,000 metric tons (MT) since 2005 with a small increase to about 22,700 MT in 2014; representing a marginal growth of 3 percent (Figure 1). This marginal increase is against an ever increasing population (Figure 1). This stagnant production in poultry is attributed to constraints encountered in production. There are many production constraints[1] facing rural poultry farmers key among them being lack of quality and affordable feed. Different researchers have found out that expenditure on feed accounts to over 70% of the production costs, thereby making it critical for successful poultry production (Craig and Helfrich, 2002; Mwanzia, 2010; Munguti and Charo-Karisa, 2011). With the increasing feed prices feed affordability by the rural farmers become elusive. The high cost of feed is due to the high cost of ingredients whose price is increasing due to food-feed competition.

[1] Other constraints include infectious diseases, low input of veterinary services, and predators (Ayele *et al.,* 2009; Wolde *et al.,* 2011; Mazengia, 2012; Shitote *et al.,* 2012).

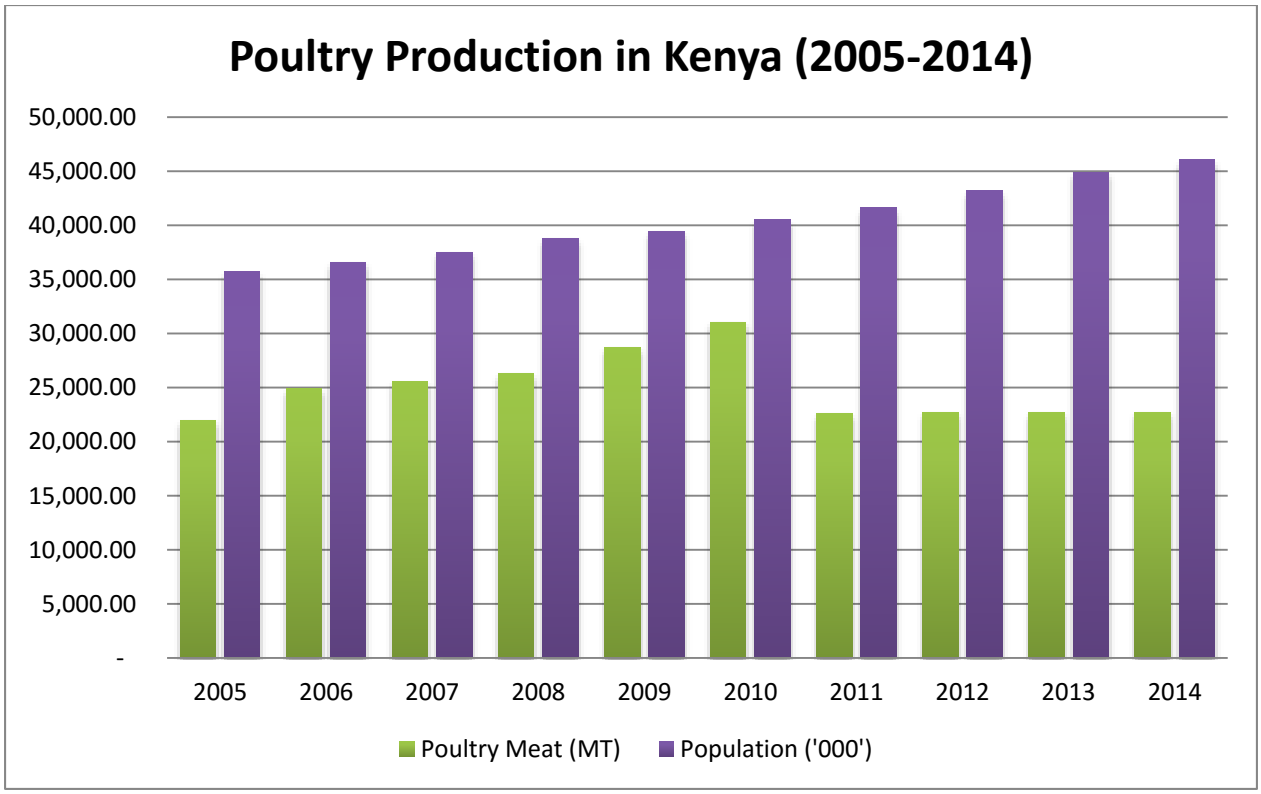


**Figure 1: Poultry production in Kenya (2005-2014)**

Source: Kenya National Bureau of Statistics, 2015

Poultry are kept under free range, semi-intensive or intensive production system. Under the free range system the birds are mostly left to scavenge for feeds such as insects, leafy vegetables and any scattered grains during the day and confined at night while under semi-intensive the birds' main mode of feeding is partial enclosure and scavenging during the day and at night they are confined in shelters of moderate cost (King'ori, 2004). Birds reared under intensive production system require special attention and are fed on commercial feeds, which are either purchased from the feed manufacturers and traders or mixed at home. Thus, depending on the production system adopted inputs requirement differ and their accessibility, availability and affordability determines the success of the enterprise.

### 1.1.2 Significance of Fish Production in Kenya

Fish farming provides food and income to rural and urban households in Kenya. Despite having a small contribution to GDP, 0.3 percent (Omiti and Okuthe, 2009) the subsector offers employment opportunities and income to over 500,000 Kenyans engaged in fish production and related enterprises (Nzungi, 2003). Research shows that the main fish species presently farmed in Kenya are the African Catfish (Clarias gariepinus), Nile tilapia (Oreochromis niloticus), Common carp (Cyprinus carpio) and Tilapia zillii. Current data shows that the quantity and value of fish farmed in Kenya, grew from 4,897 MT in 2009 with a value of Ksh.971,120,000 to 24, 096 MT valued at Ksh.5,601,722,000 representing a 3% increase from 2012-2013 (Figure 2) (KNBS, 2014;2015). Population increase in the same time period increased which provided the market for increased fish production (Figure 2). Therefore, to complement government efforts of promoting aquaculture more analysis in feed manufacture and marketing should be done. According to Gachucha et al. (2014), Kenya still has a great unexploited potential of fish farming considering the favorable climate and water availability, which, if fully exploited, could increase production to 11 million metric tons per annum which would fetch over Ksh.750 billion. Moreover, local demand for fish and fish products is increasing with the increase in human population and the diverse stakeholders' effort to improve fish consumption.

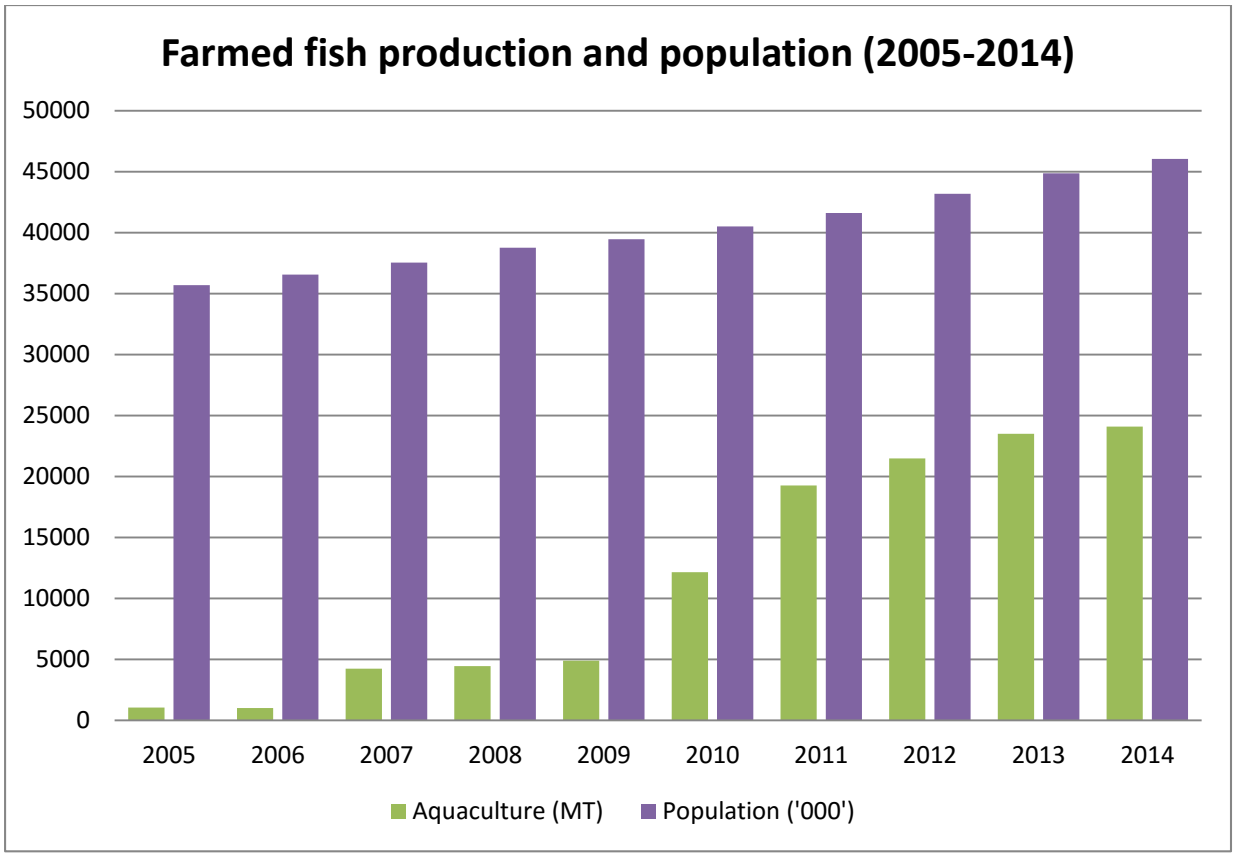


**Figure2: Fish production in Kenya (2005-2014)**

Source: Kenya National Bureau of Statistics, 2015

Fish farming in Kenya is mainly undertaken in earthen or lined ponds which measure between 200 and 500 $m^2$ (Ngugi et al., 2007; Mucai et al.,2011) and fish are fed primarily on locally available low cost agricultural by-products. Fish production is faced with a number of constraints[2], the major one being lack of affordable feeds. According to research, fish nutrition accounts for 40-50% of the total variable production costs (Craig and Helfrich, 2002; Munguti and Charo-Karisa, 2011). According to Gitonga (2014) fish feeds are unaffordable due to their

[2] Other constraints include low input of veterinary services, predators, uncoordinated fish promotion among institutions and universities and insufficient fingerlings (Mwangi 2008 ; Ayele *et al.,* 2009; Wolde *et al.,* 2011; Osure 2011; Mazengia, 2012; Shitote *et al.,* 2012)

high cost. High feed cost is attributed to high ingredients cost which is as a result of food-feed competition resulting to the ingredients price increase (Gitonga, 2014).

### 1.1.3 Status of the Poultry and Fish Feed Subsector in Kenya

Research indicates that despite their being benefits derived from poultry and fish farming, the subsectors faces several constraints that hinder the full realization of their potential. These constraints are not gender specific, but cut across. The most important constraint faced by smallholder farmers, both male and female headed households is inadequate access to affordable feed (Akinrotimi et al., 2011). Poultry feeds categories include; chick mash, growers mash, layers mash, broilers mash and Kienyeji mash. On the other hand fish feed include; mash and floating pellets. Research in agricultural production is aimed at meeting up the challenges of food and nutritional insecurity, income security and poverty alleviation (Thornton, 2010). To meet these challenges women, who are the drivers of rural economy, require support in order to participate effectively and efficiently in poultry production (Sinha, 2005). Rural women are said to be key players in raising small livestock as it provides income and employment opportunities as well as uplifting their standards of living (Gminder, 2003). To increase production efficiency at the rural level, resource poor farmers both men and women participation and training for knowledge acquisition are important (Aboe et al., 2006).

According to research feed costs account for between 40-70% of the production costs, thereby making it critical for successful production, both in poultry and fish production (Craig and Helfrich, 2002; Mwanzia, 2010; Munguti and Charo-Karisa, 2011). Notable key ingredients in feed manufacture include fish meal and soy, which are also used as human food, resulting to

food-feed competition, thereby increasing the price of the ingredients (Gitonga, 2014). High and fluctuating prices of poultry and fish feed hamper sustained supply of the products to the market and result to unmet domestic consumption; because farmers are forced to abandon the enterprises due to increased cost of production (Bett et al., 2015). High cost of production are likely to be have greater effect among the resource poor farmers especially female farmers, hence negating the potential of poultry and fish enterprises in improving food security and reducing poverty in rural areas.

According to Zeitler et al, (1984) protein, one basic nutrient in feeds, cannot be compromised with during feeding and feed formulation. Thus, manufacturers and farmers have to incur a higher cost to ensure a balance of proteins in fish and poultry feeds. However, as the prices of feed ingredients become high due to increased food-feed competition the feeds become expensive and less accessible to smallholder farmers. This results in farmers reducing production dependent on the feed and this has been associated with the marginal increase in production of poultry meat, eggs and fish.

### 1.1.4 The Insect Feed for Poultry and Fish (INSFEED) project

Insect feed for poultry and fish production in Sub-Saharan Africa, INSFEED, is a pilot project funded by the International Development Research Centre (IDRC) of Canada to explore the potential of alternative source of protein for poultry and fish feed. The project explored techniques for cost effective rearing, harvesting and post-harvest handling of insects and insect-based feed for small holder farmers in Uganda and Kenya. In Kenya the project was

implemented by the International Centre for Insect Physiology and Ecology (ICIPE) in collaboration with other partners from both the public and the private sectors.

In exploring techniques for cost effective rearing, harvesting and post-harvest handling of insects and insect-based feed for small holder farmers existing demand was explored. The status of feed demand for poultry and fish is important as it can provide interventions in the livestock sector against which targets for the supply of alternative protein based feed can be set. In addition, knowledge of feed demand parameters would increase an understanding of the underlying determinants of aggregate demand for feed by poultry, fish and general livestock. The knowledge generated can also expand the analytical base for policy and other economic analyses that span the crop and livestock sectors, in Kenya and other developing countries.

### 1.2 Statement of the problem

Sustained supply of poultry and fish products relies on the production of poultry and fish. This heavily depends on availability and accessibility of affordable inputs, including feed, which is one of the most critical inputs that constrain poultry and fish farming among smallholder farmers in Kenya. For example feed costs account to over 60 percent of the total cost in poultry production and 40-60% in fish production (Munguti and Charo-Karisa, 2013). Therefore, any change in the prices of feed is expected to increase the overall production costs of the enterprise. As a result of an increase in overall production costs and subsequent reduction in profits farmers reduce production affecting supply (Bett et al., 2015).

The high cost of feed has mainly been attributed to expensive protein ingredients used in feed formulation (Gitonga, 2014). For example, fish meal and soya beans are the main sources of protein for animal feed in Kenya but are also used for home consumption. The competing uses of the protein sources make them scarce and hence expensive, ultimately making any component made from them including feed expensive. In order to minimize costs, many farmers have resorted to either using feed mixed on the farm or to cheaper feed produced by local small scale feed processors and traders (Charo-Karisa et al., 2013). The challenge with such feed is that it is prone to poor processing and high fiber content which limit bio-availability and presence of anti-nutritional factors, compromising productivity of the enterprise (Tacon 1997).

Fortunately, scientific efforts are underway to devise means of reducing the cost of protein in feed by examining the possibility of using alternative proteins apart from fish as a source of proteins in livestock feed. This will not only provide an alternative source of protein, but will also minimize the strain on available feed ingredients resulting in cheaper and affordable feeds for livestock. Understanding the status of feed demand for poultry and fish will provide interventions in the livestock sector against which targets for the supply of alternative protein sources can be set. Moreover, knowledge of feed demand parameters would increase an understanding of the underlying determinants of aggregate demand for feed by poultry, fish and general livestock. The knowledge generated can also expand the analytical base for policy and other economic analyses that span the crop and livestock sectors in Kenya and other developing countries. However, empirical studies on feed demand are scarce in Kenya, as in other developing countries. The present study examined the demand for fish and poultry feed among smallholder farmers in Kenya.

## 1.3 Purpose and Objectives

### 1.3.1 Overall objective

The main purpose of this study was to analyze the demand for poultry and fish feed in Kenya in order to develop policies that will promote their least cost production and utilization.

### 1.3.2 Specific objectives

The **specific objectives** were

1. To estimate the quantity of fish and poultry feed demanded by smallholder farmer households in Kenya.
2. To estimate the own and cross price elasticities of demand for poultry and fish feed among smallholder farmers in Kenya.
3. To estimate the own and cross price elasticities of demand for poultry feed among households headed by male and female in Kenya.

## 1.4 Hypotheses

1. That there are no significant differences in the quantity of feed demanded by smallholder fish and poultry farmers in Kenya.
2. That the own price and cross price elasticities of demand for poultry and fish feed types are positive.
3. That the own price and cross price elasticities of demand for poultry feed types between households headed by males and those headed by females are positive.

## 1.5 Justification of the study

Poultry and fish are among the key sources of animal protein in Kenya. They are also crucial economic activities among smallholder livestock producers in the country. For instance, in Kenya, eggs contribute 0.4 per cent of per capita consumption of animal protein while poultry meat contributes 0.2 percent (FAOSTAT, 2012). The importance of poultry as a source of animal protein is expected to increase with global demographic changes. According to Kirimi and Olwande (2010) global poultry meat consumption is expected to increase from around 376,200 metric tons (MT) in 2010 (representing 2kg per capita) to over 1,124,505 MT in 2020 (4.5 per capita). This increase is attributable to the ever-growing human population coupled with increasing per capita disposable incomes and increasing urbanization. Fish especially farmed fish; on the other hand, is gaining prominence due to the health awareness of the consumers. Therefore, its per capita consumption is expected to grow from the current 0.5 kg creating opportunities in the fisheries sub-sector (KNBS, 2015).

## 1.6 Organization of the thesis

This study is organized as follows: Chapter one introduces the study by giving an overview of the poultry and fish subsectors stating the objectives of this study. Chapter two reviews literature in Sub-Saharan Africa and other developed world on the analysis of inputs in production with a special focus on livestock feed. Chapter three outlines the methodologies used in realizing the stated objectives. Chapter four presents the results of the study starting with the descriptive results followed by inferential results for poultry and fish feed demand. Finally chapter five presents a summary of the study with recommendations and areas of further research.

# CHAPTER TWO: LITERATURE REVIEW

## 2.1 Introduction

This chapter reviews past studies undertaken in poultry and fish management, feed resources, gender issues in poultry production and demand for production inputs, especially feed in developed and developing countries with a focus on Sub-Saharan Africa.

## 2.2 Empirical reviews on poultry and fish management, feed resources, gender issues in poultry production and the demand for livestock feed

Livestock production in developed countries provides crucial information in the analysis of feed demand in developing countries. For instance Arguello et al. (2008) did a study to derive demand for cottonseed with a special focus to the dairy industry component in the United States. The study used a trans-log cost function to analyze the data. The study found out that own-price elasticity for cottonseed meal was inelastic implying that an increase in the price of cottonseed meal will decrease quantity demanded. Also the study found out that a one percent increase in the amount of grains used will increase the quantity of milk produced. This study is similar to Arguello et al. (2008) in that it analyses own price and cross price elasticities of demand using a cost function. However, this study differs from Arguello et al.(2008) in that it is not limited to one livestock category, but captures information about poultry and fish and focuses in a developing country.

In developing countries livestock production is in the growth stage and thus requires careful analysis to enable a smooth transition to maturity stage. This approach will differ in certain aspects from those done in developed countries, but will follow a similar approach in others. Fabiosa et al. (2004) did a study on output supply and input demand system of commercial and backyard poultry producers in Indonesia. The study utilized a normalized quadratic function on a

secondary datasets for household and registered establishment surveys conducted in 1996 and another registered establishment survey conducted in 2000. The study found out that, own price elasticity for both inputs and output supply were consistent with theories and significant. According to the study results, own price elasticity for feed for the household survey was -0.296 while that for registered establishments was -0.211 in the 1996 survey and -0.359 in the 2000 survey. This study on factors influencing demand for poultry and fish feed benefits from Fabiosa et al. (2007) in area of analysis but differs by introducing econometric assessment by feed types and gender on the feed demand.

Okitoi et al. (2007) did a study on gender issues in poultry production in rural households of Western Kenya. The study used a qualitative analysis on a sample of 407 farmers. The study found out that most of the poultry is owned by women (63%) and by children (18%). According to the study most of the activities such as feeding, cleaning and treating poultry were undertaken by women while men and children participated in construction of poultry houses and purchase of production inputs. This study on factors influencing demand for poultry and fish feed benefits from Okitoi et al. (2007) in area of analysis but differs by introducing econometric assessment by gender of the feed demand.

Kavoi et al. (2009) analyzed the determinants of the production structure and derived demand for factor inputs in smallholder dairying in Kenya. The study used a restricted translog cost function. The study found out that dairy production experiences scale diseconomies. This study is similar to Kavoi et al. (2009) in that it analyses own price and cross price elasticities of demand using a cost function. However, this study differs from Kavoi et al.(2009) in that it incorporates

household and market characteristics and is not limited to one livestock category, but captures information about poultry and fish.

Yirga and Hassan (2013) analyzed the key factors responsible for use of inorganic fertilizers in the mixed crop-livestock farming systems in the central highlands of Ethiopia. The study used Heckman's two-step procedure with a sample of 229 randomly selected households. The study found out that education level of the head of the household, number of livestock owned, number of plots owned, land tenure, access to credit and extension, agro-ecology and manure use influenced both the likelihood of adoption and intensity of inorganic fertilizer use. On the other hand, shrinking plot size as a result of repeated plot subdivisions may induce current users of inorganic fertilizers to use more nutrients per unit of land in an attempt to raise productivity. This study is similar to the Yirga and Hassan (2013) study in that they both use the Heckman two-step procedure to account for sample selectivity bias, but differs in that apart from applying a translog cost function in analysis it applies to poultry and fish subsectors.

Jacobi (2013) examined the potential of fish farming to improve the livelihoods of farmers in the Lake Victoria Region, Kenya. The study used a structured questionnaire on 60 fish farmers' selected through snow balling sampling method. The study found out that fifteen per cent of farmers exclusively fed formulated feeds; 8.3% did not use these feeds at all. According to the study the majority of farmers (73.3%) fed their fish on a mixture of formulated and other feeds. The study also found out that livelihoods of farmers supported by Economic Stimulus Programme (ESP) improved in terms of protein consumption through incomes from aquaculture, but pond productivities were low. According to the study, ESP subsidies helped fish farmers in

the short-term, i.e. through income generation and increased protein accessibility, however it failed to teach farmers self-sustainable aquaculture without depending on subsidies. The current study extends the study on fish feed utilization to analysis of elasticities between floating pellets, mash and own made feeds.

Assa et al.(2014) studied the factors that affect smallholder farmers' demand for purchased fertilizer and seed using cross sectional data from 160 farmers in Malawi. The study used a translog cost function to undertake the analysis. The study found out that education, field size (plot of land cultivated) and household size have a significant negative relationship with the share of fertilizer purchased and positively related with share of seed. However, the price of output, fertilizer, seed and income of the household were found to be significantly and positively related to the share of fertilizer and negatively related to the share of purchased seed. This study is similar to Assa et al. (2014) in that it employs a translog cost function, but differs by undertaking a study on livestock production estimating the cost and share equation simultaneously.

Mbugua (2014) analyzed the demand for antibiotics in poultry production in Kiambu County, Kenya. The study used a sample of 238 commercial chicken farmers who were selected using a multistage sampling procedure. The study collected primary data using semi-structured questionnaires. The study employed a normalized restricted trans-log profit function to estimate own-price and cross-price elasticity of antibiotic demand in layer and broiler production systems. The study found out that-the own price elasticity of demand for antibiotics was -1.68 for broiler and -1.24 for layers. This study is similar to Mbugua (2014) in that it analyses own price and

cross price elasticities of demand. However, this study on demand for fish and poultry feed among smallholder farmers differs from Mbugua (2014) in that apart from disaggregating results by gender for poultry it also covers more than one poultry species that is, indigenous and exotic and also analyses fish.

Ouedraogo and Point (2015) analyzed the determinants of input demand for local red sorghum beer production in Ouagadougou. The study useda translog cost function on a sample of 154 farmers. The study found out that weak price elasticity hampered the fuel wood price policy. However, the simulation regarding taxation of fuel wood price effect on quantity demanded consequently stated an overall reduction in demand for fuel wood in Ouagadougou. This brings about a decrease in the local beer producer's profit for a given level of production. This study on demand for fish and poultry feed among smallholder farmers is similar to the study by Ouedraogo and Point (2015) in that it usesa translog cost function, but differs by undertaking a study on the livestock sector,poultry and fish, disaggregating results by gender for poultry .

Mwesigwa et al. (2015) undertook a study to evaluate smallholder local chicken production and available feed resources in Central Uganda. The study used qualitative analysis on a sample of 300 farmers randomly selected. The study found out that less than 5% knew the nutritive value of the feeds. The study also found out that high food-feed competition was pushing prices of feed up and that the high cost of feed contributed to reduced production. This study on factors influencing demand for poultry and fish feed benefits from Mwesigwa et al. (2015) in area of analysis but differs by introducing econometric assessment by gender on the feed demand.

Mekonen et al. (2016) did a study to determine the status of small scale poultry management at rural, urban and peri-urban areas of Assosa district in Benishangul Gumuz region, western Ethiopia. The study used Descriptive, ANOVA and qualitative analysis techniques on a sample of 90 farmers. The study found out that 93.3% of the rural producers left the birds to scavenge while only 66.6% and 33.3% of the peri-urban and uban respectively left their birds to scavenge. According to the study rural farmers did not use any purchased feed while 6.6% of peri-urban and 10% of urban farmers used purchased feed. In addition the study found out that 10% of the urban farmers, 6.6% of the peri urban farmers and 3.3% of the rural farmers practiced supplementary feeding. This study on factors influencing demand for poultry and fish feed benefits from Mekonen et al. (2016) in area of analysis but differs by introducing econometric assessment by gender on the feed demand.

## CHAPTER THREE: METHODOLOGY

### 3.1 Conceptual framework

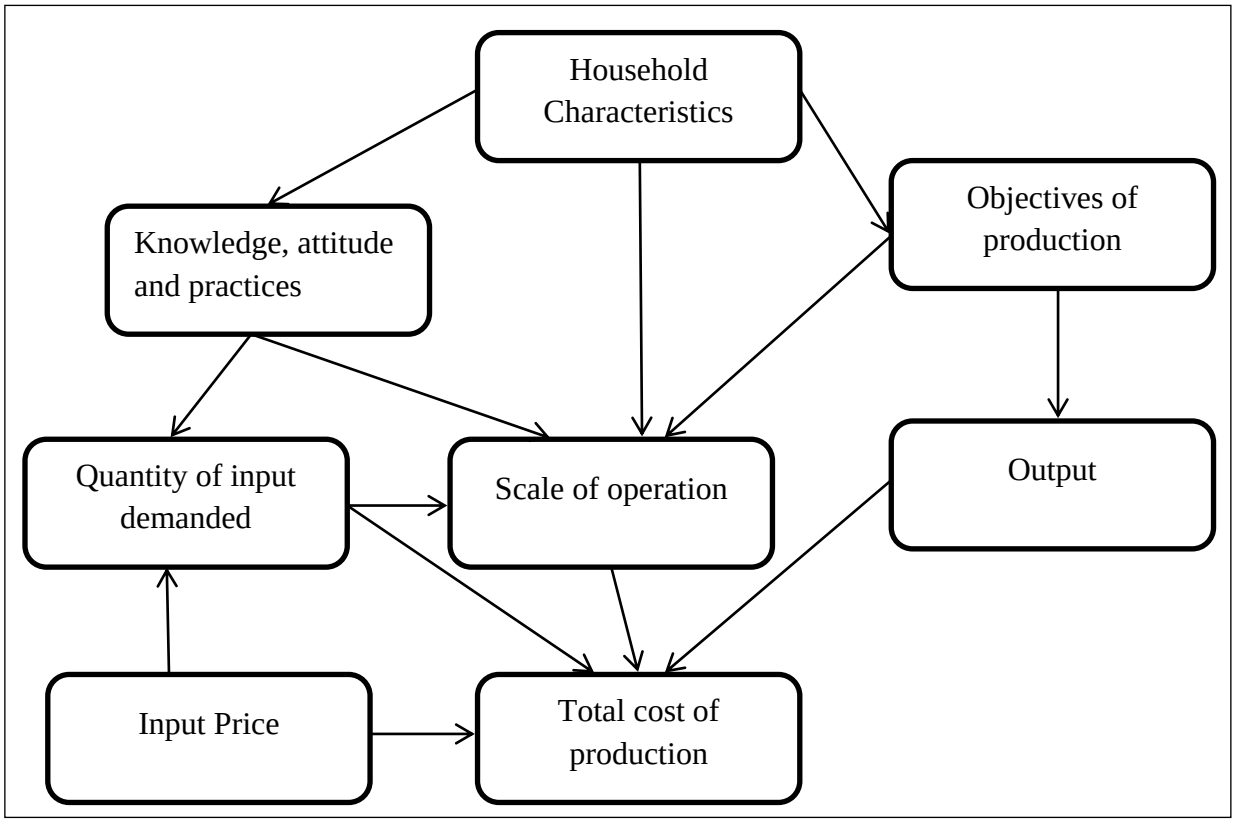


**Figure 3: Conceptual framework for the poultry and fish production**

Source: Author's Conceptualization

In livestock production management decisions are influenced by the farm and farmer characteristics, the objectives, and the knowledge and attitudes of farmers (Sutherland, 1987). Some farmers have multiple objectives for keeping livestock. These objectives include; cash resource, financial security, store of wealth, draught power, own consumption of animal products, bride price, and social status. All these influence the decision-making process of the farmer. Characteristics such as experience and education of the farmer also influence decisions made in animal management. Education increases the managerial capacity of small-scale farmers by exposing them to more information. Consequently, the ability to comprehend complicated

information related to modern livestock production acquired through learning determines the management skills to be employed by a farmer. Another determinant of management decision is the type of production system adopted by a farmer. The higher the degree of intensification adopted the higher the reliance on inputs and modern technologies. Other important farm characteristics that may influence management decisions include labor, income from both livestock or crop products and size of the livestock resource.

There are economic factors that influence the decisions of small-scale farmers in animal management. These include; the existence of markets, for outputs as well as for inputs, the level of input and product prices, and the demand and supply relationships (Little, 1984). The existence of markets for animals and animal products influences the production decisions of small-scale farmers. For instance, lack of markets acts as a dis-incentive for small-scale farmers to adopt livestock improvement technology (Little, 1984). The demand and supply relationships of livestock and livestock products influence input choice and use intensity. Finally, the existence or non-existence of input markets is important. If inputs such as feed and medical services are not available or only available at high prices, their uptake is limited.

### 3.2 Theoretical framework

This study is based on the producer theory which postulates that firms or producers either aim to maximize profits or minimize costs subject to technological constraints (Varian, 1992). To achieve this and determine the producer's response, two elements were important; the production function and producer behavior. The production function gives the technological relationship that exists between any particular combination of inputs and the resulting levels of outputs while the

producer behavior gives the producers' behavior with respect to the choice of inputs used to produce a desired level of output, given the prices of factors and products as well as the availability of fixed resources (Debertin, 1986).Although most smallholder farmers make joint decisions on production and consumption for optimal production, given a desired output level that maximizes utility, the farmers will operate to minimize costs, especially costs of purchasing inputs when producing for own consumption with sale of excess.

### 3.2.1 Demand analysis using input demand approach

Input demand analysis can be done in two ways; the first is the estimation of input elasticities directly from a production function and the second one is by the estimation of input elasticities indirectly from a cost or profit function, also known as the "dual approach". Estimation of input elasticities directly from a production function is also referred to as a "primal approach" in production economics literature (Diewert, 1971). This method involves postulating a functional form for the production function and then using Lagrangian or programming techniques to obtain the derived demand functions. The parameters of the production function are estimated and the factor equation demands derived analytically by imposing the assumptions of cost minimization. The main advantage of the primal approach is that it uses data on quantities. Data on quantities is easy and more accurate to capture in developing countries compared to factor price data.

According to Diewert (1971) the estimation of input elasticities indirectly from a cost or profit function, also known as the "dual approach" involves postulating a functional form for the cost or profit function and obtaining derived demand functions by differentiating the function with respect to input prices. There is assumed duality between production and cost or profit function,

provided that the function satisfies regularity conditions. Pope (1982) stated that when there exist a one-to-one correspondence between the two functions, either the cost or profit function can be used to derive the properties of the production function. This approach is commonly used where there is limited information on relevant primal variables and thus possible estimation problems associated with the production function. The dual approach allows researchers derive input and output supply systems directly from either a profit or a cost function. One of the advantages of the dual approach is the ability to accommodate a multiple output as well as a multiple input framework (Tocco et al., 2013). Therefore, this study adopts the dual approach.

### 3.2.2 Functional forms for cost functions

Several functional forms such as Cobb-Douglas, constant elasticities of substitution (CES), the variable elasticity of substitution (VES), nested-CES and the translog can be used to estimate the cost function (Chaudhary et al.,1998). Although, the Cobb-Douglas function is easier to work with and make calculations on, it is based on highly restricted assumptions, which include the unitary elasticity of substitution, constant returns to scale, and a priori imposition of separability restrictions (Christensen et al., 1971; Ramskov and Munksgaard, 2001). Thus, the function yields invalid elasticities which fail to explain genuine relationships between inputs and output (Diewert, 1971). The estimates of elasticities therefore are not robust enough to accurately predict producers' responsiveness to input and output prices and thereby for formulating effective policy interventions. In this case, more flexible, cost functions are desired.The CES, the VES and the nested CES are considered as superior to the Cobb-Douglas profit function. For instance, in these functions, prices of all inputs influence the demand for each input unlike in a Cobb-Douglas cost function where only the price of the input itself influences demand (Ramskov

and Munksgaard, 2001).They are, however, based on rigid restrictions. For example, the CES function yields a constant, though not unitary value for the elasticity of substitution while the nested CES form involves the arbitrary aggregation of independent variables (Chaudhary et al., 1998).The disadvantage of using functional forms that are more restrictive is that more exogenous parameters are specified. This might cause problems as it is not always easy to find realistic data to determine the parameter values (Ramskov and Munksgaard, 2001). Therefore, these production functions are characterized by weaknesses that are incapable of explaining the exact relationships among variables (Chaudhary et al., 1998). The challenges in the more restrictive functional forms have led to the adoption of more flexible ones in analyzing input demand and output supply, such as the translog cost function which this study adopts.

The translog cost function is flexible and is able to use more than one factor. In addition the specification is a second degree flexible function in prices and fixed inputs. Its estimation imposes no restriction; it integrates the input demand functions with the output supply function and uses input prices rather than input quantities. It therefore does not involve the problem of aggregation, which is associated with input quantities (Chaudhary et al., 1998). It has both linear and quadratic terms with the ability of using more than two factor inputs (Christensen et al., 1973). It also has an additional beneficial property; that differentiating the function with respect to input or output price (or what is known as the Hoteling's lemma), gives the cost share equation for that specific input or output. The cost shares are the basic forms used to compute price elasticities of inputs and output (Christensen et al., 1971). Despite these less restrictive functional forms being more desirable, they often require more information and thus may come at the expense of parameter estimation (Tocco et al., 2013).

### 3.2.3 Empirical model

Following Binswanger (1974) the translog feed cost function for poultry and fish production in Kenya can be specified in equation (1):

$$(1), \ln C^{*} = \varphi_0 + \ln \varphi_q Q + \sum_{i=1}^{3} \varphi_i \ln P_i + \frac{1}{2} \sum_{i=1}^{3} \sum_{j=1}^{3} \varphi_{ij} \ln P_i \ln P_i + \sum_{i=1}^{3} \varphi_{iq} \ln P_i \ln Q \text{ ; i=(1,2 ,3)}$$

Where $C^{*}$ is the total cost of feed used in production for the enterprise derived as the total costs of the three variable feed inputs (1=vegetables, 2=grains and 3=mixed feed[3] for poultry production and 1=own made feed, 2=mash and 3=floating pellets for fish production), Q is the output (number of poultry units in poultry production and number of fish in fish production), $P_i$ is the money price per kilogram of feed type and $\varphi_i$ are the parameters to be estimated. The function can be estimated directly or in its first derivatives, which by Shepherd's lemma are the factor share functions (Binswanger, 1974; Greene, 2011). The share equations for the feed types are specified in equation (2):

$$(2), \frac{\partial \ln C^{*}}{\partial P_i} = S_i = \frac{P_i X_i}{C^{*}} = \alpha_i + \sum_{j} \varphi_{ij} \ln P_j + \gamma_{iy} \ln Q \text{ , (i=1,2, 3,)}$$

Where, $X_i$ is the quantity of feed i (1=vegetables, 2=grains and 3=mixed feed for poultry production and 1=own made feed, 2=mash and 3=floating pellets for fish production), $S_i$ is the expenditure share for input i. The parameters and symbols are as identified earlier. The farm-level feed demand model can be specified in equation (3):

$$(3), S_i = \alpha_i + \sum_{j=1} \varphi_{ij} \ln P_j + \sum_{f=1} \beta_i \ln W_f + \gamma_{iy} \ln Q + \varepsilon_i$$

[3] Mixed feed covers all purchased feed manufactured such as layers, broilers mash and chick mash and that which is prepared by the farmer

where i indexes the three feed types used in poultry production, f indexes quasi-fixed factors (W); These including marital status to control for the effect of access to labor on input demand; employment to control for the effect of access to extra sources of income on input demand; income to control for the effect of access to resources on input demand; and bird type to control for the effect of bird type on input demand. In fish production the quasi-fixed factors (W); include age to control for the effect of farming experience on input demand; distance in kilometers (KM) to nearest trading center to control for effect of market access on input demand; education to control for the effect of access to information on input demand; marital status to control for the effect of access to labor on input demand;

For statistical specification, additive errors with zero expectations and finite variance are assumed for each of the four demand equations of the models. The covariance of the errors of any two of the equations for the same farmer may not be zero, but the covariance of the errors of any two equations corresponding to different farms are assumed to be identically zero. Under these assumptions an asymptotically efficient method of estimation (Zeller, 1962) is used to estimate jointly the system of demand equations (2 and 3) by application of the seemingly unrelated regression (SURE) method. The estimator is an Maximum Likelihood Estimator (MLE). Symmetry constraints $(\varphi_{ij} = \varphi_{ji})$ and adding up restrictions were imposed on the equations. The adding up restriction was imposed by excluding one equation, in this case the share for vegetables in poultry production and share for mash in fish production. In addition, the estimated parameters ( $\varphi_{ij}$ ) which have little economic meaning of their own were used to derive the cross (Equation 4) and own price elasticity (Equation 5) of factor demand (Biswanger,1974; Berndt and Wood, 1984).

$$(4), \eta_{ij} = \frac{\varphi_{ij}}{S_i} + S_j \quad \text{for all i, j; i} \pm \text{j}$$

$$(5), \eta_{ii} = \frac{\varphi_{ij}}{S_i} + S_i - 1 \quad \text{for all i}$$

### 3.3Research design, Sample sizes and Sampling procedure

#### 3.3.1 Research design

I undertook a study to estimate the quantity of feed demanded by both poultry and fish farmers in Kenya with Kisii, Kirinyaga and Nakuru counties as the study areas. The study was conducted through a household survey. Primary data were collected from selected respondents using semi-structured questionnaires.

#### 3.3.2 Sample sizes and Sampling procedure

Yamane (1967) provides a simplified formula to calculate sample sizes when the population is known. This is represented as follows

$$\text{n} = \frac{\text{N}}{1 + \text{N}(\text{e}^2)}$$

Where n is the sample size, N is the population size, and e is the level of precision. This formula was used to calculate the sample sizes used in the survey for poultry and fish farmers. A 95% confidence level was assumed in the calculation of the sample sizes for poultry and fish farmers. According to the Sub-county officers from the three counties i.e. Kisii, Kirinyaga and Nakuru there were 2310 active fish farmers and around 6000 poultry farmers distributed in Table 3.1.

**Table 3.1: Poultry and fish farmers' distribution**

| County | Fish farmers (Active) | Poultry farmers (over 20 birds) |
|---|---|---|
| Kisii | 915 | 2365 |
| Nakuru | 644 | 2554 |
| Kirinyaga | 751 | 876 |
| **Total** | **2310** | **5795** |

Table 3.2 shows the distribution of the sample in the three Counties proportionately.

**Table 3.2: Poultry and fish farmers sample distribution**

| County | Fish farmers (Active) | Poultry farmers (over 20 birds) |
|---|---|---|
| Kisii | 87 | 175 |
| Nakuru | 86 | 151 |
| Kirinyaga | 105 | 63 |
| **Total** | **278** | **388** |

Stratified sampling was employed to select sub-counties. Then random sampling was used to identify the specific respondents at the ward level. The sample frame composed of a census of active smallholder poultry farmers and fish farmers in the survey sites compiled by the respective Sub-County Agricultural Officers for the sites targeted for this study. From this list, 388 households were randomly selected from the poultry farmers, and 278 households from the fish farmers. Then the questionnaires were administered by trained enumerators.

### 3.3.3 Definition of variables

Table 3.3 summarizes the explanatory variables used for empirical estimation. The dependent variable in the empirical estimation is the total cost of poultry feed used by the smallholder farmers. The explanatory variables are motivated by the theoretical behavioral hypothesis, empirical literature and availability of data. Price determines the total cost of the feed purchased and used for each feed type. The higher the price the higher the total cost. Marital status of the household head indicates competing needs for money and labor availability in a household. Therefore married individuals have a different set of priorities when compared to singles and may thus spend less on buying feed for their poultry. However they possess the labor required for small livestock management. Business engagement provides an extra source of income which can be used to support poultry production and therefore are likely to purchase feed. The income of the household determines the ability to purchase feed to support production. The higher the income the more likely is the farmer to purchase feed. When a farmer can easily access feed there is a higher likelihood of purchasing feed for poultry production.

**Table 3.3: Variables and variable definition for use in the poultry translog cost function**

| Variables | Variable definition | Expected Sign |
|---|---|---|
| **Dependent variable** | | |
| Total cost of feed | Total cost incurred in purchase of feed | |
| **Independent Variables** | | |
| Output | Number of poultry units | + |
| Vegetables | Price of Vegetables in Kshs. Per unit | + |
| Grains | Price of Grains in Kshs. Per unit | + |
| Purchased feed | Price of purchased feed in Kshs. Per unit | + |
| Marital status | Marital status of the household head | + |
| Employment status | Whether the household head is engaged in | +/- |
| | business or not | +/- |
| Income | Income of the household | +/- |
| Bird type | Type of bird whether local or not | + |

Table 3.4 summarizes the explanatory variables used for empirical estimation. The number of fish owned influences cost positively in that the higher the number the higher the likelihood of purchasing feed. Price of feed whether owned made, mash or floating pellets influence the overall feed costs positively in that the higher the price the higher the feed costs. Those farmers who have the intention of selling their fish have a higher likelihood of buying feed to enhance their productivity thereby influencing costs positively. Age indicates the willingness to take risks while education denotes knowledge and management skills for production. The objective of the

farmer in keeping the fish also influences whether the farmer will buy feeds or will try low cost production system.

**Table 3.4: Variables and their definition used in the fish translog cost function**

| Variables | Variable definition | Expected Sign |
|---|---|---|
| **Dependent variable** | | |
| Log of Total cost of feed | Log of Total cost of feed | |
| **Independent Variables** | | |
| Output | Number of Fish | + |
| Ln price of Own made feed | Price of Own Made Feed | + |
| Ln Price of Mash | Price of Own Mash | + |
| Ln Price of floating Pellet | Price of Own floating pellets | + |
| Age | Age of the Household head | + |
| Marital Status | Marital status of the Household head | +/- |
| Education level | Education level of the Household head | +/- |
| Sale | For sale | +/- |

### 3.4 Econometric models

The following are the econometric models used for data analysis in this study

Poultry

$$\ln C = \beta_0 + \beta_1 \ln P_{veg} + \beta_2 \ln P_{grn} + \beta_3 \ln P_{mixed} + \beta_4 \ln Q + \beta_5 \ln P_{veg} \ln P_{veg} + \beta_6 \ln P_{veg} \ln P_{grn} + \beta_7 \ln P_{veg} \ln P_{mixed} + \beta_8 \ln P_{veg} \ln Q + \beta_9 \ln P_{grn} \ln P_{grn} + \beta_{10} \ln P_{grn} \ln P_{mixed} + \beta_{11} \ln P_{grn} \ln Q + \beta_{12} \ln P_{mixed} \ln P_{mixed} + \beta_{13} \ln Q \ln Q + \beta_{14} \ln P_{veg} Marst + \beta_{15} \ln P_{grn} Marst + \beta_{16} \ln P_{mixed} Marst + \beta_{17} \ln P_{veg} Emp + \beta_{18} \ln P_{grn} Emp + \beta_{19} \ln P_{mixed} Emp + \beta_{20} \ln P_{veg} Inc + \beta_{21} \ln P_{grn} Inc + \beta_{22} \ln P_{mixed} Birdtype + \beta_{23} \ln P_{veg} birdtype + \beta_{24} \ln P_{grn} birdtype + \beta_{25} \ln P_{mixed} birdtype$$

Where $C^*$ is the total cost of feed used in production, Pveg= price of vegetables, Pgrn=price of grains and Pmixed=price of mixed feed, Q is the output (number of poultry units), Marst=Marital Status of the Household Head, Emp=Employment status of the Household head, Inc=Income, birdtype= type of bird kept and $\beta_0$-$\beta_{25}$ are the parameters to be estimated.

Fish

$$\ln C = \beta_0 + \beta_1 \ln P_{own} + \beta_2 \ln P_{mash} + \beta_3 \ln P_{pellet} + \beta_4 \ln Q + \beta_5 \ln P_{own} \ln P_{own} + \beta_6 \ln P_{own} \ln P_{mash} + \beta_7 \ln P_{own} \ln P_{pellet} + \beta_8 \ln P_{own} \ln Q + \beta_9 \ln P_{mash} \ln P_{mash} + \beta_{10} \ln P_{mash} \ln P_{pellet} + \beta_{11} \ln P_{mash} \ln Q + \beta_{12} \ln P_{pellet} \ln P_{pellet} + \beta_{13} \ln Q \ln Q + \beta_{14} \ln P_{own} Age + \beta_{15} \ln P_{mash} Age + \beta_{16} \ln P_{pellet} Age + \beta_{17} \ln P_{own} Marst + \beta_{18} \ln P_{mash} Marst + \beta_{19} \ln P_{pellet} Marst + \beta_{20} \ln P_{own} Educ + \beta_{21} \ln P_{mash} Educ + \beta_{22} \ln P_{pellet} Educ + \beta_{23} \ln P_{own} Sale + \beta_{24} \ln P_{mash} Sale + \beta_{25} \ln P_{pellet} Sale$$

Where $C^*$ is the total cost of feed used in production, Pown=price of own made feed, Pmash=mash and Ppellet=floating pellets, Q is the output (number of fish), Age=Age of the household head, Marst=Marital Status of the Household Head, Educ=Education level of the Household head, Sale=Participation in the market and $\beta_0$-$\beta_{25}$ are the parameters to be estimated.

### 3.5 Study areas

The study areas were Nakuru, Kisii and Kirinyaga Counties. Kisii county has a high population density which translates to a high demand for food, Kirinyaga is located within a close distance

to Nairobi thus it's close to the market while Nakuru is located in a peri-urban environment providing a market for livestock products. Nakuru County is located in the central rift region of Kenya with a surface area of 7,495.1 $km^2$. The County has two rainy seasons; April, May and August (long rains) and October and December (short rains) and temperatures can range from 10 to 20 degrees Celsius. The County receives 700mm and 1200mm of rainfall annually, with average annual rainfall being an approximated 800mm. The county has a population of 1,603,325 people (male – 50.2% and female – 49.8%) whose main occupation is farming. Most farmers in the County are small scale holders with farm sizes of one or less than one hectare. The County has a population density of 214 persons per square kilometer. Forty three per cent of the population in this County lives below the poverty line (Nakuru County Integrated Development Plan, 2013; Kenya National Bureau of Statistics, 2015).

Kisii County is located to the south east of Lake Victoria. The total area of the County is 1,317.4$km^2$. It lies on a highland equatorial climate, thus receives rain almost throughout the year, and there are two rainy seasons; short season of September to November and long season from February to June. The County receives annual rainfall of over 1500mm and temperatures can range from 16 to 27 degrees Celsius. The County has well drained red clay soils that support a variety of crops, including cash crop production (tea and coffee) and subsistence crops maize, beans, millet and potatoes). The County also has several permanent rivers and streams that drain into Lake Victoria. The population of the County is 1,152,282 people (48% male and 52% female) and has an annual growth rate of 2.75 %. Most farmers aresmall scale holders with farm sizes ranging from 0.1 to 1 hectare. The County has a high population density with over 800

persons per square kilometer. Fifty one per cent of the population in this County lives below poverty line (Kapanga et al 2003).

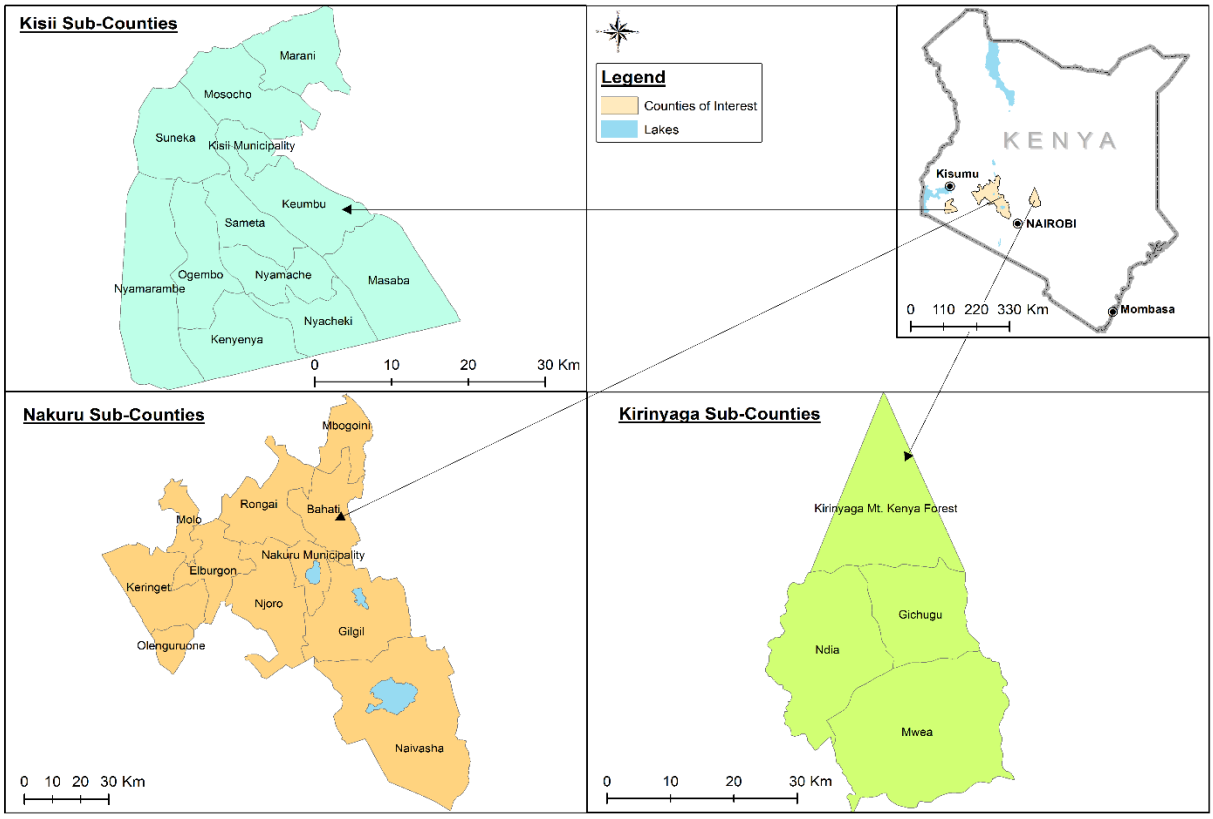


**Figure 4: Map of study areas**

Source: GIS

Kirinyaga County is located to the south east of Mt Kenya. The total area of the County is 1479.09km$^2$. There are two rainy seasons; short season of October to December and long season from March to May. The county receives rainfall of over 1250mm per annum and temperatures can range from 12 to 26 degrees Celsius. The population of the County is 528,054 people (49% male and 51% female).Most farmers are small scale with farm sizes ranging from 0.1 to 1 hectare. The County's population density is488 persons per square kilometer. Twenty five per

cent of the population in this County lives below the poverty line (Kirinyaga County First Integrated Development Plan, 2013).

### 3.6Data analysis

All the questionnaire data were captured in Open Data Kit (ODK) and analyzed in STATA version 13. Descriptive statistics involving the computation of means, independent sample t-tests, and frequencies, were undertaken to characterize the respondents' socio-demographic attributes. The results were presented in a tabular form.Thereafter, econometric analysis was undertaken to assess the effect of a unit change in factor prices on the demand for feed used in poultry and fish production in Nakuru, Kisii and Kirinyaga Counties by estimating the translog cost equation and their respective share equations using STATA software.

# CHAPTER FOUR: RESULTS AND DISCUSSION

## 4.1 Introduction

This chapter presents the summary of findings from the survey of poultry and fish farmers conducted in Kenya in July, 2015. The chapter provides information on the attributes of the farmers, econometric results on poultry and fish feed among farmers disaggregated by counties and by gender for poultry production.

## 4.2 Socio Economics and Demographics of the surveyed poultry and fish farmers

### 4.2.1 Attributes of Poultry Farmers

Table 4.1 shows the main socioeconomic characteristics of poultry farmers, comparing across the three study sites. These include gender of the farmer, age, participation in nonfarm sector, marital status of the head of household, size of the household, distance to the nearest feed trader and income. The survey results show poultry farmers in the three study sites are generally comparable with respect to the attributes above; only slight variations are noted (Table 4.1). In particular, the results show that the majority of the farmer households were headed by males, as reported by 90% of the households surveyed. The average age of the household head was 52years. An average farmer in Nakuru was about 55 years old at the time of the survey; slightly older than farmer from Kirinyaga (52 years) and Kisii (49 years). This is consistent to Mbugua (2014), Sani et al (2007). The highest level of education for the household head's was secondary school, which was almost similar in all the three counties. This is consistent to Alabi and Aruna (2006) and Ndahitsa (2008). According to the results, 60% of the household heads were involved in wage or some form of business contributing additional income. Income was estimated at about

Kshs. 60874.3 on average; with an average farmer in Kirinyaga reporting higher income of about Kshs. 68401.0 than Nakuru (Kshs. 54513.8) and Kisii (Kshs. 63444.6). The average size of a household was about three members; Kisii County recorded the highest size of household of 4 members followed by Nakuru and Kirinyaga counties, each with 3 members per household. This result differed from Mbugua (2014) by a difference of one member. On average, farmers travelled about 4.7 kilometres to reach the nearest feed trader. The distance to the feed traders was for a household residing in Kisii (about 5.4km) followed by farmers residing in Kirinyaga (4.6km) and Nakuru (3.9 km).

**Table 4.1: Selected socioeconomic characteristics of poultry farmers**

| Characteristic | Pooled (n=388) | Nakuru (n=151) | Kisii (n=175) | Kirinyaga (n=62) |
|---|---|---|---|---|
| Age of the Household head | 52.1 | 55.2a | 49.1 | 52.8 |
| | (0.65) | (0.99) | (0.99) | (1.68) |
| Gender of the Household head | 0.1 | 0.2a | 0.1 | 0.2 |
| (0=Male, 1=Female) | (0.02) | (0.03) | (0.02) | (0.02) |
| Marital status of the Household | 0.8 | 0.7a | 0.9c | 0.7 |
| head(1=married, 0=otherwise) | (0.02) | (0.04) | (0.02) | (0.05) |
| Education level of the | 9.3 | 9.3 | 9.3 | 9.2 |
| Household head | (0.24) | (0.39) | (0.36) | (0.61) |
| Engagement in business for the | 0.6 | 0.6 | 0.7c | 0.5 |
| Household head(1=Yes, 0=No) | (0.02) | (0.04) | (0.04) | (0.06) |
| Household size | 3.8 | 3.2a | 4.5c | 3.1 |
| | (0.10) | (0.15) | (0.14) | (0.18) |
| Distance to a feed trader (in | 4.7 | 3.9 | 5.4 | 4.6 |
| Kilometres) | (0.56) | (0.31) | (1.19) | (0.58) |
| Income from poultry (Kshs) | 60874.3 | 54513.8 | 63444.6 | 68401.0 |
| | (7534.94) | (10532.16) | (11798.51) | (21591.33) |
| Availability of a Market | 0.9 | 0.9 | 0.9 | 0.9 |
| (1=Available 0=Otherwise) | (0.02) | (0.04) | (0.04) | (0.05) |

NB:**Standard errorsin parenthesis,** a indicates thatthe difference of means between Nakuru and Kisii is significant at 10%, b indicates thatthe difference of means between Nakuru and Kirinyaga is significant at 10%, and c indicates that the difference of means between Kisii and Kirinyaga is significant at 10%.

Source: Survey data 2015

### 4.2.2 Socio-demographic characteristics of the sampled poultry farm households by gender

Table 4.2 presents the main socioeconomic characteristics of poultry farmers disaggregated by gender. The summary statistics show that an average head of poultry farmer household was about 52 years old with female headed households having a higher average age of 55 years. The mean number of persons in a household was about 4 members for the male headed household, but 3 members for a female headed household. The results further show that about60% of the households surveyed engage in off farm income generating activities with only 40% of the households headed by female engaging in off farm income generating activities. The results further show that poultry production is dominated by free range farming system (as reported by 50% of the farmers surveyed) with female headed households reporting a higher percentage of 60%. Local birds were the major bird type kept; about90% of the male headed household and 80% of the female headed households reported that they reared local poultry. The average number of birds reared was 32for both male and female headed households.

**Table 4.2 Characteristics of male and female headed poultry farmer households**

| | All households (n=386) | Male headed (n=334) | Female headed (n=52) | T-statistic | P-value |
|---|---|---|---|---|---|
| Age of the Household head (Years) | 52.1 | 51.6 | 55.1 | -1.8 | 0.0666 |
| | (0.65) | (0.71) | (1.72) | | |
| Education level of the Household head | 9.3 | 9.2 | 10.0 | -1.1 | 0.2779 |
| (years) | (0.24) | (0.26) | (0.71) | | |
| Marital status of the Household head | 0.8 | 0.9 | 0.2 | 16.4 | 0.0000 |
| (1=married, 0=otherwise) | (0.02) | (0.02) | (0.06) | | |
| Engagement in business (1=Yes, 0=No) | 0.6 | 0.7 | 0.4 | 3.8 | 0.0002 |
| | (0.02) | (0.03) | (0.07) | | |
| Distance to a feed trader (KM) | 3.7 | 3.7 | 4.1 | -0.2 | 0.8094 |
| | (0.56) | (0.64) | (0.66) | | |
| Household size (Number) | 3.8 | 3.9 | 2.9 | 3.8 | 0.0002 |
| | (0.10) | (0.10) | (0.30) | | |
| Income ( Kshs) | 60874.3 | 55523.9 | 95240.0 | -1.8 | 0.0733 |
| | (7573.39) | (7484.60) | (28946.83) | | |
| Main poultry production system(1=Free | 0.5 | 0.5 | 0.6 | -0.6 | 0.5304 |
| range, 0=Otherwise) | (0.03) | (0.03) | (0.07) | | |
| Bird type (1=local, 0=otherwise) | 0.9 | 0.9 | 0.8 | 1.8 | 0.0677 |
| | (0.02) | (0.02) | (0.06) | | |
| Number of poultry units | 32.7 | 32.7 | 32.2 | 0.2 | 0.8574 |
| | (0.98) | (1.08) | (2.23) | | |

Note: **standard errors in parentheses**

Source: Survey data 2015

### 4.2.3Attributes of fish farmers

Table 4.3 presents the main socioeconomic characteristics of fish farmers. The results of the survey revealed that the majority of the households were headed by males as reported by 90% of the households surveyed. This is consistent with Jacobi (2013) who found out most fish farmers were male. The average age of the household head was 57 years. An average fish farmer in Nakuru County at the time of the survey was 61years old; slightly older than a farmer in Kirinyaga (57 years) and Kisii (54 years). This is slightly different from Jacobi (2013). The results further showed that the highest level of education attained by the household heads was secondary school, which was similar across all the three counties. This is inconsistent with Jacobi (2013) who found out that most farmers' level of education was primary. The study also found out that 50% of the household heads were involved in wage or some form of business contributing to additional income. Income from fish production for the period under study was estimated at an average of Kshs.41,018; with an average farmer in Kirinyaga reporting higher incomes of Kshs. 68,244 compared to Nakuru(Kshs.36,827) and Kisii (Kshs. 26,026) Counties. The average size of a household was four members with Kisii County havingthe highest at 5 members followed by Nakuru and Kirinyaga with 4 members each. This is inconsistent with Jacobi (2013) who found average household size to be 7.6 members. On average, farmers travelled 9.6kilometers to reach the nearest feed trader. Farmers residing in Nakuru travelled an average of 11.60kilometers followed by farmers residing in Kisii (8.8) and Kirinyaga (8.8) kilometers. This is consistent with Jacobi (2013) who found out that farmers travelled an average of 10.3 kilometres.

**Table 4.3: Socioeconomic characteristics of fish farmers**

| Characteristic | Pooled (n=278) | Nakuru (n=87) | Kisii (n=88) | Kirinyaga (n=103) |
|---|---|---|---|---|
| Gender of the Household head | 0.9 | 0.8ab | 0.9c | 0.9 |
| (0=Female 1=Male) | (0.02) | (0.04) | (0.03) | (0.04) |
| Age of the Household head | 57.3 | 61.1ab | 53.7 | 57.2 |
| (Years) | (0.77) | (1.44) | (1.41) | (1.12) |
| Marital status of the Household | | | | |
| head (1=Married 0=otherwise)(% | 0.8 | 0.8 | 0.9 | 0.8 |
| of Married) | (0.02) | (0.04) | (0.04) | (0.04) |
| Education level of the Household | 10.6 | 10.6 | 9.9 | 11.2 |
| head (Number of years) | (0.25) | (0.46) | (0.51) | (0.36) |
| Business engagement of the | 0.5 | 0.6b | 0.6 | 0.4 |
| Household head (0=No 1=Yes)(%) | (0.03) | (0.05) | (0.05) | (0.05) |
| Experience in fish farming (Years) | 5.4 | 4.8a | 6.6c | 4.8 |
| | (0.33) | (0.84) | (0.41) | (0.36) |
| Household size (Number of | 4.1 | 4.2 | 4.5c | 3.6 |
| people) | (0.13) | (0.26) | (0.26) | (0.16) |
| Market (1=Easily Available | 0.8 | 0.8 | 0.8 | 0.7 |
| 0=Not Easily Available)(%) | (0.03) | (0.04) | (0.04) | (0.05) |
| Income (Kshs) | 41,018.4 | 36,827.4 | 26,026.4(88 | 68,244.8 |
| | (7104.1) | (4658.5) | 57.3) | (21492.0) |
| Distance to the feed Supplier | 9.6 | 11.3 | 8.8c | 8.8 |
| (KM) | (1.85) | (1.22) | (5.79) | (0.61) |

NB:**Standard errors in parentheses,** a indicates that the difference of means between Nakuru and Kisii is significant at 10%, b indicates that the difference of means between Nakuru and Kirinyaga is significant at 10%, and c indicates that the difference of means between Kisii and Kirinyaga is significant at 10%.

Source: Survey data 2015

### 4.3 Quantity of feed demanded, feed prices and expenditure on feed

#### 4.3.1 Quantity of poultry feed demanded, feed prices and expenditure on feed by county

Table 4.4 reports the average quantity of feed demanded by poultry farmers categorized by feed type and county. Purchased mixed feed for adult birds was the most highly demanded feed at 284 kilograms, followed distantly by grower mash at 168 kilograms and Chick and duck mash at 110 kilograms. Kirinyaga had the highest demand for purchased mixed feed for adult birds at 488 kilograms, followed by Kisii with grower mash at 227 kilograms while Nakuru demanded more of own made feed than other counties (Table 4.4).

**Table 4.4: Average quantity of feed demanded by poultry farmers per month**

| **Feed type** | **Pooled (n=386)** | **Nakuru (n=151)** | **Kisii (n=175)** | **Kirinyaga (n=60)** |
|---|---|---|---|---|
| Grains | 55.5 | 47.2 | 61.7 | 57.6 |
| | (4.4) | (4.2) | (8.3) | (9.6) |
| Vegetables | 48.4 | 49.8 | 42.4 | 65.0 |
| | (4.6) | (8.0) | (5.1) | (16.8) |
| Purchased mixed feed (Adult Birds) | 284.0 | 179.2 | 317.0 | 488.2 |
| | (67.1) | (41.6) | (116.4) | (276.4) |
| Growers Mash | 165.7 | 110.6 | 227.2 | 62.1 |
| | (57.3) | (29.2) | (104.1) | (16.7) |
| Chick and Duck Mash | 110.3 | 80.1 | 116.0 | 165.9 |
| | (36.3) | (25.4) | (65.0) | (121.8) |
| Own made | 46.2 | 55.3 | 42.0 | 36.6 |
| | (5.9) | (12.9) | (6.6) | (9.5) |

**Note:Standard errors in parentheses**

Source: Survey data 2015

Table 4.5 reports the average unit prices paid by poultry farmers in the three counties by feed type. Purchased mixedfeed is the most expensive at an average of Kshs. 54.6. The price is higher in Kirinyaga (Kshs.58.4) and lowest in Nakuru (Kshs.52.0) (Table 4.5). Chick mash is the second most expensive feed at an average of Kshs.46.8(Table 4.5). Vegetables were the cheapest feed type fed to poultry at an average of Kshs. 28.0 which did not differ by a big margin across the counties. Grains cost an average of Kshs. 38.4within Nakuru (Kshs.37.4) in Kisii (Kshs.38.7) and in Kirinyaga (Kshs. 40.0).

**Table 4.5: Prices at which farmers buy feed by type and county**

| Feed type | Total (N=388) | Nakuru (n=151) | Kisii (n=175) | Kirinyaga (n=62) |
|---|---|---|---|---|
| Price of Vegetables | 28.0 | 32.0ab | 27.6c | 19.2 |
| | (0.55) | (1.1) | (0.5) | (0.7) |
| Price of Grain | 38.4 | 37.4ab | 38.7c | 40.0 |
| | (0.2) | (0.4) | (0.2) | (0.3) |
| Purchased feed (Adult birds) | 54.6 | 52.0 | 55.4 | 58.4 |
| | (0.53) | (0.9) | (0.8) | (1.0) |
| Price of Growers mash | 41.5 | 39.9ab | 43.6c | 39.2 |
| | (0.4) | (0.6) | (0.6) | (1.3) |
| Price of Chick mash | 46.8 | 42.2ab | 49.1 | 51.6 |
| | (0.5) | (0.8) | (0.5) | (1.1) |

NB:**Standard errors in paretheses,** a indicates thatthe difference of means between Nakuru and Kisii is significant at 10%, b indicates thatthe difference of means between Nakuru and Kirinyaga is significant at 10%, and c indicates that the difference of means between Kisii and Kirinyaga is significant at 10%.

Source: Survey data 2015

Table 4.6 reports expenditure on feed per month by poultry farmers by county. Farmers in Kirinyaga had the highest expenditure on vegetables and mixed feed at Kshs. 1438 and Kshs. 26150 respectively, while farmers in Kisii had the highest expenditure on grains at Kshs. 2337. However, there were no significant differences in the means between the three counties.

**Table 4.6: Expenditure on feed per month by poultry farmers by county**

| | **Pooled (n=386)** | **Nakuru (n=151)** | **Kisii (n=175)** | **Kirinyaga (n=60)** |
|---|---|---|---|---|
| Grains | 2108.0 | 1790.6ab | 2337.4c | 2233.9 |
| | (165.7) | (162.1) | (316.6) | (343.7) |
| Vegetables | 1247.8 | 1339.0ab | 1117.6c | 1437.7 |
| | (111.8) | (190.9) | (143.0) | (363.3) |
| Mixed feed | 16214.4 | 11038.4ab | 17232.8c | 26150.1 |
| | (3311.8) | (2493.7) | (5764.1) | (13653.7) |

NB:**Standard errors in parentheses,** a indicates that the difference of means between Nakuru and Kisii is significant at 10%, b indicates that the difference of means between Nakuru and Kirinyaga is significant at 10%, and c indicates that the difference of means between Kisii and Kirinyaga is significant at 10%.

Source: Survey data 2015

### 4.3.2 Quantity of feed demanded, feed prices and expenditure on feed by poultry farmers by gender

Table 4.7 reports the average quantity of feed demanded, prices and average expenditure by poultry farmers categorized by feed type. Mixed feed was the most highly demanded feed at with an average of 286 kilograms. Female headed households had the highest demand for mixed feed at 479 kilograms, while male headed households had a quantity of 255 kilograms.

Vegetables were the cheapest feed type fed to poultry at an average of Kshs 28.00 which did not differ by a big margin between the male and female headed households. Female headed households bought vegetables, grains and mixed feed at a higher cost than male headed households. Mean farmer expenditure on feed was highest for mixed feed (Kshs 16214) followed by grains (Kshs. 2115) and vegetables (Kshs. 1248) (Table 4.7). The results show that expenditure on feed was generally comparable between male and female farmers. None the less household's female headed households spent more on vegetables and mixed feed compared to their male counterparts.

**Table 4.7: Average quantity of feed demanded per month, price and average expenditure**

| | Pooled (n=386) | Male headed (n=334) | Female headed (n=52) | t-statistic | P-value |
|---|---|---|---|---|---|
| **Quantity of feed (Kg) per month** | | | | | |
| Grains | 55.0 | 56.2 | 50.2 | 0.4 | 0.6786 |
| | (4.4) | (4.7) | (11.5) | | |
| Vegetables | 48.4 | 45.4 | 72.8 | -2.0 | 0.0521 |
| | (4.6) | (3.8) | (26.5) | | |
| Mixed feed | 286.1 | 254.9 | 479.0 | -1.3 | 0.2153 |
| | (53.7) | (54.9) | (185.9) | | |
| **Unit price (Kshs)** | | | | | |
| Vegetables | 28.0 | 27.7 | 29.8 | -0.4 | 0.2013 |
| | (0.6) | (0.6) | (1.6) | | |
| Grain | 38.4 | 38.4 | 38.6 | -1.3 | 0.7136 |
| | (0.2) | (0.2) | (0.7) | | |
| Mixed feed | 54.6 | 54.5 | 55.3 | -0.3 | 0.7914 |
| | (1.0) | (1.1) | (3.2) | | |
| **Total expenditure on feed per month (Kshs)** | | | | | |
| Grains | 2114.8 | 2146.3 | 1833.0 | 0.6 | 0.5734 |
| | (166.7) | (180.8) | (368.6) | | |
| Vegetables | 1247.8 | 1211.4 | 1523.6 | -0.9 | 0.3724 |
| | (111.8) | (114.3) | (419.9) | | |
| Mixed feed | 16214.4 | 14484.9 | 26949.9 | -1.4 | 0.1954 |
| | (3331.3) | (3466.9) | (10603.0) | | |

**Note**:**Standard errors in parentheses**

Source: Survey data 2015

### 4.3.3 Quantity of fish feed demanded, feed prices and expenditure on feed by county

Table 4.8 presents the amount of feed demanded by fish farmers categorized by type and county. Floating pellets were the most highly demanded feed type for fish with a demand of 63 kilograms. Kirinyaga had the highest demand for own made, mash and floating pellets monthly demand at 83 kilograms, 55 kilograms and 119 kilograms respectively. There were significant differences in means between Nakuru and Kisii counties and between Kisii and Kirinyaga counties for own made feed.

**Table 4.8: Feed quantity demanded per month by fish farmers**

| Feed type | Pooled (n=278) | Nakuru (n=87) | Kisii (n=86) | Kirinyaga (n=105) |
|---|---|---|---|---|
| Own Made Feed | 43.6 | 30.2b | 32.8c | 83.2 |
| | (6.1) | (6.8) | (8.0) | (14.6) |
| Mash | 42.4 | 36.8 | 41.3 | 55.0 |
| | (6.8) | (11.5) | (7.9) | (19.3) |
| Floating Pellet | 62.8 | 42.3 | 31.8 | 118.8 |
| | (24.9) | (6.3) | (5.3) | (80.2) |

NB:**Standard errors in parentheses ,** a indicates that the difference of means between Nakuru and Kisii is significant at 10%, b indicates that the difference of means between Nakuru and Kirinyaga is significant at 10%, and c indicates that the difference of means between Kisii and Kirinyaga is significant at 10%.

Source: Survey data 2015

Table 4.9 presents average purchase prices of fish feed by county per unit. On average, farmers in Kirinyaga County paid a higher price (Kshs.85.3) for fish floating pellets compared to their counterparts in Nakuru (Kshs.83.6) and Kisii (Kshs.67.5). With respect to mash, farmers in

Kirinyaga County also paid a higher price (Kshs.105.0) compared to their counterparts in Nakuru (Kshs.63.5) and Kisii (Kshs.64.2). It was apparent that farmers in Kirinyaga count were more efficient in making their own fish feed since they incurred lower unit cost (estimated price) of Kshs.41.8relative to the farmers in Kisii and Nakuru who incurred Kshs.55.3and Kshs.44.0respectively.

**Table 4.9: Average purchase prices of fish feed**

| **Variable** | **Pooled (n= 278)** | **Nakuru (n=86)** | **Kisii (n= 87)** | **Kirinyaga (n=105)** |
|---|---|---|---|---|
| Price of own made feed | 46.7 | 44.0a | 55.3c | 41.8 |
| | (1.3) | (1.1) | (3.1) | (1.4) |
| Price of Mash | 79.4 | 63.5b | 64.2c | 105.0 |
| | (1.8) | (1.5) | (3.8) | (1.5) |
| Price of Floating Pellets | 79.2 | 83.6a | 67.5c | 85.3 |
| | (1.8) | (3.1) | (2.9) | (2.9) |

NB:**Standard errors in parentheses,** a indicates that the difference of means between Nakuru and Kisii is significant at 10%, b indicates that the difference of means between Nakuru and Kirinyaga is significant at 10%, and c indicates that the difference of means between Kisii and Kirinyaga is significant at 10%.

Source: Survey data 2015

Table 4.10 report expenditure on fish feed by county. Farmers in Kirinyaga had the highest expenditure on own made feed, mash and floating pellets at Kshs. 4228, Kshs. 4656 and Kshs. 7821 respectively. There were significant differences in the means between Kisii and Kirinyaga counties and Nakuru and Kirinyaga counties for own made feed. Kisii and Kirinyaga counties significant differences in means for Mash but there were no significant differences of means for pellets between the three counties.

**Table 4.10: Expenditure on fish feed by county**

| Variable | Pooled (n= 278) | Nakuru (n=86) | Kisii (n= 87) | Kirinyaga (n=105) |
|---|---|---|---|---|
| Own made feed | 2001.1 | 938.5b | 1505.9c | 4227.7 |
| | (466.1) | (223.9) | (355.6) | (1753.3) |
| Mash | 2441.6 | 2124.71b | 1633.89 | 4655.6 |
| | (488.2) | (473.4) | (350.6) | (2023.6) |
| Floating Pellets | 4008.9 | 2271.1 | 2338.9 | 7821.0 |
| | (1492.7) | (275.4) | (325.8) | (4801.9) |

NB:**Standard errors in parentheses,** a indicates that the difference of means between Nakuru and Kisii is significant at 10%, b indicates that the difference of means between Nakuru and Kirinyaga is significant at 10%, and c indicates that the difference of means between Kisii and Kirinyaga is significant at 10%.

Source: Survey data 2015

## 4.4 Results for diagnostic tests

### 4.4.1 Specification test

The computed chi-square from the Breusch-Pagan Test for the total poultry feed cost SUR was 292.819 (p=0.000) while that for total fish cost was 220.615 (p=0.000). Therefore, the null hypotheses, that the errors across the Total feed cost and share equations were contemporaneously correlated, were rejected in the models implying that the assumption of error correlation across the total feed cost equation and share equations were held.

### 4.4.2 Goodness-of-fit

The computed overall adjusted $R^2$ was 0.52 in the total poultry feed cost model and 0.70 for the fish feed cost indicating that the models moderately fitted the data (Greene, 2011).

### 4.4.3 Multicollinearity

Multicollinearity results showed that most of the variables in the total poultry feed cost model and the fish feed cost had a VIF <2 (Appendix 1a and 1b). Based on the rule of thumb, that states that if VIF is less than ten then there was no evidence of multicollinearity among the independent variables in the two models.

### 4.4.4 Appropriateness of translog cost functional form

The computed F (71, 1080) for the total poultry feed cost function was 17.63 (p=0.0000) while the computed F (48, 501) for the total fish feed cost function was 25.76 (p=0.0000), thereby rejecting the null hypothesis, that all $\beta ij=0$, at 5 percent significance level for both models.

### 4.4.5 Validity of symmetry and parametric restrictions

In the model, 20 symmetrical and parametric restrictions were imposed on the poultry feed cost while 17 symmetrical and parametric restrictions were imposed on the fish feed cost. Individual tests indicated that 18 0f the 20 restrictions on the poultry model (see Appendix 2) and 17 restrictions on the fish model (see Appendix 3), the null hypothesis that, symmetry condition and the parameters of the share equations equal the corresponding parameters in the total feed cost equation, could not be rejected (P>0.1). This meant that the symmetry and parametric conditions held in all cases for both models.

## 4.5Econometric results

### 4.5.1 Factors influencing feed demand in poultry production

Table 4.11 presents the maximum likelihood estimates for the total poultry feed cost function. Prices of grains, vegetables and purchased mixed feed had a statistically significant influence on the poultry feed costs ($p<0.1$). Also, according to the results the number of poultry units owned own interaction also had a significant influence of feed costs ($p<0.01$). This is because although feeds constitute the largest proportion of costs involved in poultry production (Okello et al., 2010), their prices and the number of birds reared influences the quantity of feed of each feed type purchased and therefore the total cost of feed while producing poultry.

From the Survey data 2015, the vegetable share of the cost was the smallest (0.077) compared to the rest of the feed types (grains and purchased mixed feed) shares. This can be attributed to low price of the vegetables and the fact that poultry do not feed exclusively on vegetables, but have to be supplemented with either grains or purchased mixed feed or both.

**Table 4.11: Maximum likelihood for the total poultry feed cost function**

| Variable | Coef. | Std. Err. |
|---|---|---|
| Ln of price of grains | 2.11* | 1.22 |
| Ln of price of vegetables | 1.12* | 0.64 |
| Ln of price of mixed feed | -2.23* | 1.35 |
| Ln of number of poultry units | 0.07 | 1.22 |
| Ln of price of grains squared | 0.03 | 0.05 |
| Ln of price of vegetables squared | 0.03 | 0.23 |
| Ln of price of mixed feed squared | 0.01 | 0.04 |
| Ln of number of poultry units squared | 0.09*** | 0.03 |
| Ln of price of grains* Ln of price of vegetables | -0.05* | 0.03 |
| Ln of price of grains* Ln of price of mixed feed | 0.02 | 0.03 |
| Ln of price of grains * Ln of number of poultry units | 0.27 | 0.20 |
| Ln of price of vegetables* Ln of price of mixed feed | -0.03 | 0.03 |
| Ln of price of vegetables* Ln of number of poultry units | 0.39 | 0.31 |
| Ln of price of mixed feed * Ln of number of poultry units | -0.34 | 0.21 |
| Ln Income | -0.97 | 1.04 |
| Ln of price of grains * ln income | -0.32* | 0.19 |
| Ln of price of vegetables *Ln income | -0.22 | 0.25 |
| Ln of price of mixed feed * Ln income | 0.43** | 0.21 |
| Ln of price of grains * Marital status | 0.08* | 0.04 |
| Ln of price of vegetables * Marital status | 0.03 | 0.05 |
| Ln of price of mixed feed * Marital status | -0.10** | 0.05 |
| Ln of price of grains * Employment status | -0.01 | 0.03 |
| Ln of price of vegetables * Employment status | 0.02 | 0.04 |
| Ln of price of mixed feed * Employment status | 0.01 | 0.04 |
| Ln of price of grains * bird type | 0.20*** | 0.06 |
| Ln of price of vegetables *bird type | -0.18*** | 0.07 |
| Ln of price of mixed feed * bird type | -0.21*** | 0.07 |
| Constant | 12.68* | 4.91 |

*p< 0.1, **p< 0.05, ***p< 0.01

Source: Survey data 2015

Table 4.12 represents maximum likelihoods for grain, mixed feed and vegetable demand functions. In the vegetable demand function, price of grains had a negative effect on demand while mixed feed had a positive influence on the demand for vegetables. In the mixed feed demand function, price of the vegetables had a positive influence on demand for mixed feed demand. It is also important also to note that the type of bird reared negatively affected the demand for mixed feed and vegetables but had a positive influence on grain demand.

**Table 4.12: Maximum likelihoods for Grain, mixed feed and vegetable demand functions**

| | Grains | Mixed feed | Vegetables |
|---|---|---|---|
| Ln of price of grains | 0.03 | 0.02 | -0.05* |
| | (0.05) | (0.03) | (0.03) |
| Ln of price of vegetables | -0.05* | 0.07** | 0.03 |
| | (0.03) | (0.03) | (0.23) |
| Ln of price of mixed feed | 0.02 | 0.01 | 0.07** |
| | (0.03) | (0.04) | (0.03 |
| Ln of number of poultry units | 0.27 | -0.34 | 0.39 |
| | (0.20) | (0.21) | (0.) |
| Ln income | -0.32* | 0.43** | -0.22 |
| | (0.19) | (0.21) | (0.25) |
| Marital status of the household head | 0.08* | -0.10** | 0.03 |
| | (0.04) | (0.05) | (0.05) |
| Employment status | -0.01 | 0.01 | 0.02 |
| | (0.03) | (0.04) | (0.04) |
| Bird type | 0.20*** | -0.21*** | -0.18*** |
| | (0.06) | (0.07) | (0.07) |
| Inverse Mills Ratio (IMR) | 0.06*** | -0.08*** | 0.06*** |
| | (0.01) | (0.01) | (0.01) |
| Constant | 2.11* | -2.23* | 1.12* |
| | (1.22) | (1.35) | (0.64) |

Standard errors in parentheses, $^{*}p< 0.1$, $^{**}p< 0.05$, $^{***}p< 0.01$

Source: Survey data 2015

### 4.5.2Elasticity of demand of poultry feed types

Table 4.13 gives the results of the own price and cross price elasticities of demand for poultry feed types. According to these results average own-price elasticities of grains, vegetables and mixed feed are-0.66, -0.47 and -0.30 respectively, which is in line with the theory that own price elasticity must be negative (Kumar et al., 2010; Varian 1992). The results are consistent with Fabiosa et al (2004) and Mbugua (2014). However, the own price elasticity of vegetables and grains are not significant while the own price elasticity of mixed feed are significant ($p<0.01$). These elasticities are inelastic although in absolute terms grains had the highest elasticity followed by vegetables. Own price elasticity for grains is highest in Nakuru at -0.94 while own price elasticity for mixed feed is highest in Nakuru at -0.30. This shows a low response by poultry farmers when the prices of grains increase in Nakuru.

Cross price elasticities for all the feeds show a mixture of positive and negative responses, indicating that they are used as complements or substitutes to each other (Table 4.13). Farmers in Kirinyaga counties have an inelastic substitution between vegetables and grains while farmers in Nakuru have an elastic complementarity between vegetables and mixed feed. In Nakuru and Kirinyaga, grain and vegetable pair are used as substitutes while grain and mixed feed are used as complements.

**Table 4.13: Own and cross price elasticities of demand**

| | Pooled | Kirinyaga | Nakuru | Kisii |
|---|---|---|---|---|
| **Grain demand** | | | | |
| Ln Grain Price | **-0.66** | **-0.55** | **-0.94*** ** | **-0.31** |
| | **(0.22)** | **(0.62)** | **(0.33)** | **(0.45)** |
| Ln Vegetable Price | -0.15 | -0.06 | -0.19 | -0.26 |
| | (0.13) | (0.41) | (0.18) | (0.29) |
| Ln Mixed feed price | 0.81 | 0.59 | 1.12*** | 0.57 |
| | (0.15) | (0.32) | (0.30) | (0.25) |
| **Vegetable demand** | | | | |
| Ln Grain Price | -0.43 | -0.18 | -0.52 | -0.70 |
| | (0.36) | (1.34) | (0.47) | (0.79) |
| Ln Vegetable Price | **-0.47** | **-20.72*** ** | **2.31** | **5.32** |
| | **(2.93)** | **(7.23)** | **(4.39)** | **(6.83)** |
| Ln Mixed feed price | 0.31 | 0.18 | -0.29 | 0.57 |
| | (0.34) | (0.75) | (0.59) | (0.52) |
| **Mixed feed demand** | | | | |
| Ln Grain Price | 0.11** | 0.05 | 0.19** | 0.04 |
| | (0.05) | (0.12) | (0.08) | (0.08) |
| Ln Vegetable Price | 0.17*** | -0.01 | 0.15** | 0.25** |
| | (0.05) | (0.17) | (0.06) | (0.10) |
| Ln Mixed feed price | **-0.30*** ** | **-0.26*** | **-0.30*** ** | **-0.25*** ** |
| | **(0.06)** | **(0.14)** | **(0.10)** | **(0.09)** |

Standard errors in parentheses, *p< 0.1, **p< 0.05, ***p< 0.01

Source: Survey data 2015

### 4.5.3 Estimated total cost function poultry feed disaggregated by gender

Table 4.14 presents the maximum likelihood estimates for the total poultry feed cost function disaggregated by gender. According to the results the price of vegetables and mixed feed were significant ($p<0.05$, $p<0.1$ respectively) for male headed households. This can be attributed to the fact that total feed costs have a direct relationship with the price. In this study increase in the prices of mixed feed and vegetables increases the total feed costs. In addition, the number of poultry units owned squared had a statistically significant ($p<0.1$) influence of total feed costs for the male-headed households. These results indicate that prices of the feed type given to the poultry influence the total feed costs either positively or negatively with the price of grains affecting male headed households positively.

**Table 4.14: Maximum likelihood for the total poultry feed cost function for male and female headed households**

| | Male (N=334) | | Female (n-52) | |
|---|---|---|---|---|
| **Variable** | **Coef.** | **Std. Err.** | **Coef.** | **Std. Err.** |
| Ln of price of grains | 2.11 | 1.30 | 2.42 | 3.19 |
| Ln of price of vegetables | 1.37** | 0.67 | -0.89 | 1.98 |
| Ln of price of mixed feed | -2.48* | 1.45 | -0.53 | 3.58 |
| Ln of number of poultry units | -0.03 | 1.32 | -1.31 | 3.02 |
| Ln of price of grains squared | 0.07 | 0.05 | -0.18 | 0.11 |
| Ln of price of vegetables squared | 0.13 | 0.25 | -0.23 | 0.45 |
| Ln of price of mixed feed squared | 0.03 | 0.04 | -0.10 | 0.10 |
| Ln of number of poultry units squared | 0.10*** | 0.04 | 0.09 | 0.08 |
| Ln of price of grains* Ln of price of vegetables | -0.06** | 0.03 | 0.05 | 0.06 |
| Ln of price of grains* Ln of price of mixed feed | 0.00 | 0.04 | 0.13 | 0.08 |
| Ln of price of grains * Ln of number of poultry units | 0.23 | 0.21 | 0.43 | 0.51 |
| Ln of price of vegetables* Ln of price of mixed feed | -0.03 | 0.03 | -0.03 | 0.07 |
| Ln of price of vegetables* Ln of number of poultry units | 0.41 | 0.33 | 0.55 | 0.80 |
| Ln of price of mixed feed * Ln of number of poultry unit | -0.34 | 0.23 | -0.26 | 0.56 |
| Ln Income | -0.67 | 1.14 | -1.14 | 2.26 |
| Ln of price of grains * ln income | -0.30 | 0.21 | -0.43 | 0.51 |
| Ln of price of vegetables *Ln income | -0.31 | 0.28 | 0.07 | 0.60 |
| Ln of price of mixed feed * Ln income | 0.45* | 0.23 | 0.26 | 0.56 |
| Ln of price of grains * Marital status | 0.00 | 0.06 | 0.12 | 0.10 |
| Ln of price of vegetables * Marital status | 0.03 | 0.08 | 0.07 | 0.10 |
| Ln of price of mixed feed * Marital status | -0.04 | 0.07 | -0.15 | 0.11 |
| Ln of price of grains * Employment status | 0.02 | 0.04 | -0.25*** | 0.08 |
| Ln of price of vegetables * Employment status | 0.02 | 0.04 | 0.11 | 0.09 |
| Ln of price of mixed feed * Employment status | -0.03 | 0.04 | 0.23** | 0.09 |
| Ln of price of grains * bird type | 0.18*** | 0.07 | 0.26** | 0.12 |
| Ln of price of vegetables *bird type | -0.12 | 0.08 | -0.44*** | 0.13 |
| Ln of price of mixed feed * bird type | -0.19** | 0.07 | -0.27** | 0.13 |
| Constant | 10.50* | 5.38 | 19.04* | 11.01 |

*p< 0.1, **p< 0.05, ***p< 0.01

Source: Survey data 2015

### 4.5.4 Estimated Share demand functions for poultry feed disaggregated by gender

Examining the responsiveness of farmers to prices of inputs is important for understanding the structure of their production, and thus essential for the formulation of a variety of micro policy actions for increased agricultural productivity in farm households. In male headed households' demand functions (Table 4.15) bird type had a statistically significant influence on the grain demand and vegetable demand functions ($p<0.05$, $p<0.01$ respectively). In the mixed feed demand function, price of mixed feed and bird type had a statistically significant influence on the mixed feed demand ($p<0.05$ and $p<0.01$ respectively).

**Table 4.15: Estimated Share Functions for male headed household**

| Variable | Grains | Mixed feed | Vegetables |
|---|---|---|---|
| Ln of price of grains | 0.07 | 0.00 | -0.06** |
| | (0.05) | (0.04) | (0.03)1.31 |
| Ln of price of vegetables | -0.06** | 0.08** | 0.13 |
| | (0.03) | (0.04) | (0.25) |
| Ln of price of mixed feed | 0.00 | 0.03 | 0.08** |
| | (0.04) | (0.04) | (0.04) |
| Ln of number of poultry units | 0.23 | -0.34 | 0.41 |
| | (0.21) | (0.23) | (0.33) |
| Ln income | -0.30 | 0.45* | -0.31 |
| | (0.21) | (0.23) | (0.28) |
| Marital status of the household head | 0.00 | -0.04 | 0.03 |
| | (0.06) | (0.07) | (0.08) |
| Employment status | 0.02 | -0.03 | 0.02 |
| | (0.04) | (0.04) | (0.04) |
| Bird type | 0.18*** | -0.19** | -0.12 |
| | (0.07) | (0.07) | (0.08) |
| Inverse Mills Ratio (IMR) | 0.06*** | -0.07*** | 0.07*** |
| | (0.02) | (0.01) | (0.01) |
| Constant | 2.11 | -2.48* | 1.37** |
| | (1.30) | (1.45) | (0.67) |

Standard errors in parentheses, $^{*}p< 0.1$, $^{**}p< 0.05$, $^{***}p< 0.01$

Source: Survey data 2015

In female headed households' demand functions (Table 4.16) employment status had a statistically significant influence on the grain demand ($p<0.1$). In the vegetable demand function, bird type had a statistically significant influence on the vegetable demand ($p<0.01$). In the mixed feed demand function, employment status and bird type had a statistically significant influence on the mixed feed demand ($p<0.05$ and $p<0.01$ respectively).

**Table 4.16: Estimated Share Functions for female headed household**

| Variable | Grains | Mixed feed | Vegetables |
|---|---|---|---|
| Ln of price of grains | -0.18 | 0.13 | 0.05 |
| | (0.11) | (0.08) | (0.06) |
| Ln of price of vegetables | 0.05 | 0.00 | -0.23 |
| | (0.06) | (0.07) | (0.45) |
| Ln of price of mixed feed | 0.13 | -0.10 | 0.00 |
| | (0.08) | (0.10) | (0.07) |
| Ln of number of poultry units | 0.43 | -0.26 | 0.55 |
| | (0.51) | (0.56) | (0.80) |
| Ln income | -0.43 | 0.26 | 0.07 |
| | (0.51) | (0.56) | (0.60) |
| Marital status of the household head | 0.12 | -0.15 | 0.07 |
| | (0.10) | (0.11) | (0.10) |
| Employment status | -0.25*** | 0.23** | 0.11 |
| | (0.08) | (0.09) | (0.09) |
| Bird type | 0.26** | -0.27** | -0.44*** |
| | (0.12) | (0.13) | (0.13) |
| Inverse Mills Ratio (IMR) | 0.15*** | -0.12*** | -0.13*** |
| | (0.04) | (0.04) | (0.04) |
| Constant | 2.42 | -0.53 | -0.89 |
| | (3.19) | (3.58) | (1.98) |

Standard errors in parentheses, $^{*}p< 0.1$, $^{**}p< 0.05$, $^{***}p< 0.01$

Source: Survey data 2015

### 4.5.5 Elasticity of demand of poultry feed types disaggregated by gender

This study derived the own-price and cross-price elasticities for the three feed types used in poultry production by evaluating equation (4 and 5) using estimated coefficients from Table 4.14 and the associated expenditure shares (Table 4.15 and 4.16). The elasticity estimates are reported in Table 4.17. The results show that the own price elasticities of demand for all the feed types are negative with some having less than unit in absolute value. These results conform to the economic theory of demand (Kumar et al., 2010; Varian 1992). The results are consistent with Fabiosa et al (2004) and Mbugua (2014). Grains have the highest own price elasticity of demand of 0.66 in absolute terms, followed closely by vegetables (0.47) and slightly far by mixed feeds (0.30). This probably reflects greater use of own vegetables and supplied grains as feed rather than purchased mixed feed from the market.

With regard to gender, the results show differences in farmer responsiveness to price. For instance own price elasticity for the grain is inelastic for male and but elastic for female headed households. The results, however, show that both farmer categories exhibit an inelastic response to price of mixed feed. Cross price elasticities results show that male headed households use vegetables as substitutes to grains and mixed feed as compliments, but female headed households use vegetables as complements to grains and mixed feed. This is because female headed households key concern is food for the family and thus substitute grains with vegetables when price of either increases. In addition female headed households use grains and mixed feed as compliments but male headed households use grains as substitutes to vegetables and compliments to mixed feed. This can be attributed to the fact that female headed household's major concern is food provision and thus reduce grain for feeding poultry by a bigger margin

when prices for the grains increase to be able to meet food demand. More so, in order to maximize usage of available feeding resources and still meet the food demand of the households female headed households substitute grains with vegetables. With regards to mixed feed demand, both male and female headed households use vegetables and grain as compliments to mixed feed.

**Table 4.17: Own and cross price elasticities of demand**

| | Pooled | Male headed households | Female headed households |
|---|---|---|---|
| **Grain demand** | | | |
| Ln Grain Price | **-0.66** | **-0.47*** | **-2.11***** |
| | **(0.22)** | **(0.23)** | **(0.78)** |
| Ln Vegetable Price | -0.15 | -0.20 | 0.42 |
| | (0.13) | (0.13) | (0.44) |
| Ln Mixed feed price | 0.81 | 0.67*** | 1.68*** |
| | (0.15) | (0.16) | (0.56) |
| **Vegetable demand** | | | |
| Ln Grain Price | -0.43 | -0.60 | 0.78 |
| | (0.36) | (0.39) | (0.82) |
| Ln Vegetable Price | **-0.47** | **0.70** | **-3.96** |
| | **(2.93)** | **(3.22)** | **(5.92)** |
| Ln Mixed feed price | 0.31 | 0.33 | 0.36 |
| | (0.34) | (0.36) | (0.95) |
| **Mixed feed demand** | | | |
| Ln Grain Price | 0.11** | 0.07 | 0,24** |
| | (0.05) | (0.05) | (0.10) |
| Ln Vegetable Price | 0.17*** | 0.19*** | 0.08 |
| | (0.05) | (0.05) | (0.09) |
| Ln Mixed feed price | **-0.30***** | **-0.27** | **-0.35***** |
| | **(0.06)** | **(0.06)** | **(0.13)** |

Standard errors in parentheses, *p< 0.1, **p< 0.05, ***p< 0.01

Source: Survey data 2015

### 4.5.6 Factors influencing feed demand in fish production

Table 4.18 presents the Maximum likelihood estimates for the total fish feed cost function across Nakuru, Kisii and Kirinyaga. For the whole sample, Nakuru, and Kirirnyaga, the price of own made feed had a statistically significant influence on the fish feed costs ($p<0.01$, $p<0.01$ and $p<0.05$ respectively). The price of mash had a statistically significant influence on the fish feed costs in Kisii and Nakuru ($p<0.01$). From the Survey data 2015, the mash and own made feeds share of the cost was very small (0.15) compared to the pellet share of cost (0.58).

**Table 4.18: Maximum likelihood for the total fish feed cost function**

| Variables | Pooled (n=278) | Kisii (n=87) | Nakuru (n=86) | Kirinyaga (n=105) |
|---|---|---|---|---|
| Ln price of own made | 0.90*** | 0.00 | 0.00 | 0.64** |
| | (0.17) | (0.00) | (0.00) | (0.31) |
| Ln price of Mash | -0.29 | 1.00*** | 1.00*** | 0.00 |
| | (0.32) | (0.00) | (0.00) | (0.61) |
| Ln price of pellet | 0.39 | 0.00 | 0.00 | 0.35 |
| | (0.33) | (0.00) | (0.00) | (0.65) |
| Ln price of own made squared | -0.05** | -0.03 | -0.03 | 0.04 |
| | (0.02) | (0.04) | (0.06) | (0.04) |
| Ln price of Mash squared | -0.01 | -0.03 | -0.10 | -0.22*** |
| | (0.03) | (0.05) | (0.07) | (0.07) |
| Ln price of pellet squared | 0.08** | -0.01 | 0.08 | 0.08 |
| | (0.03) | (0.05) | (0.06) | (0.07) |
| Ln price of own made* Ln price of Mash | 0.07*** | 0.03 | 0.11** | 0.13*** |
| | (0.02) | (0.03) | (0.05) | (0.05) |
| Ln price of own made* Ln price of pellet | -0.02 | 0.00 | -0.08 | -0.17*** |
| | (0.02) | (0.03) | (0.05) | (0.04) |
| Ln price of own made* Ln Output | -0.02 | 0.01 | -0.03 | 0.03 |
| | (0.02) | (0.02) | (0.02) | (0.04) |
| Ln price of Mash* Ln price of pellet | -0.06** | 0.01 | -0.00 | 0.09 |
| | (0.03) | (0.05) | (0.07) | (0.06) |
| Ln price of Mash* Ln Output | 0.07** | -0.03 | 0.13*** | 0.05 |
| | (0.03) | (0.03) | (0.05) | (0.06) |
| Ln price of pellet * Ln Output | -0.05 | 0.02 | -0.10** | -0.08 |
| | (0.03) | (0.03) | (0.05) | (0.01) |
| Constant | -1.18 | 0.32 | 0.37 | 7.28 |
| | (2.98) | (6.22) | (3.09) | (11.93) |

Standard errors in parenthesis, *p< 0.1, **p< 0.05, ***p< 0.01

Source: Survey data 2015

### 4.5.7 Elasticity of demand of fish feed types

Table 4.19 gives the results of the price elasticities of demand for fish feed types. The results indicate that the average own-price elasticities of own made feed, mash and pellet feed are -0.42, -0.87 and -0.66respectively, which is in line with the theory that own price elasticity must be negative (Kumar et al., 2010; Varian 1992). These own price elasticities are negative, but lower in absolute terms that those found for antibiotic demand by Mbugua (2014). However, all the own price elasticities are inelastic with mash having the highest in absolute terms. Farmers in all the counties have elastic own price elasticities for mash with farmers in Kirinyaga County having the highest in absolute terms of more than 2. Own made feed and floating pellets have inelastic own price elasticities. Cross price elasticities indicate substitutionary and complementary relationships between the feeds. For instance, farmers in Kirinyaga use the pair own made feed and mash as compliments while the pair own made and pellet as substitutes. In addition, farmers in Nakuru use the pair mash and pellet and the pair own made and pellet as complements (Table 4.20).

**Table 4.19: Own and Cross Price elasticities of demand**

| | Pooled | Kisii | Nakuru | Kirinyaga |
|---|---|---|---|---|
| **Own made demand** | | | | |
| Ln Own made Price | **-0.66*** ** | **-0.63*** ** | **-0.64*** ** | **-0.59** ** |
| | **(0.05)** | **(0.08)** | **(0.14)** | **(0.23)** |
| Ln Mash Price | 0.32*** | 0.20*** | 0.50*** | 0.86*** |
| | (0.05) | (0.07) | (0.12) | (0.26) |
| Ln pellet Price | 0.35*** | 0.42*** | 0.18* | -0.34 |
| | (0.05) | (0.08) | (0.11) | (0.22) |
| **Mash demand** | | | | |
| Ln Own made Price | 0.84*** | 0.63*** | 0.86*** | 1.18*** |
| | (0.13) | (0.21) | (0.20) | (0.36) |
| Ln Mash Price | **-0.87*** ** | **-1.11*** ** | **-1.16*** ** | **-2.54*** ** |
| | **(0.17)** | **(0.36)** | **(0.29)** | **(0.55)** |
| Ln pellet Price | 0.40** | 0.85* | 1.19 | 2.50*** |
| | (0.20) | (0.51) | (0.76) | (0.61) |
| **Pellet demand** | | | | |
| Ln Own made Price | 0.41*** | 0.43*** | 0.22* | -0.10 |
| | (0.06) | (0.08) | (0.13) | (0.07) |
| Ln Mash Price | 0.18** | 0.28* | 0.84 | 0.53*** |
| | (0.0921) | (0.17) | (0.54) | (0.13) |
| Ln pellet Price | **-0.42*** ** | **-0.60*** ** | **-0.42** ** | **-0.24** ** |
| | **(0.08)** | **(0.12)** | **(0.16)** | **(0.12)** |

Standard errors in parentheses, *p< 0.1, **p< 0.05, ***p< 0.01

Source: Survey data 2015

# CHAPTER FIVE: SUMMARY CONCLUSION AND RECOMMENDATIONS

## 5.1 Summary

The main purpose of this study was to analyze the factors influencing demand of poultry and fish feed in Kenya by examining responsiveness of farmer to changes in prices. This was achieved by estimating the quantity of fish and poultry feed demanded by smallholder farmer households. It was also achieved by estimating the own and cross price elasticities of demand for poultry and fish feed among farmers in Kenya. Finally the study estimated own and cross price elasticities of demand for poultry feed disaggregated by gender among farmers in Kenya. Poultry feed types included grains, vegetables, and mixed feed while for fish feed types included own made feed, mash and floating pellets. Descriptive results show that, quantities of poultry feed demanded by an average farmer were 55.5 kilograms of grains, 48.4 kilograms of vegetables and 71 kilograms of mixed feed. With respect to head of household, the results show no significant differences between the two categories of farmers with respect to feed demand. On the other hand, the quantities of fish feed demanded by an average farmer were 42.6 kilograms of own made feed, 42.4 kilograms of mash and 62.8 kilograms of floating pellets.

Econometric results show that poultry and fish feeds are generally price inelastic and price elasticities tend to decrease with rising expenditure level. The study found out that both poultry and fish feeds have both substitutionary and complementary relationships. For instance, in poultry production, grain and mixed feed pair, and vegetable and mixed feed pair all exhibits a complementary relationship. Additionally, in poultry production female headed households were found to have a higher own price elasticity in absolute terms than male headed households for vegetables and grains.

## 5.2 Conclusion

This study was motivated by the lack of information on; 1) the quantity demanded of poultry and fish feeds against which targets can be set on supply of alternatives feeds. 2) the factors influencing quantity demanded of poultry and fish feeds against which economic analysis of poultry and fish feed demand can be based on. The study examined demand of poultry and fish feed in Kenya, comparing across counties and between female and male headed poultry farmer households. The study estimated structural models for a system of demand equations, and cost functions. In addition, the feed demand elasticities were computed.

The results of the analysis show that feeds are generally price inelastic and price elasticities tend to decrease with rising expenditure level. For instance average own-price elasticities of grains, vegetables and mixed feed were -0.66, -0.47 and -0.30 respectively, for poultry while average own-price elasticities of own made feed, mash and floating pellets were -0.66, -0.87 and -0.42 respectively for fish which is in line with theory (Kumar et al., 2010; Varian 1992). However own price elasticity of vegetables and grains are not significant while the own price elasticity of mixed feed is significant at 1%. This shows that a one percent increase in the price of mixed feed would result in a 0.30 percent decrease in the demand for mixed feed, holding all other factors constant. For fish production own made feed, mash and floating pellets re all significant at 1%. This shows that a one percent increase in the price of floating pellets would result in a 0.41 percent decrease in the demand for floating pellets, holding all other factors constant.

With regard to gender in poultry production, the results show differences in farmer responsiveness to price. For instance own price elasticity for the grain is inelastic for male

farmers, but elastic for their female counterparts. Cross price elasticities for all the poultry and fish feeds are positive, indicating that they are compliments. With regards to gender in poultry production, the results also show that male headed households use vegetables as compliments to grains, but female headed households use vegetables and grains as compliments to mixed feed. More so, in order to maximize usage of available feeding resources and still meet the food demand of the households male headed households substitute grains with vegetables.

### 5.3 Recommendations

From the foregoing results it is highly recommended that policy makers should develop policies that aim at reducing the prices of manufactured poultry and fish feed. In addition, policy makers should develop policies that aim at reducing prices of ingredients used in feed manufacture by promoting local production for those that are imported and also by reducing taxation on feed manufacturing inputs. Strategies such as training on poultry production and management to promote efficient use of available resources should be targeted towards female headed households and female farmers as they are in most instances the owners and managers of poultry enterprises.

### 5.4 Areas for further research

1. There is a great need to undertaken study disaggregated by gender to cover fish farmers.
2. There is also a need to undertake a study on other non-price incentives (such as trainings) that influence feed consumption would be also useful to policy makers in formulating qualitative policies to strengthen the prevailing and recommended policies.

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## APPENDICES

**Appendix 1a: Variance inflation factors for the variables in the poultry total feed cost model**

| Variable | VIF | 1/VIF |
|---|---|---|
| Ln of unit price of grains | 1.19 | 0.8371 |
| Ln of unit price of vegetables | 1.25 | 0.8031 |
| Ln of unit price of mixed feed | 1.06 | 0.9468 |
| Ln of income | 4.62 | 0.2163 |
| Ln of number of poultry units | 4.66 | 0.2148 |
| Marital Status of the Household head | 1.08 | 0.9232 |
| Business engagement of the Household head | 1.14 | 0.8809 |
| Bird type | 1.52 | 0.6579 |
| Nakuru | 2.55 | 0.3916 |
| Kisii | 2.44 | 0.4100 |
| **Mean VIF** | **1.85** | |

**Appendix 1b: Variance inflation factors for the variables in the fish total feed cost model**

| Variable | VIF | 1/VIF |
|---|---|---|
| Ln price of own made feed | 1.07 | 0.9326 |
| Ln of price of Mash | 1.52 | 0.6599 |
| Ln of price of pellet | 1.16 | 0.8611 |
| Ln output | 1.02 | 0.9842 |
| Age of the Household head | 1.21 | 0.8295 |
| Education level of the Household head | 1.19 | 0.8386 |
| Marital Status of the Household head | 1.03 | 0.9712 |
| For sale | 1.15 | 0.8696 |
| Manufactured feed | 1.05 | 0.9567 |
| Nakuru | 1.81 | 0.5530 |
| Kisii | 2.32 | 0.4309 |
| **Mean VIF** | **1.85** | |

**Appendix 2: Symmetry conditions for the translog feed cost function for fish**

| Symmetry conditions | F-test | P>F-test |
|---|---|---|
| [Ownmadeshare]lnpellet - [pelletfeedshare]lnOwnmade = 0 | 0.00 | 0.9466 |
| [lnTC]lnownmadesquared - [Ownmadeshare]lnownmade = 0 | 1.99 | 0.1579 |
| [lnTC]lnpelletsquared - [Pelletfeedshare]lnpellet = 0 | 0.12 | 0.7265 |
| [lnTC]lnownmademash – [Ownmadeshare]lnmash = 0 | 0.05 | 0.8171 |
| [lnTC]lnownmadelnpellet - [Ownmadeshare]lnpellet = 0 | 2.08 | 0.1493 |
| [lnTC]lnownmadelnoutput - [Ownmadeshare]lnoutput = 0 | 0.54 | 0.4638 |
| [lnTC]lnpelletlnoutput - [Pelletshare]lnoutput = 0 | 1.99 | 0.1588 |
| [lnTC]lnownmade - [Ownmadeshare]_cons = 0 | 0.19 | 0.6622 |
| [lnTC]lnpellet - [Pelletshare]_cons = 0 | 0.04 | 0.8505 |
| [lnTC]lnownmadeage - [Ownmadeshare]hhhead_age = 0 | 0.11 | 0.7445 |
| [lnTC]lnownmadeeduc - [Ownmadeshare]hhhead_higheduc = 0 | 0.40 | 0.5278 |
| [lnTC]lnownmademarst - [Ownmadeshare]hhhead_marstat1 = 0 | 0.01 | 0.9317 |
| [lnTC]lnownmadeforsale - [Ownmadeshare]hhhead_forsale = 0 | 1.11 | 0.2921 |
| [lnTC]lnpelletage - [Pelletshare]hhhead_age = 0 | 0.04 | 0.8354 |
| [lnTC]lnpelleteduc - [Pelletshare]hhhead_higheduc = 0 | 1.38 | 0.2405 |
| [lnTC]lnpelletmarst - [Pelletshare]hhhead_marstat1 = 0 | 0.34 | 0.5624 |
| [lnTC]lnpelletforsale - [Pelletshare]hhhead_forsale = 0 | 1.08 | 0.2979 |

**Appendix 3: Symmetry conditions for the translog feed cost function for poultry**

| Symmetry conditions | F-test | P>F-test |
|---|---|---|
| [Grainshare]lnmixedfeed - [Mixedfeedshare]lngrain = 0 | 0.61 | 0.4349 |
| [lnTC]lngrainlngrain - [Grainshare]lngrain = 0 | 2.01 | 0.1550 |
| [lnTC]lnmixedfeedmixedfeed -[Mixedfeedshare]lnmixedfeed = 0 | 0.86 | 0.3550 |
| [lnTC]lngrainlnvegetable - [Grainshare]lnvegetable = 0 | 0.17 | 0.6801 |
| [lnTC]lngrainlnmixedfeed - [Grainshare]lnmixedfeed = 0 | 0.03 | 0.8646 |
| [lnTC]lngrainlnoutput - [Grainshare]lnoutput = 0 | 1.27 | 0.2593 |
| [lnTC]lnmixedfeedlnoutput - [Mixedfeedshare]lnoutput = 0 | 2.59 | 0.1074 |
| [lnTC]lngrain - [Grainshare]_cons = 0 | 3.17 | 0.0749 |
| [lnTC]lnmixedfeed - [Mixedfeedshare]_cons = 0 | 1.85 | 0.1756 |
| [lnTC]lngrainmarst - [Grainshare]hhhead_marstat1 = 0 | 1.14 | 0.2851 |
| [lnTC]lngrainbuseng - [Grainshare]hhhead_buseng = 0 | 0.94 | 0.3321 |
| [lnTC]lnmixedfeedmarst - [Mixedfeedshare]hhhead_marstat1 = 0 | 1.09 | 0.2976 |
| [lnTC]lnmixedfeedbuseng - [Mixedfeedshare]hhhead_buseng = 0 | 0.00 | 0.9914 |
| [lnTC]lngrainbtype - [Grainshare]birdtypea = 0 | 0.28 | 0.5942 |
| [lnTC]lnmixedfeedbtype - [Mixedfeedshare]birdtypea = 0 | 0.27 | 0.6014 |
| [lnTC]lngrainincome - [Grainshare]lnincome = 0 | 1.32 | 0.2507 |
| [lnTC]lnmixedfeedincome - [Mixedfeedshare]lnincome = 0 | 3.31 | 0.0687 |

**Appendix 4: Own made feed demand**

| | Pooled (n=278) | Kisii (n=87) | Nakuru (n=86) | Kirinyaga (n=105) |
|---|---|---|---|---|
| Ln price of own made | -0.05** | -0.03 | -0.03 | 0.04 |
| | (0.02) | (0.04) | (0.06) | (0.04) |
| Ln price of Mash | 0.07*** | 0.03 | 0.11** | 0.13*** |
| | (0.02) | (0.03) | (0.05) | (0.05) |
| Ln price of pellet | -0.0167 | -0.00 | -0.08 | -0.17*** |
| | (0.02) | (0.03) | (0.05) | (0.04) |
| Ln Output | -0.02 | 0.01 | -0.03 | 0.03 |
| | (0.02) | (0.02) | (0.02) | (0.04) |
| Age of the household head | 0.00 | 0.00 | 0.00 | 0.00 |
| | (0.00) | (0.00) | (0.00) | (0.00) |
| Education level of the Household head | -0.00 | 0.00 | 0.00 | -0.01 |
| | (0.00) | (0.01) | (0.00) | (0.01) |
| Marital status (1=married,0=Otherwise) | 0.02 | 0.08 | -0.04 | 0.08 |
| | (0.03) | (0.07) | (0.05) | (0.05) |
| Sold any (1=Yes, 0=No) | 0.02 | -0.01 | 0.05 | 0.01 |
| | (0.03) | (0.06) | (0.04) | (0.06) |
| Manufactured feed (1=Yes, 0=No) | -0.81*** | -0.85*** | -0.93*** | -0.86*** |
| | (0.05) | (0.08) | (0.11) | (0.07) |
| Constant | 0.90*** | 0.00** | 0.00 | 0.64** |
| | (0.17) | (0.00) | (0.00) | (0.31) |

Standard errors in parentheses, *p< 0.1, **p< 0.05, ***p< 0.01

**Appendix 5: Pellet feed demand**

| | Pooled (n=278) | Kisii (n=87) | Nakuru (n=86) | Kirinyaga (n=105) |
|---|---|---|---|---|
| Ln price of own made | -0.02 | -0.00 | -0.08 | -0.17*** |
| | (0.02) | (0.03) | (0.05 | (0.04) |
| Ln price of Mash | 0.00 | 0.06 | 0.21 | 0.25*** |
| | (0.04) | (0.07) | (0.19) | (0.08) |
| Ln price of pellet | 0.08** | -0.01 | 0.08 | 0.08 |
| | (0.03) | (0.05) | (0.06) | (0.07) |
| Ln Output | -0.05 | 0.02 | -0.10** | -0.08 |
| | (0.03) | (0.03) | (0.05) | (0.07) |
| Age of the household head | -0.00 | 0.00 | 0.00 | -0.00 |
| | (0.00) | (0.00) | (0.00) | (0.00) |
| Education level of the Household head | -0.00 | 0.01 | 0.02* | -0.01 |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| Marital status (1=married,0=Otherwise) | 0.01 | 0.10 | 0.19 | -0.19** |
| | (0.06) | (0.10) | (0.11) | (0.10) |
| Sold any (1=Yes, 0=No) | 0.06 | 0.06 | 0.10 | 0.07 |
| | (0.06) | (0.08) | (0.11) | (0.10) |
| Manufactured feed (1=Yes, 0=No) | 0.61*** | 0.63*** | 0.52* | 0.62*** |
| | (0.09) | (0.12) | (0.29) | (0.13) |
| Constant | 0.39 | 0.00 | 0.00 | 0.35 |
| | (0.33) | (0.00) | (0.00) | (0.65) |

Standard errors in parentheses, *p< 0.1, **p< 0.05, ***p< 0.01

**Appendix 6: Mash feed demand**

| | Pooled (n=278) | Kisii (n=87) | Nakuru (n=86) | Kirinyaga (n=105) |
|---|---|---|---|---|
| Ln price of own made | 0.07*** | 0.03 | 0.10** | 0.13*** |
| | (0.02) | (0.03) | (0.05) | (0.05) |
| Ln price of Mash | -0.01 | -0.03 | -0.10 | -0.22*** |
| | (0.03) | (0.05) | (0.07) | (0.07) |
| Ln price of pellet | -0.06** | 0.01 | -0.00 | 0.09 |
| | (0.03) | (0.05) | (0.07) | (0.06) |
| Ln Output | 0.07** | -0.03 | 0.13*** | 0.05 |
| | (0.03) | (0.03) | (0.05) | (0.06) |
| Age of the household head | 0.00* | -0.00 | -0.01 | 0.01 |
| | (0.00) | (0.00) | (0.00) | (0.00) |
| Education level of the Household head | 0.02** | 0.00 | -0.02 | 0.03** |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| Marital status (1=married,0=Otherwise) | -0.02 | -0.27*** | -0.10 | 0.16 |
| | (0.07) | (0.10) | (0.13) | (0.10) |
| Sold any (1=Yes, 0=No) | 0.01 | 0.06 | -0.08 | -0.06 |
| | (0.06) | (0.08) | (0.12) | (0.10) |
| Manufactured feed (1=Yes, 0=No) | 0.60*** | 0.63*** | 0.52* | 0.62*** |
| | (0.09) | (0.12) | (0.29) | (0.13) |
| Constant | -0.29 | 1.00*** | 1.00*** | 0.00 |
| | (0.32) | (0.00) | (0.00) | (0.61) |

Standard errors in parentheses, *p< 0.1, **p< 0.05, ***p< 0.01

## Appendix 7: INSFEED SURVEY INSTRUMENTS

**Poultry Farmer Interview Guideline Questions**

**Household ID**: _____

**Background Information**

Date of interview __/___/2015

| | |
|---|---|
| Name of Interviewer | |
| County name | 1=Nakuru 2=Kisii 3=Kirinyaga |
| Sub-county name | |
| Ward name | |
| Village name | |

Q04 Name of the respondent(s)_____

**Q05** Sex of respondent _____(0= Male ; 1= Female)

**Q06**Relationship of respondent with the head of household_____

**Q07** Age of respondent (Yrs) _____

Qn8-1Household type ( 0= male headed; 1. Female headed)_____

**Section 1: Household Roster**

A "household" includes all members of a common decision making unit (usually within one residence) that are sharing income and other resources. Include workers or servants as members of the household. Ask the following questions about a person who was part of the household at least one month in the last 12 months.

| Person ID | Name | Sex<br>0=M<br>1=F | Age in Years | Relation to head:<br>See Code below | Marriage Status<br>See Code below | Highest grade completed<br>See Codes | Ability in English?<br>See Code Below | Engaged in any business or wage labour in last 12 months?<br>1=YES<br>0=NO | Months living at home in last 12 months? |
|---|---|---|---|---|---|---|---|---|---|
| ID | Name | A1 | A2 | A3 | A4 | A6 | A7 | A8 | A9 |
| | | | | | | | | | |

**Code for A3**:
0=Head
1=Spouse
2=Parent
3=Child
4=Grand child
5=Nephew/Niece
6=Son/daughter-in-law
7=Brother/Sister
8=Wife 2
9=Wife 3
10=Other relative
11=Other non-relative

**Code for A4**:
1=Single
2=Monogamously married
3=Polygamous married
4=Widowed
5=Separated/Divorced
6=Other (Specify)

**Code for A6**:
0=Pre-Primary
1=Primary 1
2=Primary 2
3=Primary 3
4=Primary 4
5=Primary 5
6=Primary 6
7=Primary 7
8=Primary 8
9=Secondary 1 (OL1) or (Jr. I)
10=Secondary 2 (OL2) or(Jr. II)
11=Secondary 3 (OL3)
12=Secondary 4 (OL4)
13=Secondary 5 (AL1)
14=Secondary 6 (AL2)
15=Tertiary 1
16=Tertiary 2
17=Tertiary 3
18=Tertiary 4
19=Tertiary 5
120=Post graduate
99= Never in school

Code for A7:
1=No ability
2=Comprehension only
3=Speaking only
4=Speaking and reading
5=Speaking, reading, and writing
6=Reading only
7=Writing and reading
8=speaking and writing
9=Other (Specify)

**Section 2-A: Poultry inventory**

Q9.Has any member of your household raised or owned chicken or other domesticated birds during the last 3 months?(1=yes, 0=No)

If yes to Q9, please complete the table below

| Type/name of Poultry | Poultry code | During the last 3 months, has any member of your household raised or owned any […]?<br><br>1= Yes<br>0= No | **System**<br><br>1=Free range system<br>2=Semi-intensive (back yard)<br>3=Intensive system | How many of […] are owned by your household now? Number owned now (present at your farm or away) **IF ZERO, GO TO 7.** | Number owned by men | Number owned by women | Number owned jointly | Did any one in the household buy any […] to raise during the last 3 months? | | Did any one in the household sell any [...] during the last 3 months? | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Number bought **IF NONE WRITE 0, GO TO 10** | Total purchase value of all bought **INCLUDING VALUE OF IN-KIND PAYMENTS** | Number sold | Total sales value of all sold<br><br>**INCLUDING VALUE OF IN-KIND PAYMENTS** |
| **B0** | **B1** | **B2** | | **B3** | **B4** | **B5** | **B6** | **B7** | **B8** | **B9** | **B10** |
| Local chicken (cocks) | 1 | | | | | | | | | | |
| Local chicken (hens) | 2 | | | | | | | | | | |
| Cross breeds (cocks) | 3 | | | | | | | | | | |
| Cross breeds(hens) | 4 | | | | | | | | | | |
| Broilers (Exotic) | 5 | | | | | | | | | | |
| Layers (exotic) | 6 | | | | | | | | | | |
| Pullet chicks | 7 | | | | | | | | | | |
| Growers | 8 | | | | | | | | | | |
| Turkeys | 9 | | | | | | | | | | |
| Ducks | 10 | | | | | | | | | | |
| Geese | 11 | | | | | | | | | | |
| Quails | 12 | | | | | | | | | | |
| Others (specify) | 13 | | | | | | | | | | |

**Section 2-B: Type of poultry production system and Feeds used used by the household**

| Type of system | | Who manages the enterprises?<br>Man<br>Woman<br>Both<br>Others (specify | Main feed<br>1=Vegetables (such as spinach)<br>2=Food remains from home;<br>3=Grains (wheat/corn)<br>4=Own made poultry mash<br>5=Purchased poultry feed<br>6=Others (specify___) | | | |
|---|---|---|---|---|---|---|
| C0 | | **C4** | **C5** | **C6** | **C7** | **C8** |
| Free range system | | | | | | |
| Semi-intensive (back yard) | | | | | | |
| Intensive system | | | | | | |
| Others (specify____) | | | | | | |

**Section 3 A: Expenditure on purchased feed in the last three months?**

| **Feed type** | Who procures the feed<br>Man<br>Woman<br>Joint<br>Others (specify | **Did you buy this feed in the last 3 months (1=yes, 0=No)** | **If yes, quantity purchased per month (Kg)** | **Freq. of purchase during a month** | **Expenditure per purchase** | **Distance to the nearest feed supplier (KM)** | **If you did not buy this feed, estimate the value of the feed in the last 3 months** | **Availability 1=easily available 2= Not easily available** |
|---|---|---|---|---|---|---|---|---|
| **D0** | **D1** | **D2** | **D3** | **D4** | **D5** | **D6** | **D7** | **D8** |
| 1=Vegetables (such as spinach)<br>2=Food remains from home;<br>3=Grains (wheat/corn/maize/rice)<br>4=Own made poultry mash<br>5=Purchased poultry feed(mixed feed)<br>6=Food remains from restaurants;<br>7=Feed supplements ( (specify___) | | | | | | | | |

**Q 10. Do you make own poultry feed at the farm? (1=Yes, 0=No)_____**
**If yes, complete the table below**
**Section 3-B: Own produced feed**

| | | | **Ingredients used in feed mixing** | | |
|---|---|---|---|---|---|
| **Feed for**<br>**Layers**<br>**Broilers**<br>**Chick**<br>**Growers** | **Who produces**<br>Man<br>Woman<br>Both<br>4=Male laborers<br>5=female laborers6=<br>Children | **Quantity of feed produced per week** | **Name of Ingredients Used** | **Quantity of each ingredient (kg)** | **Unit cost of ingredient (KES/kg)** |
| **E0** | **E1** | **E2** | **E3** | **E4** | **E5** |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Section 3-C: Other expenses incurred in the past three months**

| Item | **Did you pay for this item/service in the last 3 months (1=yes, 0=No)** | **If yes, how much did you spend(KES)** | **Responsible for expenses**<br>Man<br>Woman<br>Both<br>Others (specify |
|---|---|---|---|
| F0 | **F1** | **F2** | **F3** |
| Medicine for parasite and disease control | | | |
| Feeding and watering troughs | | | |
| Veterinary services | | | |

**Section 4: Gender Division of labor:**

| **Section 4a: Family labor utilization in poultry production**<br>Activity<br>Code<br>See Code below | **Family Labour Use** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Men<br>How many? | | | Women<br>How many? | | | Children<br>How many? | | |
| | Men | Hrs a day | Days | Women | Hrs a day | Days | Children | Hrs a day | Days |
| **LF0** | **LF1** | **LF2** | **LF3** | **LF4** | **LF5** | **LF6** | **LF7** | **LF8** | **LF9** |
| Brooding (annual) | | | | | | | | | |
| Feed mixing (3months) | | | | | | | | | |
| Feeding poultry (3 months) | | | | | | | | | |
| Cleaning poultry units (3 months) | | | | | | | | | |
| Collecting eggs (3 months) | | | | | | | | | |
| Selling chicken (3 months) | | | | | | | | | |
| Treating poultry (3 months) | | | | | | | | | |
| Acquisition of new poultry (3 months) | | | | | | | | | |

**Section 4b: Hired labor utilization in poultry production**

| Activity | **Hired Labour Use in the 6 months** | | | | | | | | | **Expenditure on labor** | **Who paid for the labor 1=Man 2=Woman 3=Both 4=Children** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Men How many? | | | Women How many? | | | Children How many? | | | | |
| | Men | Hrs a day | Days | Women | Hrs a day | Days | Children | Hrs a day | Days | | |
| **LF0** | **LF1** | **LF2** | **LF3** | **LF4** | **LF5** | **LF6** | **LF7** | **LF8** | **LF9** | | |
| Brooding (annual) | | | | | | | | | | | |
| Feed mixing (3months) | | | | | | | | | | | |
| Feeding poultry (3 months) | | | | | | | | | | | |
| Cleaning poultry units (3 months) | | | | | | | | | | | |
| Collecting eggs (3 months) | | | | | | | | | | | |
| Selling chicken (3 months) | | | | | | | | | | | |
| Treating poultry (3 months) | | | | | | | | | | | |
| Acquisition of new poultry (3 months) | | | | | | | | | | | |

**SECTION 5: Access to support services for poultry production**

What is the situation (availability, accessibility and affordability) of support services for the poultry farmers in this area?

| **Support service** | **Availability**<br>1=available<br>0=Not available |
|---|---|
| **K0** | **K1** |
| Microcredit (SACCOs) | |
| Extension services | |
| Training | |
| Microcredit NGO | |
| Bank | |
| Health | |
| Vaccination | |
| Treatment | |
| Agricultural Inputs | |
| Feed | |
| Fodder | |
| Selling point for poultry products | |
| New poultry technologies | |
| Market information | |

**Section 6: Major constraints faced and solutions suggested by men and women in poultry farming**

**Production constraints**

| **Females (constraints and solutions)** | | **Males (constraints and solutions)** | |
|---|---|---|---|
| **Constraints** | **Solution** | **Constraints** | **Solution** |
| | | | |
| | | | |
| | | | |

**Marketing constraints**

| **Females (constraints and solutions)** | | **Males (constraints and solutions)** | |
|---|---|---|---|
| **Constraints** | **Solution** | **Constraints** | **Solution** |
| | | | |
| | | | |
| | | | |
| | | | |

**SECTION 12: Shocks in poultryfarming**

What are the major shocks to poultry farming you experience in this area and how much are you affected?

| **Shock** | **Number of months of shock in a year** | **Who was most affected by the shock? 1. Men, 2. Women** | **Coping strategies** |
|---|---|---|---|
| **S0** | **S1** | **S3** | **S3** |
| Drought | | | |
| Poultry Disease outbreak | | | |
| Poultry Parasites | | | |
| Price fluctuations | | | |
| Sickness of household member | | | |
| Cattle raid/theft | | | |
| Others(specify) | | | |

**GPS coordinates:**

Long _____

Lat_____

Altitude_____

**FISH FARMER INTERVIEW GUIDELINE QUESTIONS**

**Household ID**: _____

**Background Information**

Date of interview __/___/2015

| | |
|---|---|
| Name of Interviewer | |
| County name | 1=Nakuru 2=Kisii 3=Kirinyaga |
| Sub-county name | |
| Ward name | |
| Village name | |

Q04 Name of the respondent(s)_____

**Q01** Sex of respondent _____(0= Male ; 1= Female)

**Q02**Relationship of respondent with the head of household_____

**Q03** Age of respondent (Yrs) _____

Qn4-1Household type ( 0= male headed; 1. Female headed)_____

**Section 1: Household Roster**

A "household" includes all members of a common decision making unit (usually within one residence) that are sharing income and other resources. Include workers or servants as members of the household. Ask the following questions about a person who was part of the household at least one month in the last 12 months.

| Person ID | Name | Sex<br><br>0=M<br>1=F | Age in Years | Relation to head:<br><br>See Code below | Marriage Status<br><br>See Code below | Highest grade completed<br><br>See Codes | Ability in English?<br><br>See Code Below | Engaged in any business or wage labour in last 12 months?<br>1=YES<br>0=NO | Months living at home in last 12 months? |
|---|---|---|---|---|---|---|---|---|---|
| ID | Name | A1 | A2 | A3 | A4 | A6 | A7 | A8 | A9 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

**Code for A3:**
0=Head
1=Spouse
2=Parent
3=Child
4=Grand child
5=Nephew/Niece
6=Son/daughter-in-law
7=Brother/Sister
8=Wife 2
9=Wife 3
10=Other relative
11=Other non-relative

**Code for A4:**
1=Single
2=Monogamously married
3=Polygamous married
4=Widowed
5=Separated/Divorced
6=Other (Specify)

**Code for A6:**
0=Pre-Primary/never
1=Primary 1
2=Primary 2
3=Primary 3
4=Primary 4
5=Primary 5
6=Primary 6
7=Primary 7
8=Primary 8
9=Secondary 1 (OL1) or (Jr. I)
10=Secondary 2 (OL2) or(Jr. II)
11=Secondary 3 (OL3)
12=Secondary 4 (OL4)
13=Secondary 5 (AL1)
14=Secondary 6 (AL2)
15=Tertiary 1
16=Tertiary 2
17=Tertiary 3
18=Tertiary 4
19=Tertiary 5
20=Post graduate

**Code for A7**:
1=No ability
2=Comprehension only
3=Speaking only
4=Speaking and reading
5=Speaking, reading, and writing
6=Reading only
7=Writing and reading
8=speaking and writing
9=Other (Specify)

**Section 2-A: Fish inventory**

Q5. Have you or any member of your household engaged in fish farming during the last 6 months?___ _____(1=yes, 0=No)

| Type/name of Fish | Fish code | During the last 6 months, has any member of your household raised or owned any […]? 1=Yes 0=No | How much fish [by type] is owned by your household now? Number owned now (present at your farm or away) **IF ZERO, GO TO 7.** | Number of ponds/tanks & Fish owned by men | | Number of ponds/tanks & Fish owned by women | | Number of ponds/tanks & Fish owned jointly | | Size of the ponds/tanks used to rear fish (ftXft) | | Did anyone in the household sell any [Fish] during the last 6 months? | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | # of ponds | # of fish | # of ponds | # of fish | # of ponds | # of fish | **Nursery ponds** | **Grow-out ponds** | Number sold | Total sales value of all sold **INCLUDING VALUE OF IN-KIND PAYMENTS** |
| **B0** | **B1** | **B2** | **B3** | **B4A** | **B4B** | **B5A** | **B5B** | **B6A** | **B6B** | **B7** | **B8** | **B9** | **B10** |
| Tilapia | 1 | | | | | | | | | | | | |
| Catfish | 2 | | | | | | | | | | | | |
| Other(specify) | 3 | | | | | | | | | | | | |

**Qn** 6. In which year did this household start rearing fish.....

**Q 7.** how many other farmers in this village rear fish?..... no of female…no of male ..

**Section 2B- Types of species reared/preferred by female and male farmers**

| **Fish species preferred by Females** | | **Fish species preferred by Females** | |
|---|---|---|---|
| **Fish species** | **Reasons** | **Fish species** | **Reasons** |
| | | | |
| | | | |

**Section 2C. Fingerings acquired in the past three Months**

| **Fish species** | **Number of fingerings acquired in the last 6 months** | **Did you buy 1=yes 0=No** | **Unit Cost of fingerings** | **Who was responsible for paying 1=man 2=woman** |
|---|---|---|---|---|
| **Tilapia** | | | | |
| **Cat fish** | | | | |
| **Others** | | | | |

**Section 2-D: Type of Fish production system used by the household**

| | Ownership<br>Man<br>Woman<br>Both<br>Others (specify | Number of fish under the system | Main feed<br>1=Vegetables (such as spinach)<br>2=Fruits (pawpaw)<br>3=Food remains from home;<br>4=Grains (wheat/maize bran/rice)<br>5=Own made fish feed<br>6=Purchased fish feed (mash)<br>7= Purchased fish feed (floating pellets)<br>8=Algea (mwani)<br>9=chicken feed<br>10=Worms<br>11= Others (specify___) | | | | Who procures the feed<br>Man<br>Woman<br>Both<br>Others (specify |
|---|---|---|---|---|---|---|---|
| C0 | **C1** | **C2** | **C3** | **C4** | **C5** | **C6** | **C7** |
| Open pond | | | | | | | |
| Open tank | | | | | | | |
| Indoor tank | | | | | | | |
| Cages | | | | | | | |
| Others (specify____) | | | | | | | |

**Section 3: Expenditure on purchased feed in the last six months?**

| **Feed type** 1=Vegetables (such as spinach) 2=Fruits(pawpaw, watermelon etc 3=Food remains from home; 4=Grains (wheat/maize bran/ rice) 5=Own made fish feed 6=Purchased fish feed (mash) 7= Purchased fish feed (floating pellets) 8=Algea (mwani) 9=chicken feed 10.=Worms 11=Others (specify___) | **Did you buy this feed in the last 6 months (1=yes, 0=No)** | **If yes, quantity purchased per month (Kg)** | **Freq. of purchase during a month** | **Expenditure per purchase** | **Distance to the nearest feed supplier** | **If you did not buy this feed, estimate the value of the feed in the last 6 months** | **Availability =easily available 2=Not easily available** | **Who is responsible for purchasing feed** Man Woman Both Others (specify |
|---|---|---|---|---|---|---|---|---|
| **D0** | **D1** | **D2** | **D3** | **D4** | **D5** | **D6** | **D7** | **D8** |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

**Q8. Do you make own FISH feed at the farm? (1=Yes, 0=No)_____**
**If yes, complete the table below**

**Section 3-B: Own produced feed for fish**

| | | | **Ingredients used in feed mixing** | | |
|---|---|---|---|---|---|
| **Feed type** | **Responsible for producing**<br>Man<br>Woman<br>Both<br>Others (specify | **Quantity of feed produced per week** | **Name of Ingredients used** | **Quantity of ingredient (kg)** | **Unit cost of ingredient (KES/kg)** |
| **E0** | **E1** | **E2** | **E3** | **E4** | **E5** |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Section 3-C: Other expenses incurred in the past SIX months**

| Item | **Did you pay for this feed /drug/ vaccine / service in the last 6 months (1=yes, 0=No)** | **If yes, how much did you spend(KES)** | **Responsible for expenses**<br>Man<br>Woman<br>Both<br>Others (specify |
|---|---|---|---|
| F0 | **F1** | **F2** | |
| Feeds/Supplements | | | |
| Nets (harvesting) | | | |
| Extension services | | | |
| Treatment | | | |
| Other expenses(specify) | | | |

**Section 4: Gender Division of labor: Roles and Responsibilities of women and men in Poultry Production, in this household**

| **Section 4a: Family labor utilization in poultry production (six months)** | **Family Labour Use** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Men How many? | | | Women How many? | | | Children How many? | | |
| Activity Code See Code below | Men | Hrs a day | Days | Women | Hrs a day | Days | Children | Hrs a day | Days |
| **LF0** | **LF1** | **LF2** | **LF3** | **LF4** | **LF5** | **LF6** | **LF7** | **LF8** | **LF9** |
| Pond/tank construction | | | | | | | | | |
| Feed mixing | | | | | | | | | |
| Pond/tank stocking | | | | | | | | | |
| Feeding fish | | | | | | | | | |
| Cleaning ponds/tanks | | | | | | | | | |
| Fishing(harvesting) | | | | | | | | | |
| Selling fish | | | | | | | | | |
| Acquisition of new stocks | | | | | | | | | |

**Section 4b: Hired labor utilization in poultry production**

| Activity | **Hired Labour Use in the 6 months** | | | | | | | | | **Expenditure on labor** | **Who paid for the labor 1=Man 2=Woman 3=Both 4=Childre n** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Men How many? | | | Women How many? | | | Children How many? | | | | |
| | Men | Hrs a day | Days | Women | Hrs a day | Days | Childre n | Hrs a day | Days | | |
| **LF0** | **LF 1** | **LF 2** | **LF3** | **LF4** | **LF 5** | **LF6** | **LF7** | **LF 8** | **LF9** | | |
| Pond/tank construction | | | | | | | | | | | |
| Feed mixing | | | | | | | | | | | |
| Pond/tank stocking | | | | | | | | | | | |
| Feeding fish | | | | | | | | | | | |
| Cleaning ponds/tanks | | | | | | | | | | | |
| Fishing(harvestin g) | | | | | | | | | | | |
| Selling fish | | | | | | | | | | | |
| Acquisition of new stocks | | | | | | | | | | | |

**Section 5: Gendered access to support services for Fish production**

What is the situation of support services for the fish farmers in this area?

| | **Availability** |
|---|---|
| | 1=available 0=Not available |
| **K0** | **K1** |
| Microcredit | |
| Extension services | |
| Training | |
| Microcredit NGO | |
| Bank | |
| Health services for fish | |
| Agricultural Inputs | |
| Feed | |
| Fodder | |
| Selling point for fish products | |
| New Fish technologies | |
| Market information on fish | |

**Section 6: Major constraints faced by men and women in fish farming**

**Production constraints**

| **Females (constraints and solutions)** | | **Males (constraints and solutions)** | |
|---|---|---|---|
| **Constraints** | **Solution** | **Constraints** | **Solution** |
| | | | |
| | | | |

**Marketing constraints**

| **Females (constraints and solutions)** | | **Males (constraints and solutions)** | |
|---|---|---|---|
| **Constraints** | **Solution** | **Constraints** | **Solution** |
| | | | |
| | | | |

**Section 12: Shocks in fishfarming**

What are the major shocks to fish farming you experience in this area and how much are you affected?

| Shock | Number of months of shock in a year | Impact on gender roles in fish farming | Coping strategies | |
|---|---|---|---|---|
| **S0** | **S1** | | **Men** | **Women** |
| Drought | | | | |
| Fish predators | | | | |
| Fish poisoning | | | | |
| Price fluctuations | | | | |
| Sickness of household member | | | | |
| Fish theft | | | | |
| Floods | | | | |
| Others(specify) | | | | |

**GPS coordinates:**

Long _____ Lat_____ Altitude_____