An Analysis of Farmers' and Traders' Awareness, Perceptions and Effect of Chicken Value Chain Practices on Newcastle Disease Outbreaks in Kenya

By

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DECLARATION

This thesis is my original work and has not been presented for an award in any other university.

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DEDICATION

This thesis is dedicated to my parents, Prof. Isaac Odeo Ipara and Prof. Hellen Ingado Ipara, whose love and support has always been immeasurable down the years. Special dedication to my brothers Edgar, Andrew and Mervyn who encouraged me where others would have discouraged.

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ABSTRACT

Newcastle disease (ND) is a major challenge affecting chicken production in Kenya. It causes mortalities of 80 to 100 percent, depriving farmers and traders of their sources of livelihood. The disease is the main challenge for farmers who rear indigenous chicken under the free-range production system. It is unclear how farmers and traders manage ND under the prevailing value chain systems due to lack of uniformity in husbandry, marketing and production practices. Farmers' and traders' awareness levels of the disease and its mitigation are relatively undefined. This leads to flaws in value chain practices, thereby increasing the frequency of disease outbreaks. Whereas evidence of control of the disease in commercial chicken is well documented, the challenge remains the control of ND in free range production systems. There exists limited information on how the chicken value chain practices influence the frequency of ND as farmers and traders manage their flocks differently. To address these gaps, this study analyzed the level of awareness, perceptions and factors influencing ND among farmers and traders as well as the effects of chicken value chain practices on the frequency of ND outbreaks in Kenya. Primary data was collected from 332 chicken rearing farmers in Kakamega and Machakos Counties as well as 336 traders in live bird markets in Kakamega, Machakos and Nairobi Counties. Descriptive statistics, the chi-square statistic, binary logit model and the Poisson regression model (PRM) were applied in the data analysis. Results showed a gender difference between chicken production and marketing activities. Chicken production was dominated by women while the marketing was dominated by men. Access to institutional support services like extension, training and credit was low among farmers and traders across the three Counties. Household type, extension, training, group membership and marital status were found to significantly influence the likelihood of chicken farmers being aware of ND. For traders, experience, group membership, age, gender and marital status were found to significantly influence the likelihood of ND awareness. The chi-

square test results showed that practices like record keeping and market channels used to source birds had significant association with farmers' perception on ND during outbreaks. Similarly, practices like market channels used to source birds, form of birds sold, mode of transportation, origin of birds, availability of designated slaughter points, waste disposal and housing of birds were also found to have significant association with traders' perception on ND during outbreaks. From the PRM, flock size and age of birds were found to have positive effects while source of birds, form of housing, housing composition, frequency of cleaning shelter, screening of birds, mixed production system as well as farmer attributes like access to extension were found to have negative effects on the frequency of ND outbreaks among farmers. Among traders, practices like breed composition, form of birds, sale of other poultry species, use of motorcycle/ bicycle, mixing of birds, slaughter of birds and housing were found to have a positive effect while source of birds, origin of birds, disposal of waste as well as trader attributes like access to animal health training, licensing and gender had negative effects on the frequency of ND outbreaks. Based on the findings from this study, Kakamega and Machakos Counties should implement programs to recruit and deploy extension officers to facilitate delivery of information and extension. This will help improve the dissemination of information regarding chicken disease, good husbandry technologies and marketing practices. Credit service providers need to create affordable services and packages that target small-scale chicken farmers and traders. County governments can also establish funds that are tailored for agricultural activities where chicken farmers and traders can borrow and make payments. This will help investment in better production and marketing practices. There is need to create more awareness among chicken farmers and traders on aspects like disease detection and symptoms of ND, disease response strategies as well as mitigation measures during outbreaks.

From the findings, it is evident that form of housing, mode of feeding and flock composition under housing play a role on outbreaks of ND. Farmers should be sensitized on the need to adopt and

invest in better feeding practices for chicken as well as proper housing for chicken. Adoption of the practices will reduce the likelihood of birds coming into contact with disease spreading pathogens such as germs and wild birds. This can be done through group trainings where participants can be trained on better practices that help reduce outbreaks. County governments of Kakamega and Machakos should also develop relevant infrastructure such as vaccine storage facilities at sub Counties to facilitate efficient cold chain systems for good quality and effective vaccine delivery. Results from the PRM highlight transportation, the slaughter of birds within the market place and poor disposal of waste as practices that contribute to the increased frequency of ND in markets. The County governments can prioritize invest in market infrastructure through construction and provision of market facilities such as designated slaughter points, shelters to house birds within the market place and waste disposal equipment such as waste bins within the LBMs. There is also need of authorities in charge of live bird markets to ensure the enforcement and compliance of biosecurity, sanitation and hygiene practices within the markets. This can be done through regular inspection and monitoring of markets by animal health officials.

Keywords: Chicken management, marketing, live bird markets, Newcastle Disease.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

ACRONYMS`

ACIAR	Australian Center for International Agricultural Research
AIC	Akaike Information Criterion
ASDSP	Agricultural Sector Development Support Program (Kenya)
AU- IBAR	African Union- Inter-African Bureau for Animal Resource
CIDP	County Integrated Development Plan
CRA	Commission for Revenue Allocation
DVS	Directorate of Veterinary Services (Kenya)
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
KALRO	Kenya Agricultural and Livestock Research Organization
KIPPRA	Kenya Institute for Public Policy Research and Analysis
KNBS	Kenya National Bureau of Statistics
KSHs	Kenya Shillings
KWS	Kenya Wildlife Service
LBMs	Live Bird Markets
MOLFD	Ministry of Livestock and Fisheries Development
NAFIS	National Farmers' Information Services
NBRM	Negative Binomial Regression Model
ND	Newcastle Disease
NDV	Newcastle Disease Virus
OIE	World Organization on Animal Health
OLS	Ordinary Least Squares
PRM	Poisson Regression Model
RSS	Residual Sum of Square
RNA	Ribonucleic acid
SSA	Sub-Saharan Africa
UN	United Nations

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Poultry is a very important component of the agricultural and household economies in developing countries through provision of food for the growing populations, creation of employment and generation of income for resource poor households (Gueye, 2002). It is linked to the religious and socio-cultural aspects of millions of resource-poor farmers as it provides some degree of sustainable farming and economic stability (Mbabazi et al., 2012). It is also a significant form of livestock in terms of ownership, access to proteins and nutrition and a potential for cash earnings. It has the advantage over other forms of livestock as it is a low investment enterprise, suitable for areas where land ownership is a constraint due to its low space requirements (Mack et al., 2005; King'ori et al., 2010; Nduthu, 2015). It is also seen as an entry point in the production of other livestock species such as cattle and goats (Alders and Copland, 2009).

In Sub-Saharan Africa (SSA), village poultry are mainly owned and managed by women and children and are essential in female-headed households (Mack et al., 2005 and Islam et al., 2014). It contributes a substantial proportion of internal supply of animal protein in both rural and urban areas with rural poultry accounting for 70 percent of poultry products and 20 percent of animal proteins (Adeniyi and Ogutunji, 2011). Poultry provides an important source of high-quality nutrition and income with very little production costs and management time (Knuepell, 2009). Poultry production allows poorer rural communities to convert labour, which is their major comparative advantage into improved food security and cash (Alders and Copland, 2005).

In Kenya, poultry is a major source of livelihood through income generation as well as meeting socio-cultural roles (FAO, 2007a; Omiti and Okuthe, 2010). Its contribution to the gross domestic product (GDP) of Kenya is about 1.7 percent (NAFIS, 2018). Poultry is one of the most important enterprises in terms of food and nutrition security for rural poor households (Chepkemoi et al., 2016). As of 2017, Kenya's poultry population was estimated at about 40 million birds (KNBS, 2013). This is distributed as shown in Table 1.

Table 1: Poultry Species and Population in Kenya

Type	Number	Percent
Indigenous	31,400,000	84.1
Layer	3,100,000	8.3
Broiler	5,700,000	5.7
Others (Turkey, Guinea fowls, Ducks and geese)	700,000	1.9
Total	37,300,000	100

Source: KNBS (2013).

The annual production of poultry meat in Kenya is about 20,000 metric tons while the value of egg production is estimated at 1,251 million Kenya shillings (FAOSTAT, 2016). Poultry meat consumption is still low but is expected to rise with increasing GDP and a growing middle class (Duns and Willems, 2010). Poultry production systems especially the free-range are characterized by low productivity and face constrains related to high mortality and disease, housing, feeding, breeding, marketing, credit, education and training (Knueppal, 2009).

High incidences of disease are one of the major constraints to poultry production. Most serious poultry diseases occur every year, killing an average of 70 to 80 percent of unvaccinated rural poultry flock (Gueye, 2002). Worldwide estimates show that the average loss due to disease is more than 20 percent with the average economic loss being 2 billion dollars (AU- IBAR, 2016).

Newcastle disease (ND) is the major constraint to poultry production in many developing countries. Its outbreaks are unpredictable and discourage poultry keepers from paying attention to husbandry practices and the welfare of chicken (AU-IBAR, 2016). It is a highly contagious disease of respiratory and nervous system, mostly affecting chicken and other species of poultry (Mbabazi et al., 2012).

The disease rarely leaves survivors in unvaccinated flock (Gueye, 2002). It is the most pathogenic of annual poultry epidemics that accounts for over 50 percent of deaths (Tomo, 2009). It is highly contagious and can be spread through droppings and discharge from birds, direct contact, through air or contaminated materials such as the shoe soles, vehicles, food or infected cages (Mbabazi et al., 2012). According to Tomo (2009), the common virus source infects chicken and the outbreaks are mainly attributed to movement through markets and traders. A chicken incubating the disease can introduce the virus to an isolated, fully susceptible flock; resulting to 100 percent mortality. Continuous vaccination offers the only effective control measure against the disease. Swai et al. (2011) noted that the absence of routine vaccination favors the spread of disease.

The ND is responsible for high economic losses of up to 100 percent in unvaccinated poultry populations (Ogali et al., 2018). Although the disease is endemic[1] in village poultry, it mostly follows an epidemic[2] pattern. This makes it one of the constraints to increasing small-scale poultry production (FAO, 2004). Epidemics occur during times of climatic stress such as heavy

[1]Endemic disease- refers to a disease that is always present in a certain population or region.
[2]Epidemic disease- refers to a disease that rapidly to a large number of animals in a given population within a short period of time

rainfall and cold weather, resulting to its seasonal occurrence. The outbreaks of Newcastle Disease Virus (NDV) in village poultry populations are relatively slow due to low rates of contact (Awan et al., 2004). Sustainable control of ND requires the maintenance of high level of quality control in production and investment in production and extension.

1.2 Statement of the Research Problem

The ND is regarded as the most prevalent and fatal chicken disease in Kenya (King'ori et al, 2010a; Atela et al., 2016). Its outbreaks often cause 80 to 100 percent mortality in unvaccinated poultry, leading to high economic losses through deaths. The losses from ND act as a disincentive in improving aspects of husbandry in birds (AU-IBAR, 2013a). Despite the known losses, efforts to address the problem of the disease are not adequate.

The challenges faced in controlling ND in Kenya include lack of basic preventive and control mechanisms, lack of basic training on animal health and inadequate knowledge regarding the disease. Moreover, the levels of awareness and perceptions of the disease are not precisely known among farmers and traders in Kenya. Limited awareness and negative perceptions of disease leads to flaws in management and production, leading to increased disease outbreaks.

Vaccination is seen as the most effective way to control ND and is mostly carried out by commercial poultry farmers. However, most small-scale chicken farmers rarely vaccinate their flock partly because commercially available vaccines require refrigeration during storage and transportation to the end users. This makes it unsuitable for small, multi-aged and scattered free range chicken (Wachira et al., 2011). Outbreaks are also being recorded in both vaccinated and non-vaccinated poultry.

Free range systems of production pose difficulties in terms of management of ND because they expose the birds to direct contact with parasites and disease-causing pathogens (Ogada et al.,

2016). This makes it difficult for farmers to monitor and manage the disease due to lack of uniformity, thus an avenue for disease entry. It is also unclear how the farmers especially those using the free-range production system manage the disease.

According to Olwande et al. (2010), the birds in free range systems are kept with little or no inputs like vaccinations and antibiotics. There is also low investment by farmers in veterinary care and disease-proof poultry housing in free range systems. Rather, practices like unregulated confinement of birds, disposal of droppings from sick birds and the disposal of carcasses of birds that have died from diseases favor the maintenance of virus in poultry (Njagi et al., 2010b).

Marketing practices also provide an avenue for ND outbreaks. Mixing of birds from different sources increases the likelihood of disease transmission (Akinwumi et al., 2009). Traders also use different modes like bicycles, motorcycles, passenger service vehicles and open vehicles to transport the birds; each of these exposing birds to different levels of ND outbreaks. Sale of sick birds, mixing of birds from different places, inappropriate disposal of sick and dead birds, poor mechanisms for disposing waste and poor biosecurity[3] are documented to influence disease (Mulisa et al., 2009). The use of such practices favors the introduction and outbreaks of the disease, posing challenges in the control of ND. It also remains unclear how traders handle sick birds or the possibility of getting the birds from farmers.

Whereas evidence of control of the ND in commercial chicken is well documented, the challenge remains in free range production systems. There exists limited empirical information on how the chicken value chain practices influence ND outbreaks as farmers and traders manage their flocks differently.

[3]Biosecurity- refers as a set of preventive measures designed to reduce the risk of transmission of diseases in livestock

1.3 Objectives of the Study

The main objective of this study was to determine farmers' and traders' awareness, perceptions and effect of chicken value chain practices on ND outbreaks. The specific objectives were to:

1. Assess the factors influencing chicken farmers' and traders' awareness on Newcastle Disease.
2. Assess the association between farmers' and traders' Newcastle Disease perceptions and their choice of the control practices.
3. Estimate the effect of production systems and management practices on the frequency of Newcastle Disease outbreaks.
4. Analyze the effect of transportation and marketing practices on the frequency of Newcastle Disease outbreaks.

1.4 Research Hypotheses

- Gender, training on animal health and age have no effect on Newcastle Disease awareness among farmers and traders.
- Farmers' and traders' perception on Newcastle Disease have no association with choice of value chain practices.
- Screening of birds, vaccination and form of housing have no significant effect on frequency of Newcastle Disease outbreaks.
- Modes of transportation, screening of birds and marketing channels used have no significant effect on frequency of Newcastle Disease outbreaks.

1.5 Justification of the Study

Chicken diseases like ND constitute the major constraint facing production in Kenya resulting in low productivity and losses to farmers and traders. This study assessed farmers' and traders' awareness of ND. Information on awareness will help County governments that have prioritized

the chicken value chain to develop and implement appropriate and relevant trainings, extension service programs and information delivery systems on disease detection, control and management for farmers and traders. This will provide chicken farmers and traders with the technical knowledge and information that will help in effective response to disease outbreaks and management. This will enable the achievement of timely detection, treatment, and control of poultry diseases as highlighted by the National Poultry Policy (Republic of Kenya, 2010b).

Kenya's Agricultural Sector Development Strategy (ASDS) aims at reducing food insecurity by 30 percent by 2020, attaining nutritional security and transforming the agricultural sector into a viable sector (Republic of Kenya, 2010a). Poultry is necessary in achieving food and nutritional security through provision of cheap proteins from meat and eggs. Another objective of this study is to assess the effects of management practices on ND frequency. Information on the type of practices and their influence of ND will help policy makers and researchers to develop cost effective and appropriate management packages and interventions that can be adopted by farmers. Adoption of better management, husbandry and production practices will help prevent outbreaks and spread of diseases, resulting in increased production.

The information will also help County animal health officers, agro-vets and researchers to develop effective and affordable vaccination programs to facilitate disease control and mitigation. The information will also help in highlighting the interventions in the poultry marketing chain to reduce ND outbreaks. Control of the ND will help to increase productivity, contributing to increased incomes and food security. This is consistent with Kenya's Vision 2030 agricultural sector strategic thrust of improving productivity (Republic of Kenya, 2010c)

Considering that poultry is a priority value chain in many Counties as a means of income generation, information from the study will help address the challenges faced by farmers and traders along the chicken value chain. This will increase the income of traders and farmers. This

is consistent with Kenya's National Poultry policy (2010) that aims at raising the poultry's industry contribution towards food security and employment creation (Republic of Kenya, 2010b). Control of ND will contribute to increased production of chicken meat and eggs. This will boost the incomes of the small-scale chicken farmers from the sale of chicken and chicken products as well as provision of food and animal proteins. Increased incomes and availability of food will help in achieving the Sustainable Development Goals (SGDs) number 1 and 2 that aim at attaining zero poverty and zero hunger, respectively (UN, 2015).

1.6 Study Area

The study was conducted in three Counties namely; Kakamega, Machakos and Nairobi Counties (*see Figure 1, 2 and 3*). The three Counties were selected because of the relevance of the chicken value chain as it serves as a source of livelihood and economic activity to farmers and traders.

Kakamega County is located in the western part of Kenya, and is the second populous County after Nairobi, with the largest rural population. The County mainly relies on agricultural production and is ranked 9th in terms of agricultural output produced across the Counties in Kenya. It contributes 2.4 percent of the GDP of the Country (KNBS, 2019). Chicken is predominant with 92 percent of the households keeping poultry under the backyard production system for consumption purposes as well as for cultural significance. As of 2018, the estimated chicken population in Kakamega was estimated at 958,746 indigenous chicken and 73,876 commercial chicken (CIDP, 2018a). The presence of Kakamega and Malava forests within the County provide an environment for interaction between wild birds, migratory birds and domesticated birds; and these were of significant interest to the study on ND outbreaks. Markets for chicken within the county are mainly categorized as urban, semi-urban and rural markets,

with market activities mostly taking place on specific days of the week. This was also of interest to this study due to the movement of chicken and traders across different markets.

Machakos County is located in the eastern part of the country and agriculture is the predominant economic activity in terms of employment, food security and income creation. The main constraints to agriculture in the County include high costs, poor livestock husbandry practices, lack of markets and limited extension services. Based on the 2015 estimates, there were 1,306,000 indigenous poultry, 174,800 broilers, 184,100 layers and 23,720 other chicken (Republic of Kenya, 2015c). Indigenous chicken is one of the prioritized value chains in the County with the number of indigenous chickens in the past few years estimated at 862,392 birds (ASDSP, 2016, CIDP, 2018b). The County is also located along a migratory corridor for wild birds and animals as well as pastoralists moving their animals. This creates a conducive environment for the interaction between wild animals and domesticated poultry. Markets for chicken within the county are also categorized as urban, semi-urban and rural markets, with market activities taking place on specific days. This was also of interest for the study due to the difference in marketing activities across the markets.

Nairobi is the capital of Kenya, where there is a large urban population providing a high demand for chicken. It contributes the largest proportion to Kenya's GDP at 19.8 percent compared to the other 46 Counties (KNBS, 2019). Chicken (both exotic and indigenous) is one of the key value chains in the County. People in slums are increasingly rearing indigenous chicken due to consumer preferences (KNBS, 2010; ASDSP, 2016). The County has a number of markets that are classified as urban and semi-urban due to their locations. The annual value of slaughtered poultry in Nairobi is estimated at 191.48 million Kenya shillings (Republic of Kenya, 2015d, CIDP, 2018c). The markets activities are mostly carried out on a daily basis hence the frequent trade.

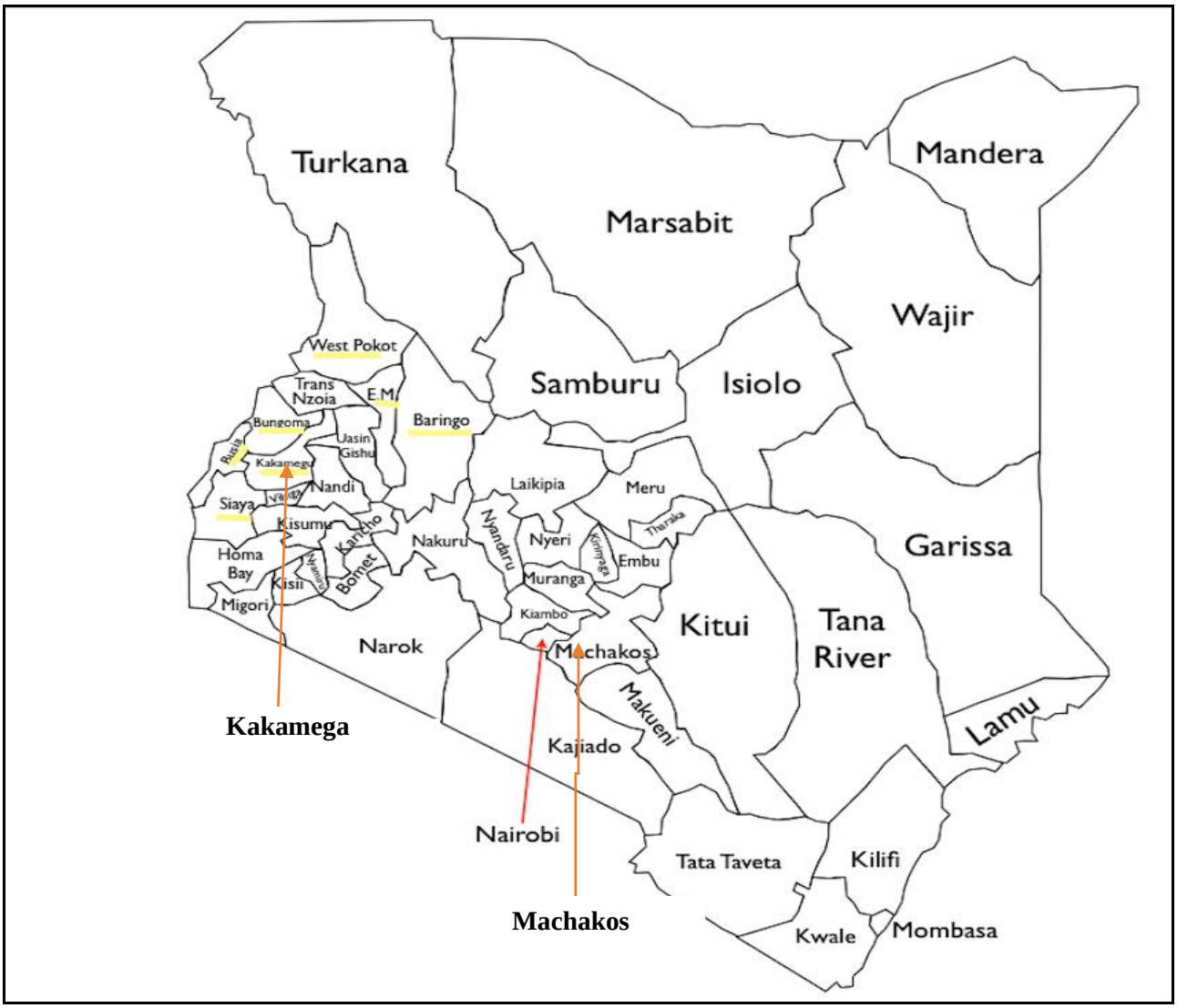

Figure 1: Map of Kenya showing the location of the study areas

Source: KNBS (2015).

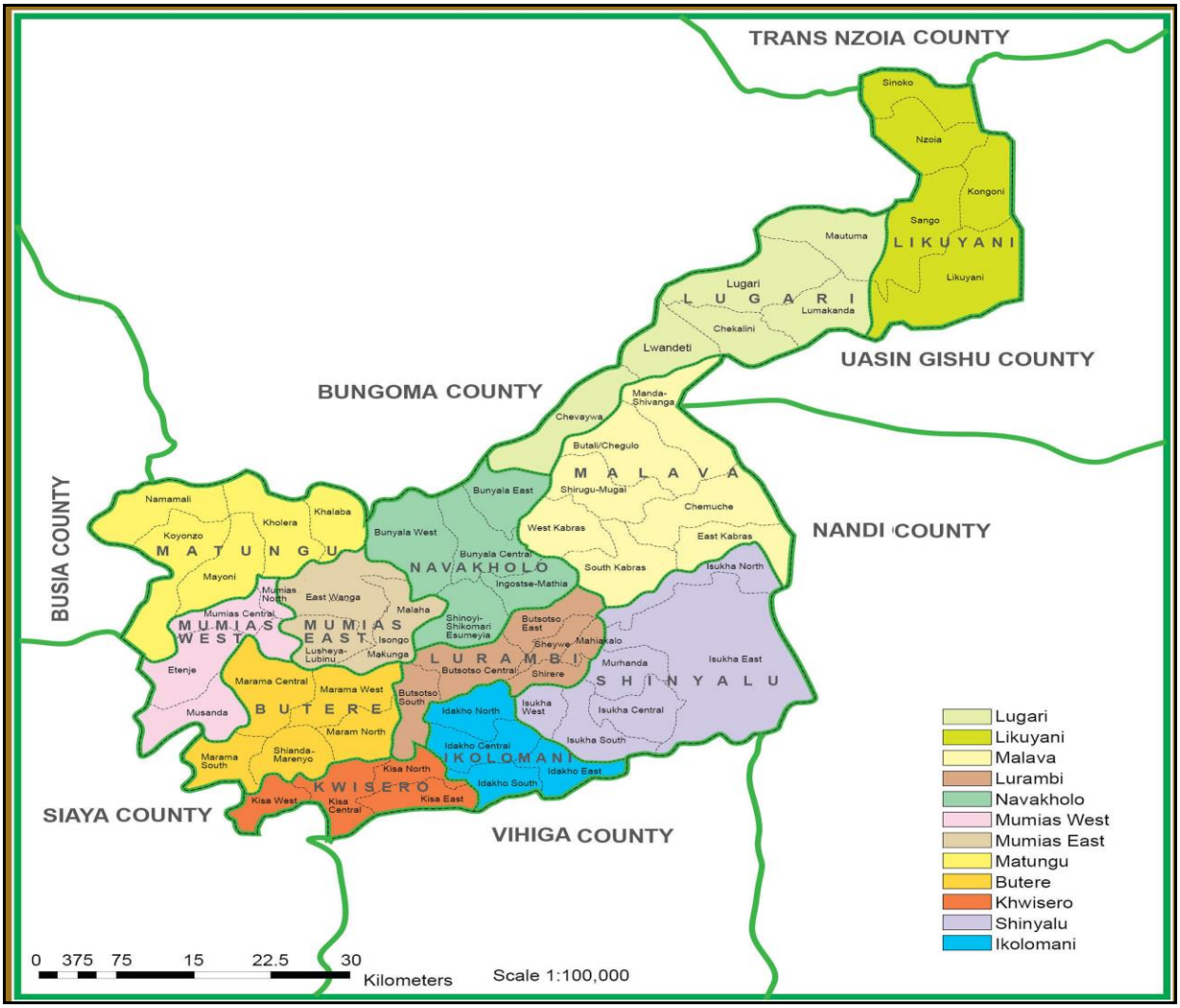

Figure 2: Map of Kakamega County, Kenya.

Source: CIDP (2018a).

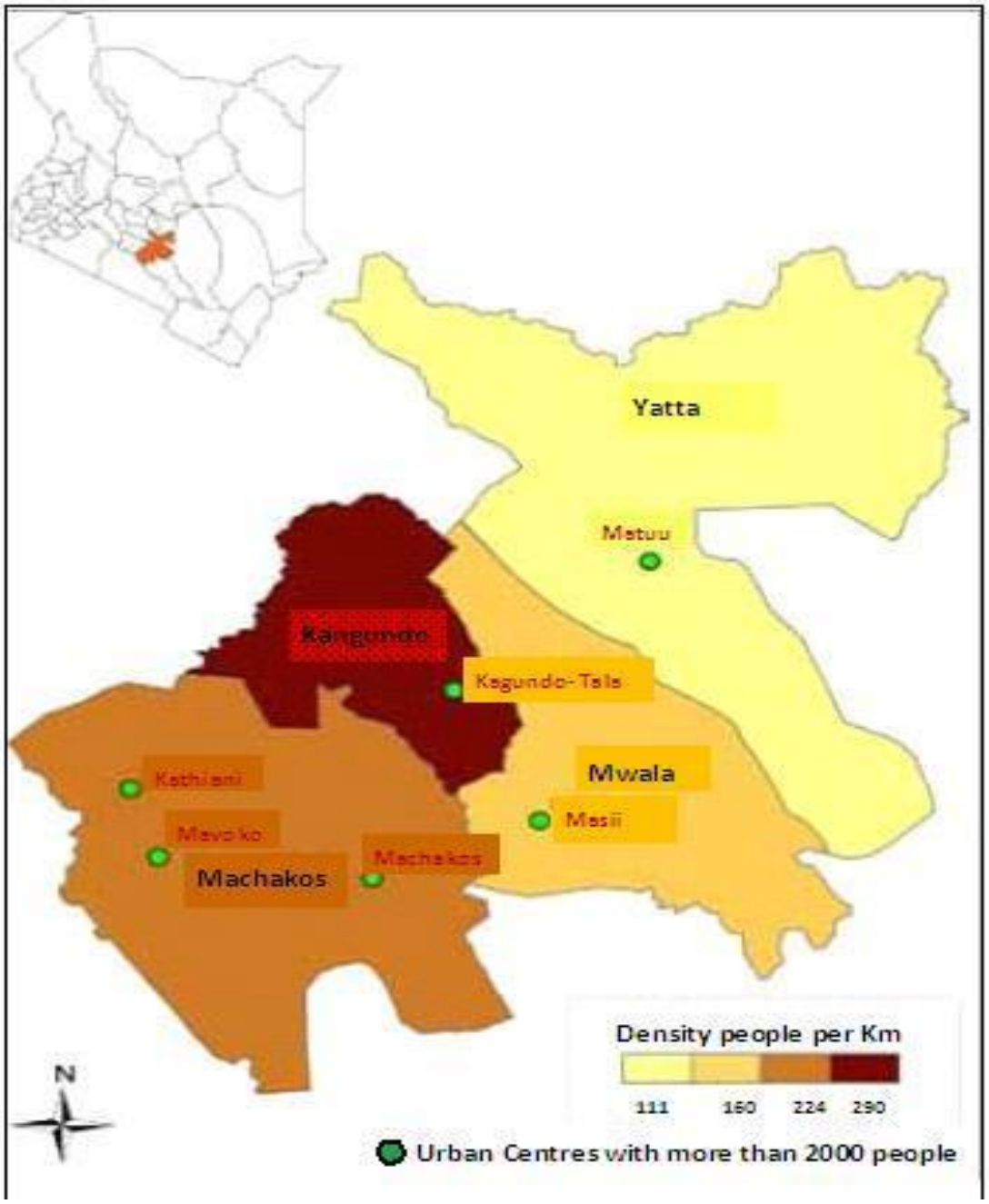

Figure 3: Map of Machakos County, Kenya

Source: CIDP (2018b).

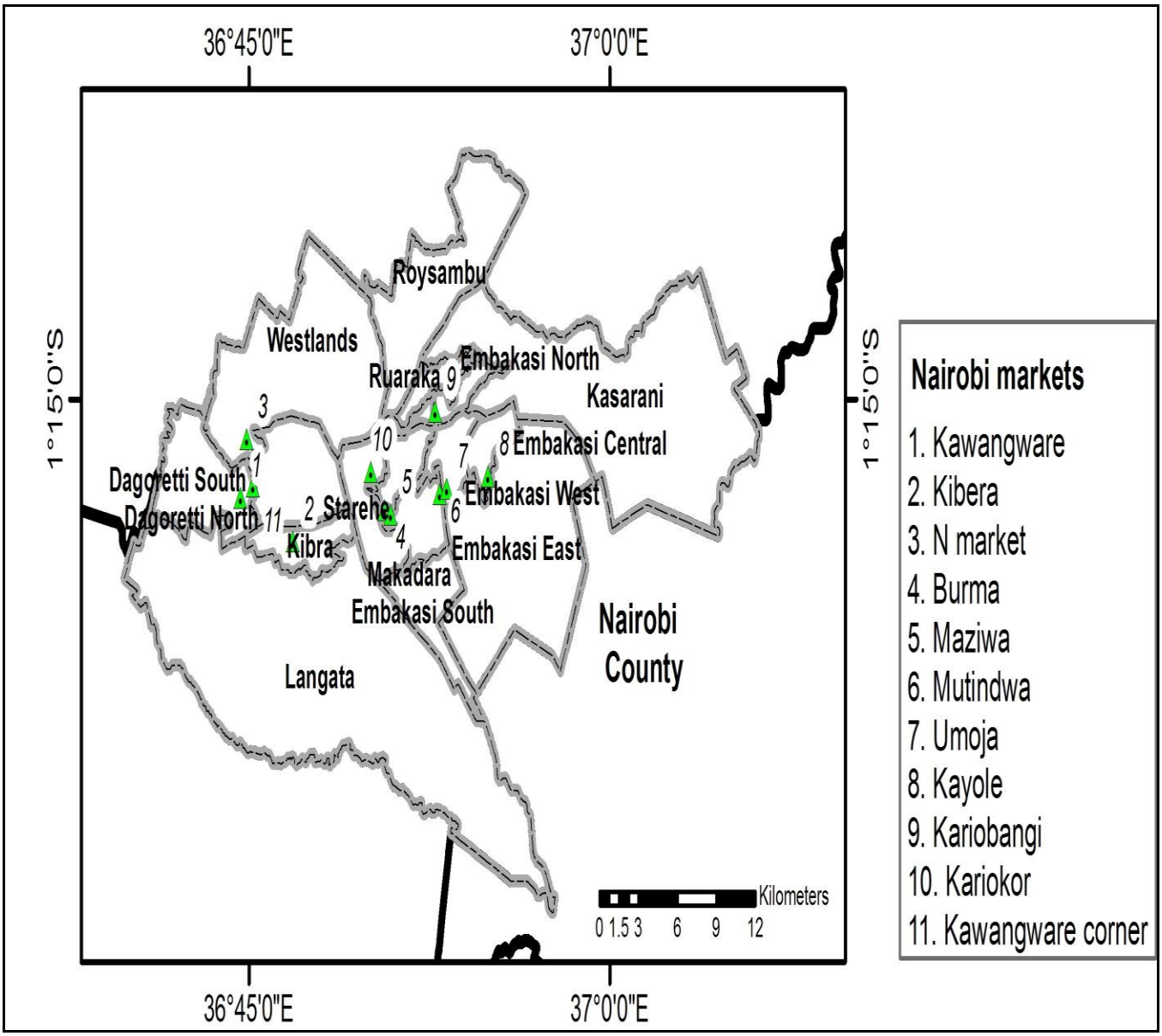

Figure 4: Map of Nairobi County, Kenya

Source: CIDP (2018c).

1.7 Organization of the Thesis

This thesis is organized into five chapters. Chapter one introduces the research issue with a background of the study and the research problem. The research objectives, the study areas and a justification for the study are also presented here. Chapter two entails a review of literature on chicken production and Newcastle disease. Chapter three provides a detailed discussion of the theoretical and conceptual frameworks on which the study is based. The sampling procedure, data collection methods as well as methods of data analysis are also discussed in this chapter. In chapter four, the results from the data analysis are presented. Chapter five provides the conclusions and policy implications.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 An Overview of the Poultry Subsector in Kenya

Poultry production plays a significant role in the lives of many resource-poor households in terms of food and income provisions; hence it is an important pathway out of poverty (Magothe et al., 2012; Murekefu, 2013). It also plays the socio-cultural roles among poultry keepers with poultry being slaughtered during religious festivals like Christmas and Easter as well as traditional rites (Kimani, 2006; FAO, 2007a). It is an integral part of farming systems in Kenya and is a suitable activity especially where land is a limiting factor (Murekefu, 2013). Poultry meat is the primary source of animal protein in Africa and a source of survival for millions of small-scale farmers (World Bank, 2016).

The subsector employs approximately two million people directly in production and marketing; and indirectly through linkages with input suppliers like day-old-chicks, feeds and veterinary services. The poultry industry is highly integrated with the upstream and downstream activities in the economy like input suppliers, feed manufacturers, breeders, processors, transporters, traders and consumers (USAID, 2010; Wachira and Nyingi, 2017).

Poultry meat consumption is expected to rise to 1,124,505 metric tons in 2020 due to increasing GDP and growing middle class whose disposable income is increasing. This will lead to increased demand for white meat in urban areas with consumption shifting from basic foods like vegetables and fruits to white meat (USAID, 2010; Duns and Willems, 2015). The Food and Agriculture Organization of the United Nations (FAO) projects that worldwide poultry production is expected to rise by 2.5 percent annually by 2030, with the supply of other forms of meat growing by about 1.7 percent. The consumer preference especially for indigenous poultry

meat is due to leanness and the presumed organic flavor (King'ori et al., 2010). The estimated annual poultry meat production was 64,000 metric tons in 2018 compared 20,000 metric tons in 2008 (KNBS, 2018). Figure 5 shows the trend in the value of the annual marketed poultry and eggs in Kenya.

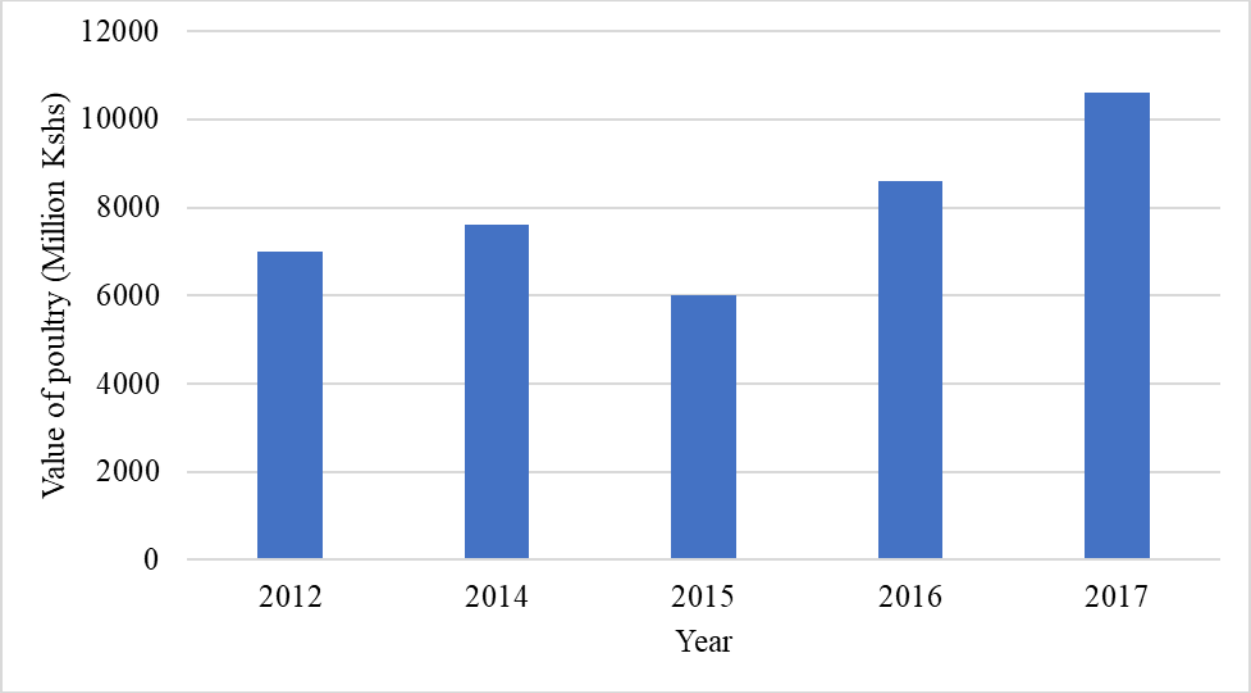

Figure 5: Kenya's marketed chicken and eggs value (2013-2017)

Source: KNBS (2018).

Poultry in Kenya is generally classified into commercial and indigenous poultry. The commercial system is mainly practiced in peri-urban and urban areas. It consists of hatcheries where poultry is bred and hatched for commercial purposes and day-old chicks sold to farmers (FAO, 2007a). Hatcheries are well linked with most actors in the poultry industries and the rest of the economy. The indigenous poultry is mostly found in the rural areas and in urban informal settlement with varying flock sizes depending on the region, species and consumption needs. This makes it a low- input low- output production system involving low income households (Devesh, 2008; Yemane et al., 2013; FAO, 2017).

According to Omiti and Okuthe (2009), the Kenyan poultry industry consists of four sectors. Sector 1 is the Industrial Integrated sector. This sector is characterized by large-scale commercial birds and measures to prevent diseases (biosecurity) at all the points of production. It involves downstream integration through contract farming. Sector 2 comprises of hatcheries like Kenchic and Muguku farms. It involves high levels of bio security. This sector is not integrated. Sector 3 consists of semi- commercial enterprises. It is dominated by small-scale producers who derive 73 percent of their incomes from poultry. There is minimal to low bio-security. Sector 4 consists of the village or backyard poultry. It is subsistence oriented with little or no purchased inputs, resulting in low output levels. There are no disease preventive measures, with chicken being in contact with humans.

The free-range chicken dominates the poultry industry in Kenya. It is a small-scale production system consisting of fully scavenging flock. The management involves minimum use of input and low capital investment of any livestock system with short cycles of production hence a low input- low output system of production (Copland and Alders, 2005). It is characterized by low production due to high mortality, uncontrolled natural mating and no immunization. This results in risks of exposure of the birds to disease and predators (Nduthu, 2015). The low productivity is due to poor management practices like lack of proper health care, poor nutrition and poor housing (King'ori, 2010; Okitoi et al., 2007). Chicken are kept in free range conditions where they are left to scavenge for worms, insects and greenery. They require fewer inputs hence an advantage over other species of livestock for the poor rural households. Their diet is also supplemented by household food scraps and maize wastes (Mavale, 2001).

There is growing recognition of the role and importance of small-scale poultry production in poverty reduction. It ranks highly by being an existing resource whose production can be increased with minimum input (Copland and Alders, 2005). Increasing evidence highlight the

role of small-scale poultry production in improving the nutritional security of poor households and promotion of gender equity (FAO, 2007b). The village poultry are generally owned and managed by rural poor especially women who own 75 percent (Alders, 2005). Village chicken is an important source of animal proteins through meat and eggs provision. The sale of meat and eggs is also an important income source that helps improve the livelihood of the farmers. The manure is also of high quality and can be sold to supplement incomes (ACIAR, 2014).

High mortality rate due to disease is the main constraint for indigenous poultry production. Poultry diseases like the ND are the major threats to poultry production. Outbreaks result in severe economic losses within the shortest possible time. The ND is the most fatal and prevalent poultry disease in Kenya (King'ori et al., 2010).

2.2 A Review of Economic Losses Associated with Poultry Diseases

Animal diseases in a production system reduce the efficiency of transforming inputs into outputs thereby decreasing productivity (Otte and Chilonda, 2000). According to Bennett (2003), the presence of disease has an effect on production, output and input prices. Diseases cause direct economic losses to producers with potential losses of value. The presence of diseases leads to inefficient production where producers operate on lower production functions.

According to the FAO (2016) and World Bank (2016), the effects of diseases can generally be classified into direct, ripple, spillover and long-term effects. The direct effects include production and productivity losses as diseases lead to reduced feed intake, high morbidity and mortality and weight loss, low egg production abortions and slower growth rates. In poultry, disease leads to income losses due to the falling prices of meat and eggs while reducing the productivity. Ripple effects include the impact of diseases on upstream and downstream activities. Outbreaks of disease may result in increased costs hence decrease in revenue and loss

of employment. A case of the avian influenza scares in Kenya in 2006 affected downstream activities of the poultry industry especially the fast food outlets due to a sharp fall in the consumption of poultry products by between 20 and 90 percent. It also had effects on employment as farms responded to the scare by laying off workers and freezing employment. Most medium and large establishment cut of labour by 50 and 80 percent. Income losses incurred by producers ranged from 40 and 50 percent in the less affected areas to 80-90 percent in the more affected areas. Where birds were sold, they were disposed of at very low prices of 100 Kenya shillings instead of the prevailing market price at the time of between 180 and 200 Kenya shillings (Okello et al., 2010).

Spillover effects include the effects on other sectors. Diseases impact on human nutrition by disrupting the food supply limiting access to food. Diseases also affect tourism, wildlife and biodiversity due to culling so as to remove a potential disease reservoir. Disease impact on the environment when wildlife is threatened especially where the combating measures have a negative effect on the environment. Long term effects include the effects on quality and availability of food. Additional costs are incurred in financing prevention and control measures.

2.3 A Review of how Chicken Value Chain Practices Contribute to Disease Spread

Management practices, biosecurity and routine practices influence transmission of pathogens in poultry production environment. Farmers of traditional chicken lack routine feeding and disease management practices. Njagi et al. (2010b) noted that management practices like confinement of birds favor the maintenance of the ND virus in village population. Other studies indicate that chicken that are not housed pose management difficulties in inspecting for signs of illness or injury and disease vaccination. For instance, Ochieng et al. (2013) noted that where there is low adoption of housing for chicken, there is high mortality from ND in first year of hatching.

Nyaga (2007) observed that indigenous chicken is mostly produced in village/backyard poultry with little or no biosecurity measures. The system is characterized by unconfined birds that are left to scavenge hence often interact with wild birds and other livestock. Biosecurity risks arise where birds get scavenged feed resources that are contaminated with disease agents from wild birds, dead birds and disposed manure. There are little or no veterinary services given to the birds. Aila et al. (2012) noted that production, processing, trade and consumption tendencies of indigenous chicken is not entirely bio secure, therefore can be devastating to the industry in case of avian influenza.

A study by Odemero and Ogheneuvwe (2016) found that litter management, stocking density, proximity to other poultry farms, routine cleanliness, timely medication and available infrastructure influenced outbreaks. The study also revealed that higher mortality was due to substandard biosecurity practices.

Marketing practices and transportation may influence disease outbreaks. Live chickens are mostly sold when sick or in need of cash (Atela et al., 2010). The marketing channels of live birds are undefined due to low and irregular chicken productivity. Traders purchase chicken and eggs from farmers and transport them to markets in urban areas (Nyaga, 2007). According to Okello et al. (2010), the lack of disease preventive measures (biosecurity) and the organization of poultry trade pose challenge in designing strategies to prevent outbreaks.

Transport of live birds in open carriers, inside passenger vehicles, by hand or ox-driven carts lead to great exposure to infectious disease. A study by Mulisa et al. (2014) in Ethiopia found several marketing practices like poor biosecurity measures and the use of similar marketing channels in the markets that promoted ND transmission among birds. Birds from different origins are placed in the same cages and sold either to traders in other live poultry markets or consumers. Such practices tend to increase the likelihood of ND among birds.

Akinwumi et al. (2009) showed that collectors and distributors mixed poultry species in cages and deliberately sold sick birds. This encouraged the outbreaks of avian influenza in Nigeria with many cases and outbreaks occurring between producers' farms and live bird traders. The study also highlights that transporters mix poultry species due to poor incentives to engage in proper biosecurity measures. Emerging market of poultry manure was also highlighted to facilitate the outbreaks of disease from one farm to another.

From the literature, it is evident that there is lack of uniformity in production systems and management practices, resulting to disease spread and outbreaks. However, it is still unclear on which management and marketing practices have an effect on disease spread and frequency of disease. This study identified the chicken management practices and their influence on disease entry and outbreaks. The study builds on existing studies to identify the effect value chain practices on ND frequency.

2.4 Awareness and Attitudes on Poultry Diseases

Awareness of the disease and control measures is a major step in preventing outbreaks of ND and mitigating the effects. Attitudes of small-scale farmers towards risk will affect decision making process by influencing the perception and benefit associated with decisions (Chilonda and Van Huylenbroeck, 2001). According to Antle and Goodger (1988), bad attitude towards diseases may lead to sub-optimal economic decisions, unwillingness to adopt innovation and adoption of prophylactic measures rather than clinical service.

Chilonda and Van Huylenbroeck (2001) observed that perception of small-scale farmers towards characteristics of a particular technology affects decision to adopt a technology. Attitude plays a role in choice of veterinary interventions and it relates to the attitude of small-scale farmers towards disease, effectiveness of control strategies and attitude towards veterinary delivery systems. Limited awareness and lack of adequate knowledge leads to bad attitude towards

diseases, resulting in flaws during management and marketing of livestock like chicken, increasing the frequency of disease outbreaks. Studies by Lawal et al. (2015) and Ibrahim et al. (2016) in Nigeria reported relatively low levels of awareness to ND and prevention measures like vaccination and the consequences of the disease. Similar results have been reported by Chengula et al. (2013) in Tanzania where awareness to disease among livestock farmers was found to be minimal, subjecting them to great risks.

In Kenya, Ogali et al. (2018) found low awareness to ND and use of ND vaccination among poultry keeping households. However, awareness levels and perceptions on ND among farmers and traders is not clearly documented in Kenya.

2.5 A Review of Newcastle Disease

The ND is a highly contagious poultry disease of respiratory and nervous system, with chicken being the most susceptible; while also affecting other forms of poultry (Alders and Spradbrow, 2001; Mbabazi et al., 2012). It is an epidemic disease responsible for high economic losses making it the most important animal disease in terms of number of animals affected annually and the economic losses associated with outbreaks (Oluwadare et al., 2016).

Although endemic among rural poultry, the disease follows an epidemic pattern. It has been reported endemic in many developing countries like Kenya (Njue et al., 2001; Njagi, 2010) Outbreaks occur during times of climate stress, resulting to seasonal occurrence, and can have a huge impact on food security and incomes of farmers and traders, especially in developing countries where birds are a significant source of protein and diseases are endemic. The outbreaks are unpredictable and discourage poultry keepers from giving proper attention to husbandry practices and welfare of chicken (AU-IBAR, 2013a).

The disease is transmitted through various ways depending on environmental factors such as temperature, humidity and stocking density. The main methods include: drinking of contaminated water and food by birds; contact with contaminated material like farm tools and equipment; contact with contaminated chicken houses; contact with people and vehicles from infected areas; movement of contaminated poultry products such as carcasses; non-avian hosts and airborne outbreaks; direct physical contact with infected birds (FAO, 2007b).

The range and outbreaks of the clinical signs is influenced by the virus strain, age, conditions and species of the birds. Birds exhibit mild to almost unapparent respiratory and breathing difficulty with chicks exhibiting coughing, gasping and sneezing. There is very severe depression with birds losing appetite and being droopy. Egg production reduces up to zero in four days and when laying resumes, the eggs are misshaped and have rough shells or bleached shells (NAFIS, 2016). Long-term nervous signs are exhibited through twisted necks, swollen necks and heads. The death rate without the exhibition of signs of the birds can be 100 percent in severe forms of the disease. Birds also suffer from diarrhea hence excreting greenish faces. This leads to high mortality and morbidity (FAO, 2004).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Conceptual Framework

The ND is considered a major constraint to chicken production in Kenya. Control of the disease is critical in improving the lives of households that derive their livelihoods from chicken production. Figure 6 shows the linkages between disease awareness, the value chain practices that influence the frequency of ND and outcomes from the control of ND.

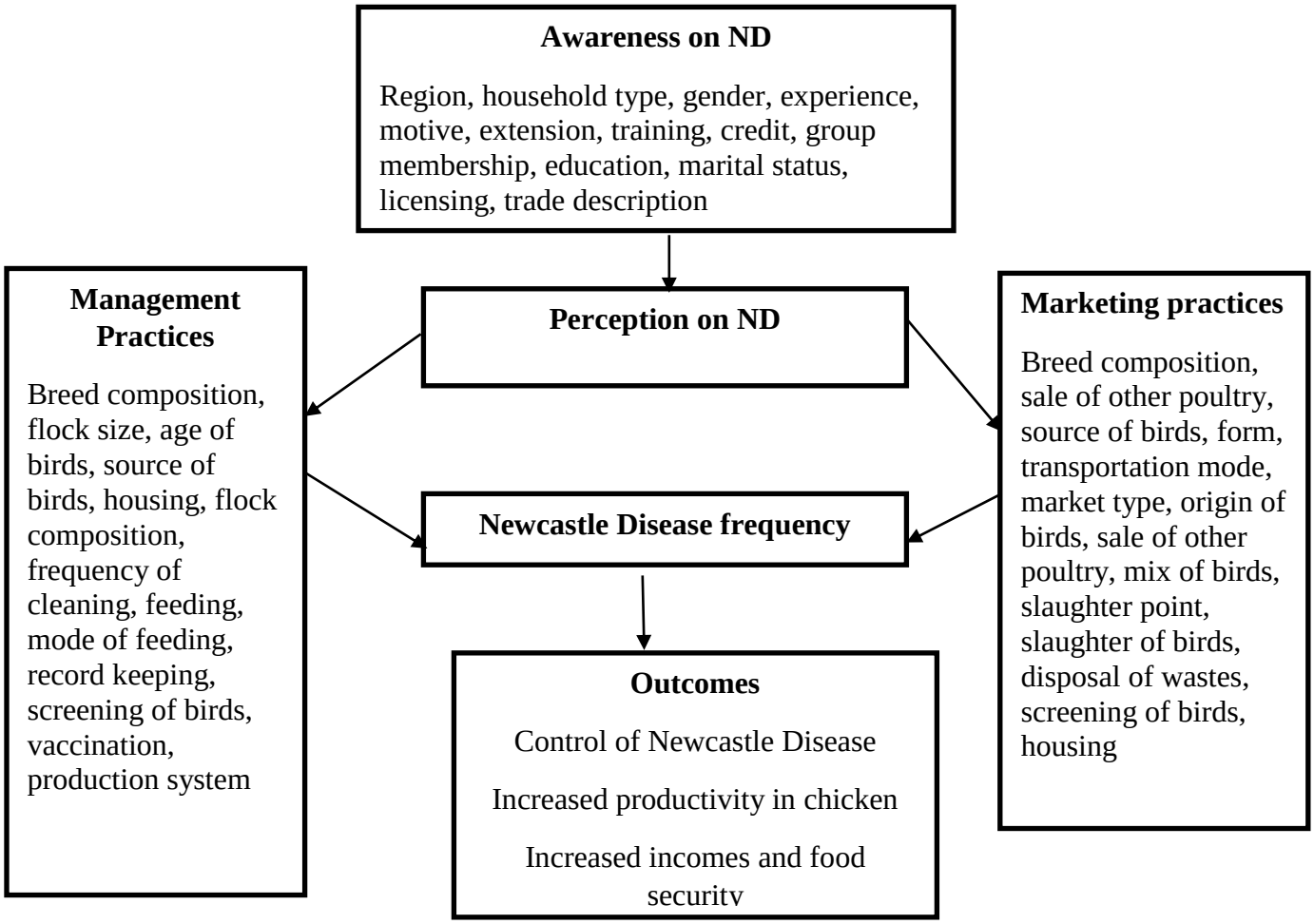

Figure 6: Conceptualization of linkage between value chain practices and outbreaks of ND

Source: Author's own conceptualization.

To mitigate risks associated with diseases, there is a need to better understand how livestock producers perceive and manage risks of disease transmission (Lowenstein et al., 2016). Awareness, knowledge and perception of the disease and control is a major step in preventing outbreaks through development and implementation of strategies appropriate for disease control and averting losses (Omiti and Okuthe, 2011). Poultry husbandry and management practices are hypothesized to influence the frequency of ND outbreaks. Likelihood of flaws and use of poor management and husbandry practices increase the frequency of diseases as they provide an avenue for disease entry and spread.

Several studies (see Njagi et al., 2010, Munyua et al., 2012, Mulisa et al., 2012, Ogada et al., 2016 and Ogali et al. (2018) have highlighted different practices that may contribute to disease outbreaks. For instance, poor housing and lack of disease preventive measures may lead to entry of disease hence outbreaks of the disease. Marketing practices and transportation are also hypothesized to have an effect on the frequency of ND outbreaks. Practices like deliberate sale of sick birds, lack of bio-security measures pose challenges in prevention of outbreaks.

Understanding the chicken value chain practices have an effect on the frequency of ND is help in developing control and mitigation measures for the disease. The control of the disease is expected to increase productivity of chicken by increasing the production of eggs and meat. This will raise the incomes of farmers and traders who rely on the chicken enterprise as a livelihood means as well as improving the nutritional and food security.

3.2 Theoretical Framework

The study adopted the framework of factors influencing decision-making by small-scale farmers in animal health management as proposed by Chilonda and Van Huylenbroeck (2001). The framework indicates that small-scale farmers make decisions in animal health management as a

result of the interaction of several variables. These are grouped into variables that relate to characteristics specific to small-scale farmers and farms, economic factors, institutional setting and biophysical factors.

Farmer characteristics include aspects relating to farmers objective, knowledge and attitudes that have an influence on animal health management decisions. Farmers possess varying knowledge regarding animal husbandry, cause and methods of animal disease control and benefits of disease control. Attitude plays a role in the choice of veterinary interventions and this relates to their attitude towards animal diseases. Personal characteristics such as education, frequency of contact with veterinary agents and past experience influence decisions made in animal health management.

Farm characteristics include aspects such as the type of production system which is known to influence animal health decisions by small scale farmers. Economic factors include existence of markets for output and inputs, product prices and the demand and supply relationship. Market existence influence production decisions as well as animal health decisions.

Institutional factors influence farm management practices as well as animal health decisions. These relate to policy and organization of veterinary delivery systems, general infrastructure, marketing infrastructure, proximity to veterinary services, sources of information and extension services. The lack of support infrastructure limits the choice of animal health inputs. Biophysical factors relate to a number of different factors that determine the occurrence of disease in animal populations. Understanding the variables that affect the occurrence of disease, is important in animal health management decisions. The interaction of these factors influences decisions on choice of animal health management practices.

3.3 Sampling Procedure

A three-stage sampling procedure was used in this study. In the first stage, purposive sampling was used to select three Counties; Kakamega Nairobi and Machakos Counties. Kakamega was purposively selected because of the large number of households (92 percent) keeping indigenous chicken in area. Poultry is the main source of animal proteins in the area and has cultural and traditional significance to the communities. Indigenous poultry is also a prioritized value chain in the County (CIDP, 2018a). Machakos County was selected because indigenous chicken is one of the prioritized value chains by the County government, with the number of indigenous chickens being 862,392 (ASDSP, 2016). Nairobi County was selected due to the large number of live bird markets where chicken slaughtering is also being carried out. There is high demand for poultry by consumers in the County due to a rise in income by middle class residents. Nairobi is also a final destination for poultry from across the country as well as being a transit point for poultry within the region (McCaron et al., 2017)

In the second stage, sub- counties were selected based on the distribution of households that reared chicken as well as proximity to forested areas/ migratory routes for wild birds. In Kakamega, 6 sub-Counties namely; Ikolomani, Shinyalu, Lurambi, Mumias, Matunguu and Butere were selected from Kakamega based on the distribution of households that reared chicken in the areas as well as the proximity to forested areas within the County. In Machakos, 5 sub-Counties namely; Masii, Kathiani, Mwala, Kola, Masaku. Villages in the sub-Counties were randomly selected with the help of sub-County Agricultural officers. A total of 192 and 140 chicken farmers in villages were then randomly selected for interview in Kakamega and Machakos Counties.

Live bird markets were purposively selected in Kakamega, Machakos and Nairobi based on purposively selected based on the number of traders and the volume of birds traded. Proximity to nearest towns/ city centers and the main market outlets was also used to categorize the markets. Markets within a 2 km distance to city centers or major towns were classified as urban markets. Those that were located beyond two kilometers from major towns but with close proximity to residential areas and market outlets like supermarkets were classified as peri urban markets. Markets located in areas with informal set ups were classified as rural markets.

In Kakamega, most market activities are conducted on specific days hence the frequent movement of traders and chicken to different markets/points of sale. Eight markets for live birds were selected within the in Kakamega. Kakamega town and Mumias markets were selected as urban markets, Bukura and Butali were selected as peri urban markets while Musoli, Shikambi, Ogalo and Koyonzo were selected as rural markets. In Machakos, seven markets were selected within the county. Machakos town market was selected as an urban market, Kangundo and Masii were selected as peri-urban markets while Mwala, Wamunyu, Kola and Katangi were selected to represent rural markets within the county.

In Nairobi, most markets operate throughout the week hence the limited movement of chicken. markets. Thirteen such markets were selected. Burma, Maziwa and Kariakor were selected as urban markets while Kawangware, Kona, Uthiru, Kibera, Kangemi, Mutindwa, Kayole, Umoja, Kariobangi North and Githurai were selected as semi urban markets.

A total of 119, 105 and 112 chicken traders were randomly selected from the markets within Kakamega, Machakos and Nairobi Counties, respectively.

For farmers, determining the exact number of farmers keeping poultry was a challenge because majority of the households in both Kakamega and Machakos rear chicken. Based on literature,

studies like Ochieng et al. (2013), Kyule et al. (2014) and Njoroge et al. (2015) have used sample sizes of below 200 farmers. Determining the actual population of traders in markets was also difficult due to the nature of the chicken trade as it involves multiple actors and the frequent movement of traders. This provided problems in estimating the sample sizes for this study. According to Mendoza (1995), there are no agreed sampling procedures or sample sizes to be used in different marketing chain segments. Other studies like Mandefro et al. (2012), Ayieko et al. (2014) and Ogali et al. (2018) have used sample sizes of below 125 traders in LBMs.

For this study, challenges such as the unwillingness of respondents to participate in the interviews and distance to different sub counties were experienced. This resulted in the relatively low sample sizes among farmers and traders in the individual counties.

In total, 668 respondents comprising 332 farmers and 336 traders were interviewed in the three Counties.

3.4 Data Collection

A Focus Group Discussion (FGD) was conducted in Kakamega County to gain insights on trends and changes in chicken uses and production, management and husbandry practices, marketing and disease management. The FGD had 30 participants who included chicken farmers, chicken traders, County livestock production officers and veterinary officers. To account for differences in perspectives due to the involved nature of agriculture in Kenya, key informant interviews were conducted in all the three counties. The interviews were conducted to get information regarding chicken marketing activities, practices and disease outbreaks. Key informants included local extension officers, livestock production officers and veterinary officers about chicken production and ND in the areas. The insights from the FGD and key informant interviews were utilized to refine and validate the survey tools to be used during data collection. Data collected from the FGD was analyzed and helped validate the descriptive results obtained in the study.

A semi-structured questionnaire was used to collect data from households and traders. A household survey questionnaire was administered to households that reared chicken in Kakamega and Machakos Counties. A traders' survey questionnaire was administered to chicken traders in live bird markets in Kakamega, Machakos and Nairobi Counties. The questionnaires were administered through face-to-face interviews and observations. According to Minhat (2015), face to face interviews are useful in exploring experiences perceptions and providing detailed insights required from individual participants. The information collected included farmer attributes, institutional and support services, production and management practices, marketing practices and ND awareness and outbreaks.

3.4 Empirical Data Analysis

3.4.1 Factors influencing ND awareness among chicken farmers and traders

The dependent variable had two possible outcomes; awareness of ND or otherwise. For this study, farmers and traders who knew about ND and could positively identify the disease based on the signs and symptoms consistent with ND were deemed aware, hence given the value of 1 if aware and 0 if otherwise. Empirically, the dependent variable was specified as follows:

$$Y_i \begin{cases} 1 \; if \; aware \\ 0 \; if \; otherwise \end{cases} \qquad (1)$$

In such cases, logit and probit models are normally used. The difference between the two lies in their assumptions on the distribution of the error. The logit model assumes a logistic distribution of the error term, while the probit model assumes a standard normal distribution. The logit model is used because of its simple mathematical form. For this study, the dependent variable was discrete hence the binary logit model was the most appropriate.

Following Greene (2003), the probability that an individual is aware is modelled as follows;

$$\text{Prob}\left[Y_{ij}=1\right]=\frac{exp\ B'X_1}{1+\exp\ B'X_1}=\Lambda B'X_1 \quad (2)$$

I and j denote the farmer/ trader and farmer's/trader's awareness [1= aware, 0= otherwise].

Equation (2) is the reduced form of the binomial logit model, where the X_i is the row vector of the explanatory variables (both socioeconomic and institutional factors) for the i^{th} farmer/trader and the non-observed $e's$ account for errors in perception and measurements.

The errors are assumed to follow a logistic probability distribution with a density function

$$F'(B'X_1)=\Lambda(B'X_1)[1-\Lambda(B'X_1)] \quad (3)$$

The probability that an individual is aware was estimated empirically as

$$Pr[Y_i=1]=B'X_1+e_i \quad (4)$$

where *X* is a vector of socioeconomic and institutional characteristics that are hypothesized to influence a respondent's probability of either being aware of ND or not;

B_i is a vector of parameters to be estimated, while e_i is the statistical random term specific to a respondent.

The factors hypothesized to influence ND awareness among farmers included region, household type, gender of the respondent, experience in chicken farming, motive for rearing chicken, access to extension, access to training, credit access, group membership, age of the respondent, education level of the respondent and marital status of the respondent (Table 2).

Table 2: The expected signs of variables affecting farmer awareness on ND

Variable	Description of the variable	Expected sign
Region	Dummy (1= Urban, 0= Rural)	+
Household type	Dummy (1= Female headed, 0 = Male headed)	+
Gender	Dummy (1= Female, 0= Male)	+
Experience	Dummy (1= Above 5 years, 0 = 5 years and below)	+
Motive for rearing	Dummy (1= Commercial, 0= Subsistence)	+
Extension	Dummy (1= Yes, 0 = No)	+
Training on animal health	Dummy (1= Yes, 0 = No)	+
Access to credit	Dummy (1= Yes, 0 = No)	+
Group membership	Dummy (1= Yes, 0 = No)	+
Age	Respondent's age in years	+/-
Education level	Dummy (1= Above primary 0= Primary and below)	+
Marital status	Dummy (1= Married, 0= Otherwise)	+/-

Source: Survey Data (2018).

The factors hypothesized to influence ND awareness among traders included trade description, licensing of trader, experience in chicken trader, access to training, group membership, access to credit, age of trader, gender of the trader, education level of the trader, marital status of the trader and market location. These variables are highlighted in Table 3.

Marginal effects were estimated to measure the instantaneous effects of changes in the explanatory variables on predicted probability of being aware, while holding other explanatory variables constant. According to Anderson and Newell (2003), the marginal effects were computed as follows.

$$\mathrm{B}_m = \left[\frac{\delta\left(B' X_1 = e_i\right)}{\delta B' X_1}\right] B_i \text{ for continuous independent variables.} \quad (5)$$

$$\text{or } B_m = P_r[Y_i = 1] - P_r[Y_i = 0] \text{ for dummy coded variables.} \quad (6)$$

Table 3: The expected sign of variables affecting trader awareness on ND

Variable	Description of the variable	Expected sign
Trade description	Dummy (1= Regular, 0 = Seasonal)	+
Licensing of trader	Dummy (1= Yes, 0 = No)	+
Experience	Dummy (1= Above 5 years, 0 = 5 years and below)	+
Training	Dummy (1= Yes, 0 = No)	+
Group membership	Dummy (1= Yes, 0 = No)	+
Credit	Dummy (1= Yes, 0 = No)	+
Age	Respondent's age in years	+/-
Gender	Dummy (1= Male, 0= Female)	+
Education	Dummy (1= Above school, 0 = Primary and below)	+
Marital status	Dummy (1= Married, 0 = Otherwise)	+/-
Market location	Dummy (1= Urban, 0 = Rural)	+

Source: Survey Data (2018).

For this objective, the null hypothesis that gender, training and age had no significant was rejected if the variables were found to have a significant effect on ND awareness among farmers (p<0.05). This results in the conclusion that the variables had significant effect on ND awareness among farmers and traders.

3.4.2 Association of choice of practices and ND perception among farmers and traders

This was achieved using descriptive statistics. A Likert scale used to determine farmers' and traders' perception level of perception of ND among farmers and traders who had experienced the outbreaks. The Likert scale comprised of 5 levels of perception: very severe, severe, neutral, not severe and not very severe. The management practices used by chicken farmers and marketing practices used by chicken traders were identified. A chi-square test was applied to determine any association between the practices used and ND perception during outbreaks. The results were presented in form of frequency tables where p<0.05 was considered significant hence evidence of association between ND perception and value chain practices.

The null hypothesis that there was no significant association between ND perception and the practices used was rejected if the *p* value were found to be significant ($p<0.05$). This results in the conclusion that there was significant association between perception on ND and the value chain practices used by farmers and traders.

3.4.3 Effects of production systems and management practices on ND frequency

This study used a count data model to analyze the effects of production systems and management practices as well as the farmer attributes on the frequency of ND outbreaks. The dependent variable was the frequency of ND and was measured as the number of outbreaks a farmer has experienced within a 6-month period. The commonly used methods for estimating count data are Poisson Regression Model (PRM) and Negative Binomial Regression Model (NBRM).

Count data are non-normal and hence not well estimated by Ordinary Least Square (OLS) regression (Maddala, 2001). The PRM and NBRM models have become the most common regression techniques used in studies where response variables have a non-negative integer with no excess zero counts than would be expected (Greene, 2008).

According to Greene (2003) both PRM and NBRM models are related to OLS regression model more than any other discrete choice models. The two models differ in their assumptions relating conditional mean and variance of the dependent variable. Poisson regression assumes that the conditional mean equals the conditional variance of the distribution, while NBRM does not assume an equal mean and variance.

The PRM assumes that the dependent variable y_i given vector of predictor variables X_i has a Poisson distribution. The probability density function of y_i *given* X_i is completely determined by;

The conditional mean $E(y_i|x_i = \lambda_i)$ and its equi-dispersion $Var(y_i|x_i) = \lambda_i$ (7)

Its density function is given by (Greene 2008):

$$f(y_i|x_i) = \frac{e^{-\lambda(x)}\lambda_i(x)^y}{\Gamma(1+y_i)} \quad (8)$$

where;

λ_i =exp $(\alpha + X'\beta)$ and $y_i = 0,1, \ldots, i$ is the number of birds affected by Newcastle disease,

X is the vector of explanatory variables and $\propto$ and β are the parameters to be estimated (Greene 2008).

Wooldridge (2002) and Greene (2008) show that the expected number of events y_i (i.e. number of ND outbreaks) is given as;

$$E\ (y_i|x_i) = \ \mathrm{Var}[y_i|x_i] = \ \lambda_i = \mathrm{Exp}(\alpha + X'\beta) \text{for i} = 1,2, \ldots, n \quad (9)$$

where *X*′ was a vector of the explanatory variables (Table 4).

The estimated PRM for this study was specified as;

ND frequency = f (breed composition, flock size, age, source, form housing, housing composition, frequency cleaning, means feeding, feed administration, record keeping, biosecurity, vaccination, production systems, ND awareness, extension, experience, education level, training + e) (10)

Table 4: Expected signs of management practices influencing frequency of ND outbreaks

Variable	Measurement of the variables	Expected sign
Management practices		
Breed composition	Dummy (1= Single breeds: 0 = Multiple breeds)	-
Flock size	Number of birds owned by farmer)	+/-
Age of birds	Dummy (1= Multi aged 0 = same aged)	-
Source of birds	Dummy (1= Direct 0 = Otherwise)	-
Form of housing	Dummy (1= Special housing 0 = Otherwise)	-
Housing composition	Dummy (1= Separation of birds 0 = Otherwise)	-
Frequency of cleaning	Dummy (1= Daily 0 = Otherwise)	-
Means of feeding	Dummy (1= Use of feed troughs 0 = Otherwise)	-
Feed administration	Dummy (1= Inside shelter 0 = Otherwise)	-
Record keeping	Dummy (1= Yes, 0 = No)	-
Screening of birds	Dummy (1= Yes, 0 = No)	-
Vaccination	Dummy (1= Yes, 0 = No)	-
Production system	1= Free range 2 = Intensive 3 = Semi intensive 4 = Mixed	+/-
Farmer attributes		
Extension access	Dummy (1= Yes, 0 = No)	-
Experience	Number of years in chicken farming	-
Training on animal health	1= Above primary school, 0 = Primary school and below	-
Gender	Dummy (1= Female, 0 = Male)	+/-

Source: Survey Data (2018).

The null hypothesis that biosecurity, vaccination and housing had no significant effects on the frequency of ND outbreaks was rejected if the *p* value were found to be significant ($p<0.05$). The rejection of the null hypothesis results in the conclusion that vaccination, biosecurity and housing had significant effects on the frequency of ND outbreaks among farmers.

3.4.4 Effects of transportation and marketing practices on ND frequency

The dependent variable was the frequency of ND and was measured as the number of outbreaks a trader had experienced within a 6-month period. To achieve this objective, the PRM was estimated with the variables shown in Table 5.

The estimated equation for this study was specified as follows; *ND frequency = f (breed composition, sale other markets, market channel, form birds, mode transportation, market type, origin, sale of other poultry, mix birds, slaughter point, slaughter birds, waste disposal, biosecurity, housing, training, licensing experience, gender + έ) (11)*

Table 5: Expected signs of marketing practices influencing frequency of ND outbreaks

Variable	Measurement of the variables	Expected sign
Marketing practices		
Breed composition	Dummy (1= Single breeds, 0 = Multiple breeds)	+/-
Sale in other markets	Dummy (1= Yes, 0 = No)	+
Source of birds	Dummy (1= Direct, 0 = Otherwise)	-
Form of birds	Dummy (1= Live, 0 = Slaughtered)	+
Transportation mode	1= Foot, 2 = Motorcycle, 3 = Motor vehicle, 4 = Others	+/-
Market type	Dummy (1= Open air, 0 = Closed)	+
Origin	Dummy (1= Single origin, 0 = Multiple origins)	-
Sale of other poultry	Dummy (1= Yes, 0 = No)	+
Mix of birds	Dummy (1= Yes, 0 = No)	+
Availability of Designated slaughter point in market	Dummy (1= Yes, 0 = No)	-
Slaughter of birds	Dummy (1= Yes, 0 = No)	+
Disposal of wastes	Dummy (1= Yes, 0 = No)	-
Screening of birds	Dummy (1= Yes, 0 = No)	-
Housing	Dummy (1= Yes, 0 = No)	-
Trader characteristics		
Training on animal health	Dummy (1= Yes, 0 = No)	-
Licensing	Dummy (1= Yes, 0 = No)	-
Experience in trading	Number of years in chicken trading	-
Gender	Dummy (1= Male, 0 = Female)	+/-

Source: Survey Data (2018).

The null hypothesis that transportation and marketing channels had no significant effects on the frequency of ND outbreaks was rejected if the p value were found to be significant ($p<0.05$). The rejection of the null hypothesis results in the conclusion that mode of transportation, biosecurity and market channels had significant effects on the frequency of ND outbreaks among traders.

3.4.5 Estimation Problems and Tests

3.4.5.1 Multicollinearity

For the econometric analyses, the variables included in the models were tested for multicollinearity, a problem usually associated with cross sectional data. Multicollinearity occurs when there exists a linear relationship between the explanatory variables. This results in the inflation of the variance of the model and the coefficients hence the confidence interval becomes wide and the inferences become unreliable.

Variance Inflation Factors (VIFs) were calculated as shown in equation 12:

$$VIF_i = \frac{1}{1 - R_i^2} \tag{12}$$

Where

R^2_i is the coefficient of determination of the regression equation

VIF values that exceed 10 are generally viewed as evidence of the existence of multicollinearity (Gujarati and Porter, 2009). There was no evidence of multicollinearity in the models estimated in this study as the VIF values were below 10 (see appendix 1, 2, 3 and 4 respectively).

3.4.5.2 Equi-dispersion

Poisson regression models have one limiting assumption: equi-dispersion that requires the variance to equal the mean. This was tested using the Pearson chi-square ratio to determine the goodness of fit. If the chi-square test is significant (p<0.05), the model is not fit. If the chi-square value is insignificant (p> 0.05), the model is deemed fit. For this study, the chi-square values for the PRM were found to be insignificant (see appendix 5 and 6), hence the models estimated fit the data.

3.4.5.3 Test of Separability

To test whether to split the data set into individual Counties during analysis or pool the data, the Chow test of separability was applied. According to Baltagi et al. (1996), the test is used to determine whether there is any significant improvement in the model by running the regressions as a split set of data or pooling the samples together.

The Chow test is calculated as follows:

$$CHOW = \frac{(RSSP_P - RSSP_1 - RSSP_2 - RSSP_3)/K}{(RSSP_P + RSSP_1 + RSSP_2 + RSSP_3)/(N - 2K)} \quad (13)$$

where

RSS_p is the Residual Sum of squares for the pooled regression line.

$RSS_{1....n}$ is the Residual Sum of squares for the regression line of the split data.

K is the degrees of freedom

N is the sample size for the pooled sample

The *F* calculated values generated from the Chow test are compared with the *F* critical values. If the *F* calculated values are greater than the *F* critical values, the null hypothesis: data can be represented in a single regression line is rejected. This results in splitting of the data sets

The F calculated values from the test for the farmers' logit, traders' logit, farmers' PRM and traders' PRM models were 4.36, 6.36, 1.75 and 2.10, respectively. This showed that there was significant improvement in running the regression by splitting the data by counties. The null hypothesis was therefore rejected, hence the conclusion that there was significant improvement in separating the data by Counties.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Characterization of chicken farmers and traders

In this section, farmers and traders were characterized based on socio-economic characteristics and institutional support services. The results are presented using tables and graphs.

4.1.1 Socio-economic characteristics of farmers

Table 6 presents the general characteristics of farmers rearing chicken in Kakamega and Machakos Counties. In the pooled data, about 61 percent of the respondents were female. The proportion of female farmers in Kakamega County was higher compared to that in Machakos County. These results highlight the dominance of women in chicken production. Gender roles within the households make women get involved in subsistence farming like chicken production, resulting in the involvement of women in chicken management practices (Okitoi et al., 2007; Vincent et al. 2011).

Table 6: Socio-economic characteristics of farmers in Kakamega and Machakos Counties

Characteristics	Kakamega (n= 192)	Machakos (n= 140)	Pooled Farmers (n= 332)	Significance difference
Gender (% female)	64	56.4	60.8	1.4073
Average age (years)	46 (15)	48 (16)	47 (15)	-1.0233
Education level (% primary and below	44.8	49.3	46.7	0.8105
Experience (% 5 years and below)	44.8	49.3	46.7	-1.3054
Marital status (% married)	75.5	81.4	78	-1.2835
Average land size (acres)	1.9 (2.8)	3.8 (4.5)	2.7 (3.6)	4.8155***
Distance to agro-veterinary service providers (kms)	2.7 (3.1)	2.3 (2.9)	2.7 (3.6)	1.3884
Access to extension (% yes)	35.4	32.9	34.3	0.485
Training on animal health (% yes)	20.8	31.4	25.3	-2.1929**
Access to credit (% yes)	25.5	24.3	25	0.2567
Membership to group (% yes)	70.3	71.4	70.8	0.2208

Note: Standard deviations are in parenthesis.

****, **,* denote significant difference between Counties at 10%, 5% and 1%, respectively.***

In SSA, women are mostly involved in the day to day management of chicken. Studies like Olwande et al. (2009), King'ori et al. (2010) and Islam et al. (2014) also highlighted the dominance of women in chicken production and farming. The average age of the respondents was 47 years. This shows that chicken production is dominated by older farmers in both Kakamega and Machakos Counties. Murekefu (2013) also found that chicken production was dominated by older farmers. More than half of the respondents having attained above primary school education. The proportion was slightly higher in Kakamega (55.2 percent) compared to Machakos (50.7 percent). These results show that chicken farmers had some basic form of literacy. Similar results were also found by Akintunde and Adeoti (2014) in Nigeria where most of the farmers had attained above the minimum primary education.

Majority of the farmers had more than five years' experience in chicken production. This shows that the level of experience in chicken farming was high. Farmers with more years of experience are likely to use better practices in raising their flock. Experience in chicken production was slightly higher in Kakamega compared to Machakos. More than three quarters of the farmers were married. This reveals the importance of chicken farming and production among married farmers. In Counties like Kakamega and Machakos, married farmers have the incentive to take part in poultry production and management due to cultural expectations that necessitate them to rear poultry. Married farmers also have more family responsibilities therefore engage in chicken activities more to provide for their families' socio-economic needs.

The average land size was more than two and a half acres for the pooled sample. The difference in land size between the two Counties was statistically significant with the average land size higher in Machakos (3.8 acres) compared to Kakamega (1.9 acres). The small land sizes in Kakamega can be attributed to high population density in the County (CIDP, 2018a). Results for Machakos slightly differed with those from the CIDP (2018b), which showed that the average

land size is 1.9 acres in Machakos County. From the overall results, it is evident that most farmers own relatively smaller land parcels making chicken production the appropriate farming activity. Studies like Nduthu et al. (2015) have highlighted that chicken production is the best enterprise especially where land is a limiting factor of production, due to its limited space requirements. The average distance to the nearest agro vet was approximately 2 kilometers. This shows that farmers faced challenges in accessing inputs for production due to the relatively long distance between the homesteads and the nearest agro-veterinary service providers.

4.1.2 Socio-economic characteristics of traders

Table 7 presents the general socio-economic and institutional characteristics of traders selling chicken in Kakamega, Machakos and Nairobi Counties.

Table 7: Socio-economic characteristics of chicken traders

Characteristics	Kakamega (n = 119)	Machakos (n = 105)	Nairobi (n = 112)	Pooled Traders (n = 336)	Significant difference
Gender (% male)	83.2	71.4	58	71.1	0.000***
Average years (years)	44 (12)	41 (12)	38 (14)	41 (13)	0.051*
Education Level (% Primary and below)	31.1	48.6	61.6	46.7	0.308
Experience (5 years and below)	70.6	66.7	64.3	67.3	0.000***
Marital status (% married)	92.4	88.6	75	85.4	0.000***
Training on animal health	18.5	9.5	16.1	14.8	0.128
Access to credit (% yes)	23.5	29.5	35.7	29.5	0.003**
Group membership (% yes)	80.7	59.1	66.1	68.7	0.156

Note: Standard deviations are in parenthesis.

******, **,* denote significance between Counties at 10%, 5% and 1%, respectively.***

Source: Survey Data (2018).

From the pooled sample, it is evident that majority of the traders were male. The proportion of male traders was higher in Kakamega compared to Machakos and Nairobi with a statistical difference. This shows the dominance of men in the chicken trade. According to Ochieng et al. (2013), men dominate cash and revenues arising from poultry production. Bett et al. (2009) also

highlights that men are involved in the marketing of chicken in major market outlets. Moreover, marketing as opposed to production involves movement from place to place, sometimes over long distances, which may not be desirable for most females who double up as home keepers.

The average age of the respondents was 41 years. This shows that chicken trade is dominated by older traders. The average age of traders was higher in Kakamega compared to Machakos and Nairobi. The results suggest that traders in Nairobi were slightly younger compared to the other Counties. Bett et al. (2009) found the average age of chicken traders to be 33 years in Nairobi. The education level attained by the traders across the three Counties was low. Less than half of the traders had accessed above primary school level of education. Education level of the traders in Nairobi was high with majority of traders having attained above primary school education. The results in Nairobi are consistent with Bett et al. (2011) and Ayieko et al. (2014) where majority of the traders had attained secondary school education.

Majority of the respondents had practiced chicken trading for more than five years. This shows that the level of experience was high. Traders with more years of experience are likely to use better practices during transportation and sale of chicken in the market places. There was a statistical difference in experience with more traders in Nairobi having more than five years of experience compared to Kakamega and Machakos. Majority of the traders in both counties were married. Married traders are considered to have family responsibilities, therefore engage in chicken trading as a quick source of income to meet the socio-economic needs of their families.

4.2 Institutional services

This sub-section highlights the institutional and support services used by chicken farmers and traders. They include access to extension services, trainings and credit access.

4.2.1 Farmers institutional and support services

4.2.1.1 Extension services regarding chicken activities among farmers

Results from Table 6 show access to extension services regarding chicken production was relatively low in the pooled sample. There was no significant difference in access to extension. Despite the crucial role of extension, there was low access to extension services. Farmers are unable to access relevant information regarding better husbandry and management practices. This is consistent with studies like Ndathi et al. (2012) and Kyule et al. (2015) who also found that farmers face challenges in accessing extension services.

Extension was mainly accessed through farmer to farmer mode of extension. Farmers relied on fellow farmers for information regarding chicken production. In comparison, farmers in Kakamega mostly relied on the County extension officers for services, which is consistent with Kakamega's CIDP (2018a). Most farmers in Machakos relied on both County extension officers and farmer to farmer modes of extension for information (*Figure 7*).

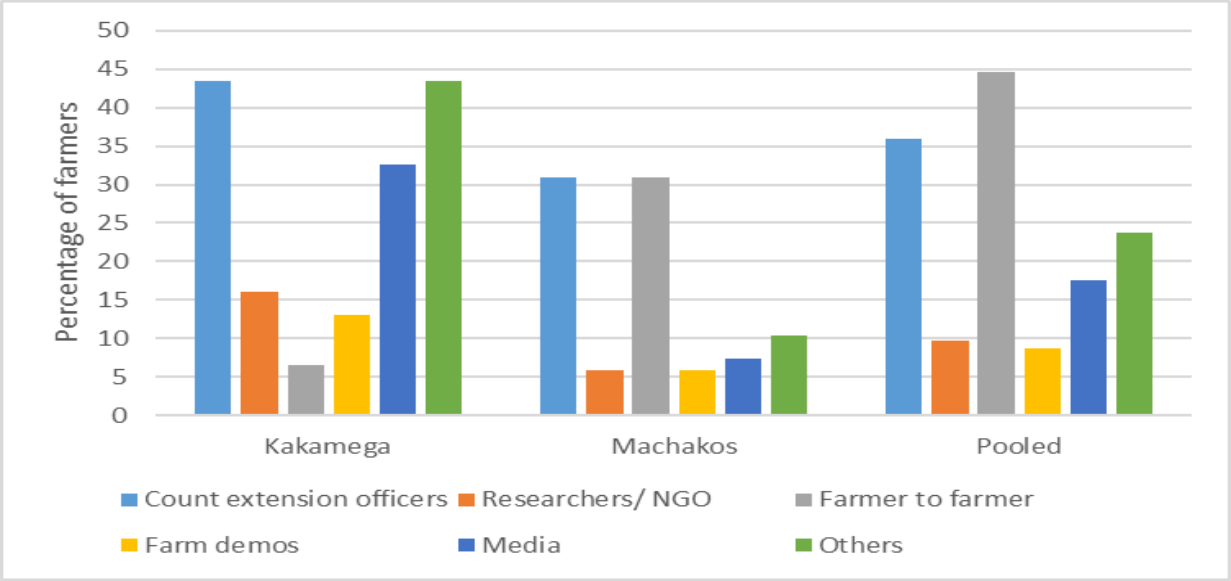

Figure 7: Sources of extension services by chicken farmers

Source: Survey Data (2018).

4.2.1.2 Training on animal health among farmers

Access to animal health training was also low with only 25.3 percent of the total respondents having accessed animal health training (Table 6). Fewer farmers accessed training in Kakamega compared to Machakos. Trainings of farmers on disease process, animal health and management practices are relevant in improving chicken production. Lack of training on such aspects leads to adoption of poor practices that lead to flaws, resulting in disease introduction and spread. Previous studies like Ochieng et al. (2013) and Mutua (2018) also highlighted the low access and inadequate training among chicken farmers.

4.2.1.3 Access to credit services for chicken activities among farmers

Access to credit for chicken production was also very low with only 25 percent of the respondents having accessed credit services in both Kakamega and Machakos Counties. The low access to credit can be attributed to several reasons such as lack of collateral, lack of access to credit facilities and high interest rates. Studies like Tsegaye et al. (2014) and Adebayo and

Adeola (2015) also reported the low access of credit among chicken farmers in Ethiopia and Nigeria respectively. As shown in Figure 8, majority of farmers in the pooled sample accessed credit through banks and microfinance institutions. However, the most dominant form of credit access in Kakamega County was the use of other credit facilities such as mobile loans and informal lending facilities. In Machakos County, groups/cooperatives were the most preferred sources of loans.

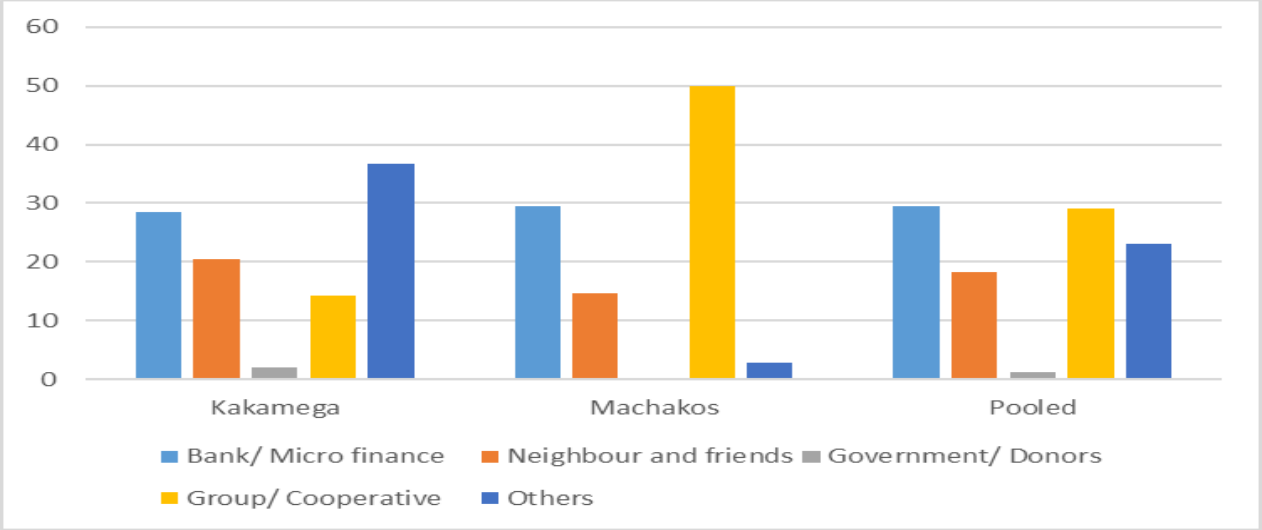

Figure 8: Sources of credit by chicken farmers

Source: Survey Data (2018).

4.2.1.4 Group membership among farmers

Majority of the respondents (70.8 percent) belonged to social organizations. Membership to groups was generally higher in Machakos compared to that in Kakamega This shows that the social capital among farmers was high. Groups are deemed necessary for farmers as they help access relevant services such as credit, joint input purchase, joint disease vaccinations and extension (Ochieng et al., 2013). As highlighted in Figure 9, most farmers belonged to *chamas* (self-help groups) while youth groups recorded the lowest membership in both Kakamega and Machakos Counties.

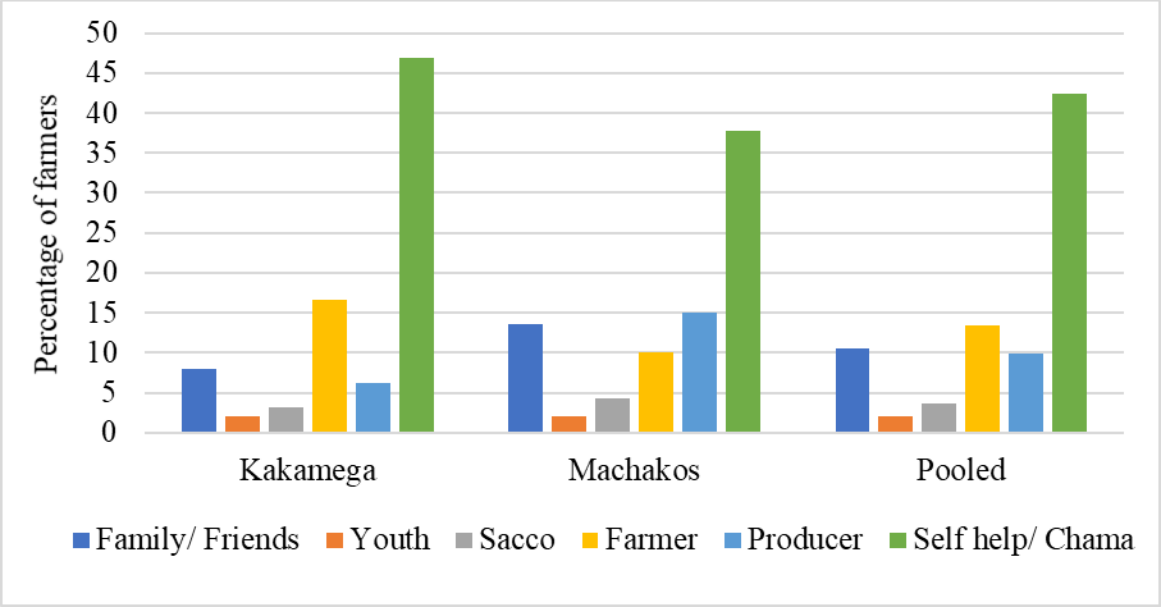

Figure 9: Group membership among chicken farmers

Source: Survey Data (2018).

4.2.2 Traders' institutional and support services

4.2.2.1 Trainings on animal health among traders

Access to animal health training was also low with only 25.3 percent of the total respondents having accessed animal health training (*Table 7*). Less traders accessed training in Kakamega compared to Machakos, with statistical difference in access to trainings on animal health. Training of traders on disease process, animal health and management practices are relevant in improving chicken production.

4.2.2.2 Access to credit services for chicken activities among traders

Access to credit was low with about a third (35.7 percent) of the respondents in the pooled sample having accessed credit services (*Table 7*). Credit access was highest among traders in Nairobi, and lowest in Kakamega County. As highlighted in Figure 10, the most dominant source of credit was through banks and microfinance in accessed credit through banks and microfinance

institutions. However, the most dominant source of credit in Machakos County was from neighbors and friends.

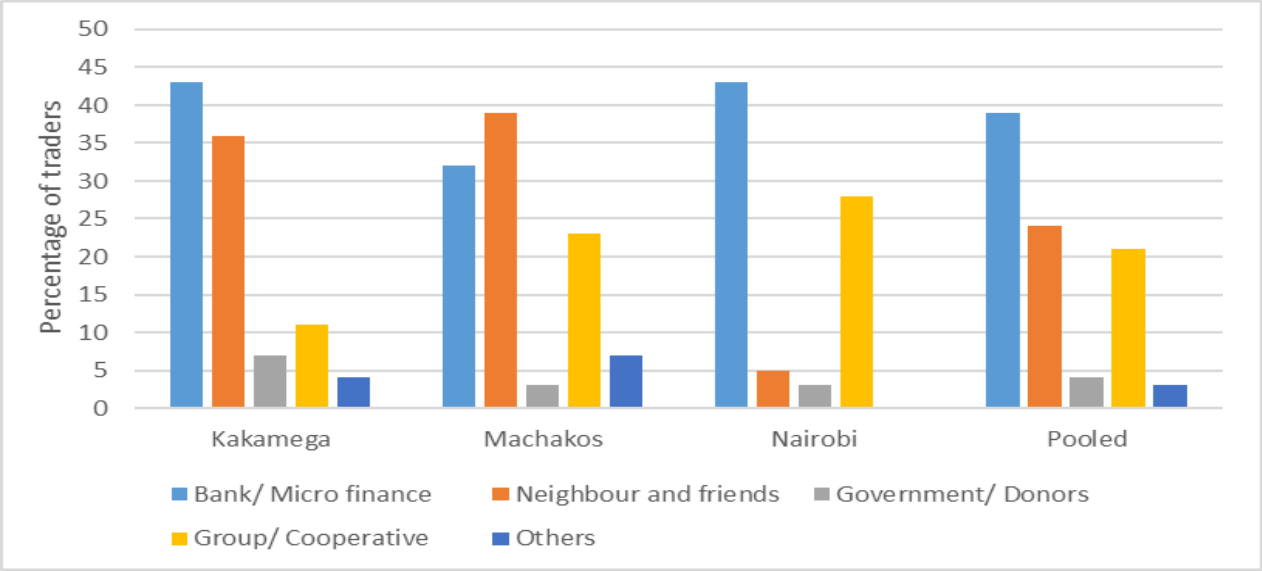

Figure 10: Sources of credit by chicken traders

Source: Survey Data (2018).

4.2.2.3 Group membership among traders

As shown in Table 7, majority of the trader (68.7 percent) in the pooled sample belonged to social organizations. Membership to groups was highest among traders in Kakamega and lowest in Machakos. This shows that the social capital among traders was higher in Kakamega compared to the other Counties. Groups are deemed necessary for traders as they help access relevant services such as training and credit access. As highlighted in Figure 11, most traders belonged to self-help groups (*chamas*) in the pooled sample as well as in Machakos and Nairobi. However, half of the traders in Kakamega belonged to producer groups.

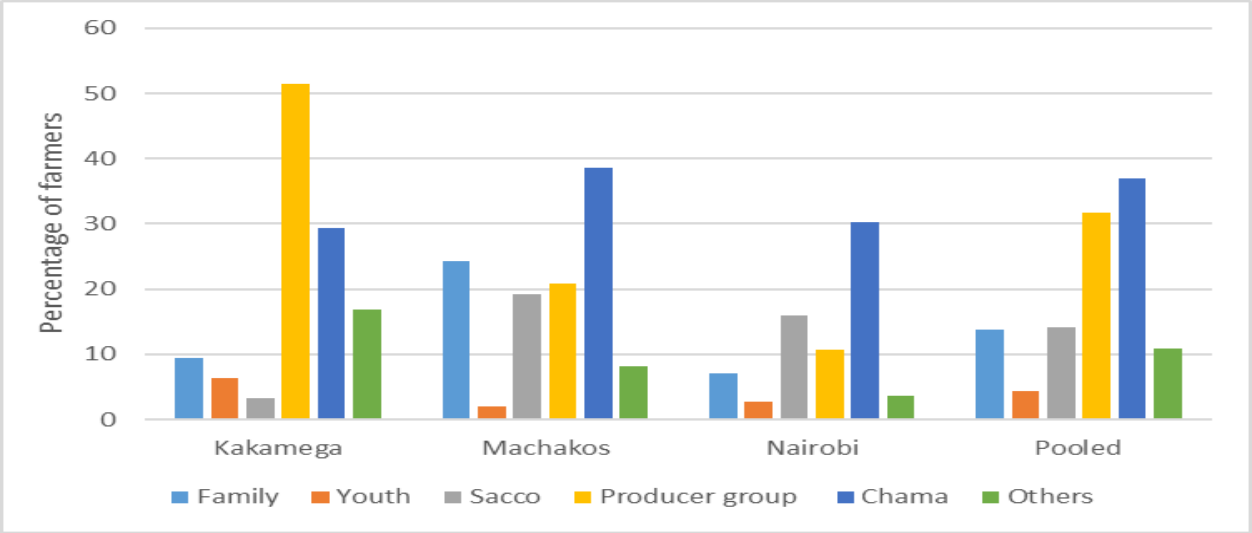

Figure 11: Group membership among chicken traders

Source; Survey Data (2018).

From Figure 12, access to training on animal health was higher among chicken farmers compared to traders. Access to training is crucial as it enables farmers and traders get relevant information regarding aspects such as good practices, disease detection and control measures during outbreaks. Credit access was slightly higher among traders compared to farmers. Traders generally accessed credit to invest in market activities through purchase of stock and payments for licenses and local government fees. Group membership was also slightly higher among traders compared to farmers. Membership to groups is regarded an important aspect for farmers and traders as the benefit form collective action. Extension services was only accessed by farmers. Farmers with access to extension are likely to practice good management of chicken as the have access to relevant information.

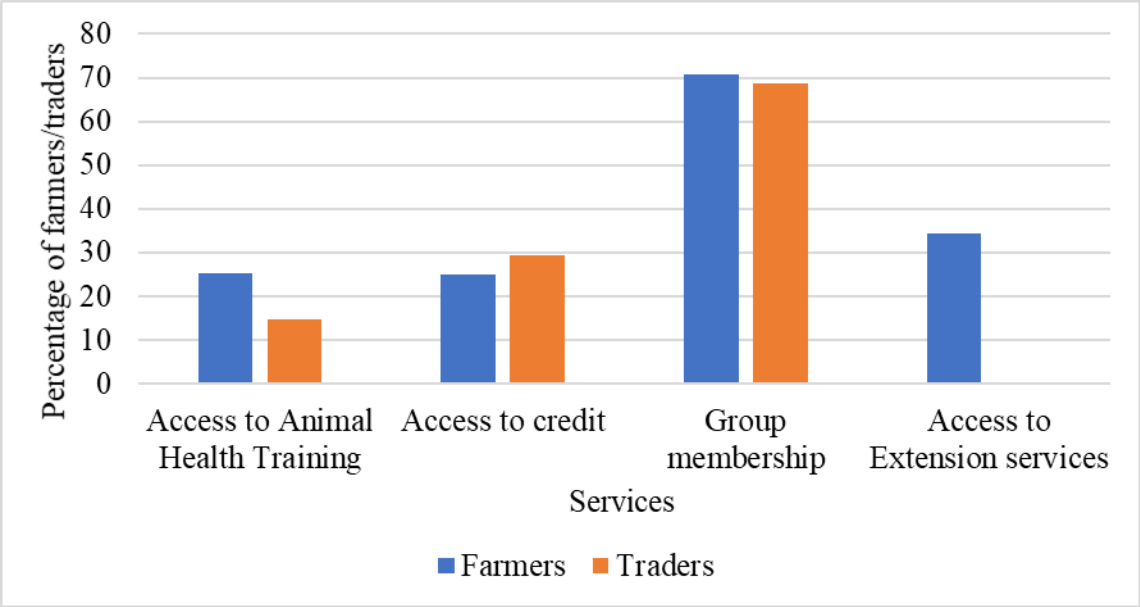

Figure 12: Comparison between farmers' and traders' access to institutional services

Source: Survey Data (2018).

4.3 Chicken production and management practices

This sub section provides a discussion on the different chicken production systems, management and husbandry practices used by chicken farmers in rearing their flocks. The practices include housing, feeding routines, vaccination and biosecurity.

4.3.1 Chicken production system

As shown in Figure 13, free-range production system was the most dominant system of production used by the farmers. The free-range system of production is generally characterized as a low input- low output system of production where birds are left to scavenge for food during the day and confined during the night (King'ori et al., 2010). The semi intensive system of production was also relatively used by farmers with 19 percent of the farmers having adopted the system. According to King'ori et al. (2010), the semi intensive system is a mostly used by financially able households who mainly rear chicken that are crosses between exotic and indigenous chicken. There is regulated movement of birds as they are allowed to scavenge

during the day ad confined in shelters at night. Some farmers also highlighted the use of mixed systems of production to raise their birds. Mixed systems of production are where a farmer employs a combination of different production systems in the farm. Use of this system was common among farmers who reared more than one variety of chicken.

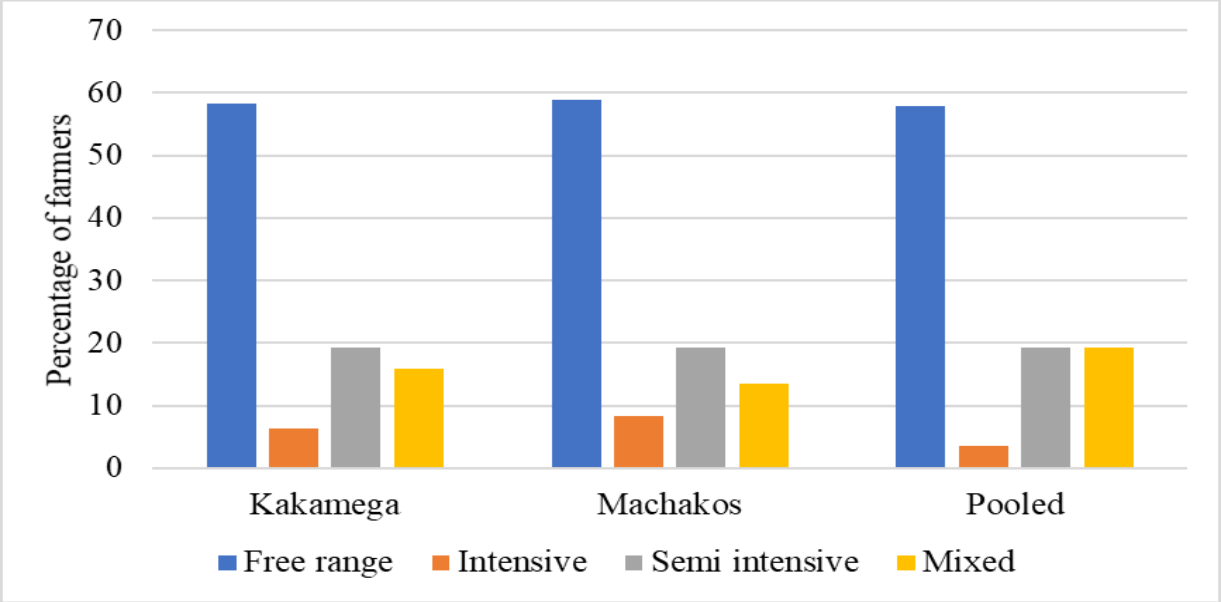

Figure 13: Production systems used by chicken farmers

Source: Survey Data (2018).

4.3.2 Feed and feeding practices

Table 8 presents the proportion of farmers using various management practices in Kakamega and Machakos Counties. The practices included feeding, housing, cleaning and disease control.

Most of the farmers in the pooled sample used broadcasting as a means of administering feed to chicken compared to the use of feed troughs. The percentage was higher among farmers in Machakos County compared to Kakamega, with significance in statistical difference. The use of broadcasting as a means of administering feeds can be linked to the use of the free-range system of production where birds are left to scavenge for food and occasionally supplemented with grains and kitchen left overs (Nyaga, 2007; Magothe, 2010).

Table 8: Chicken management and husbandry practices

Characteristics	Kakamega (n = 192)	Machakos (n = 140)	Pooled Farmers (n= 332)	Significant difference
Means of feeding (% use of feed troughs	47.4	35.7	42.5	2.1346***
Forms of housing (% special housing)	35	65.7	47.8	-1.2276
Frequency of cleaning shelter (% daily)	74.5	60.7	68.7	2.6914***
ND Vaccination (% yes)	64.4	44.3	56.0	3.1209***

Note: *, **,* statistical significance between Counties at 10%, 5% and 1%, respectively.**
Source: Survey Data (2018).

As presented in Figure 14, the most common form of feeds among the chicken farmers was the use of kitchen leftovers (household wastes). However, most farmers in Kakamega used commercial feeds to feed their free-range flock, while occasionally supplementing the birds with insects and grains.

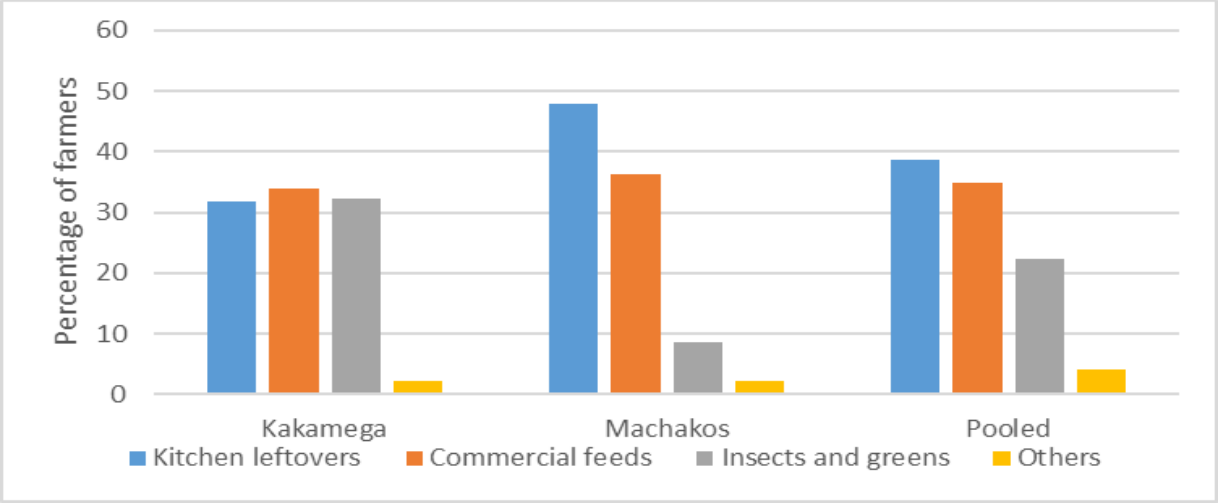

Figure 14: Forms of feed used for chicken

Source: Survey Data (2018).

4.3.3 Housing

As highlighted in Table 8, most of the farmers in the pooled sample provided other forms of housing such as make shift shelters and shared shelters with humans. In contrast, farmers in Machakos had constructed special/decent housing and cages for their chicken, unlike Kakamega where farmers used other forms of housing such as makeshift shelters and shared shelter with

humans. With shared shelter, farmers either housed their chicken in the kitchen, living rooms or shared rooms with their flock during the night. According to King'ori et al. (2010) housing especially under the free-range systems of production constitutes simple structures that are not developed. Other studies like Tarwireyi and Fanadzo (2013) and Ochieng et al. (2013) have documented the low adoption of special housing as most farmers kept their chicken in their living rooms or kitchens.

4.3.4 Hygiene and cleaning practices

As shown in Table 8, majority of the farmers cleaned the chicken shelters daily. There was statistical significance among farmers who cleaned the structures daily in the Counties, with a higher proportion being in Kakamega compared to Machakos. Farmers highlighted the use of different methods to clean the structures. Though majority of the farmers cleaned the shelters daily, the methods used are not efficient and may contribute to high disease prevalence due to poor hygiene.

4.3.5 ND vaccination and treatment

As presented in Figure 15, Newcastle disease was the most vaccinated disease in both Machakos and Kakamega County compared to other chicken diseases. Vaccination is generally seen as the most successful tool in the prevention of Newcastle disease. According to Okeno et al. (2011), control of ND is effective through vaccination and it helps reduce mortality from the disease. Non-usage of vaccination against the disease is considered as one of the factors that contributes to Newcastle disease outbreaks among chicken.

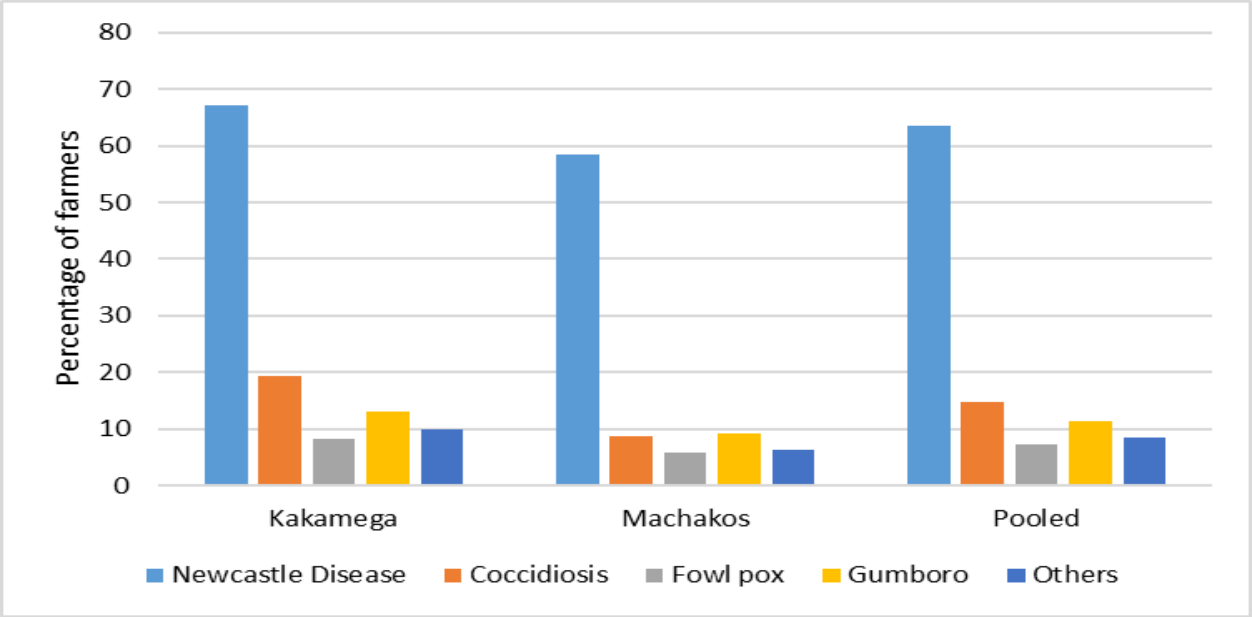

Figure 15: Vaccination against common chicken diseases

Source: Survey Data (2018).

Conventional vaccines generally purchased from the agro vet or through vaccination programs are commonly used by farmers to vaccinate their chicken against ND. From Figure 16, it is evident that most farmers in both Kakamega and Machakos relied on the local agrovet for ND vaccines. Most farmers would seek the help of the local agro vets once their birds exhibited signs and symptoms of diseases. Vaccines would then be given based on the flock size owned by the farmers. Farmers also relied on other sources for ND vaccination. Farmers relied on vaccination programs coordinated by the national and County governments to access ND vaccines. Some farmers also relied on NGOs and researchers to provide vaccines during field visits.

In Kenya, the most commonly used ND vaccination is *Lasota*, a thermostable vaccine. The vaccine is mainly stocked by different agro vets. There was substantial use of herbal medication to vaccinate against diseases. Herbal vaccination constituted the use of herbs such as pepper, Aloe Vera, ginger, Tithonia and garlic that are commonly used in the treatment of birds for

diseases. Herbal medication is less effective as a form of treatment, compared to conventional treatment measures (Kyule et al., 2015).

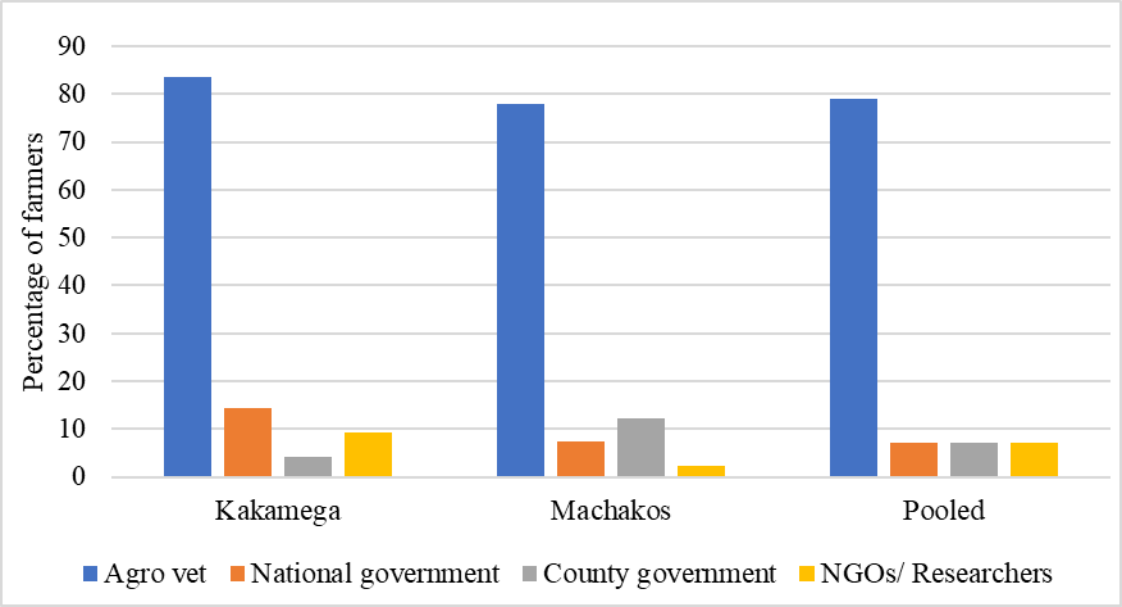

Figure 16: Sources of ND vaccination by chicken farmers

Source: Survey Data (2018).

Despite the importance of vaccination in the control of Newcastle disease, farmers still face challenges during vaccination. Results in Figure 17 show that most farmers in the pooled sample highlighted the high cost of vaccines as the biggest challenge faced during vaccination. Most farmers in rural areas are small scale chicken farmers hence have limited capital to facilitate the purchase of veterinary inputs such as vaccines. In Kakamega, lack of vaccines was ranked as the biggest challenge followed by the high cost of vaccines. Most farmers in the area had small flock sizes hence find it expensive to purchase the dosage for their small flock sizes.

According to Okitio et al (2006), there is lack of appropriate low-cost technologies like vaccines that match the socioeconomic conditions of the small-scale farmers. Farmers in Machakos ranked the lack of technical knowledge and skills as the biggest challenge during vaccination,

followed by the high cost of vaccines. Farmers generally lack the knowledge or skills to administer vaccines. This results in most farmers failing to meet the basic procedures during vaccines storage, vaccine reconstitution and administration (Nyaga, 2010).

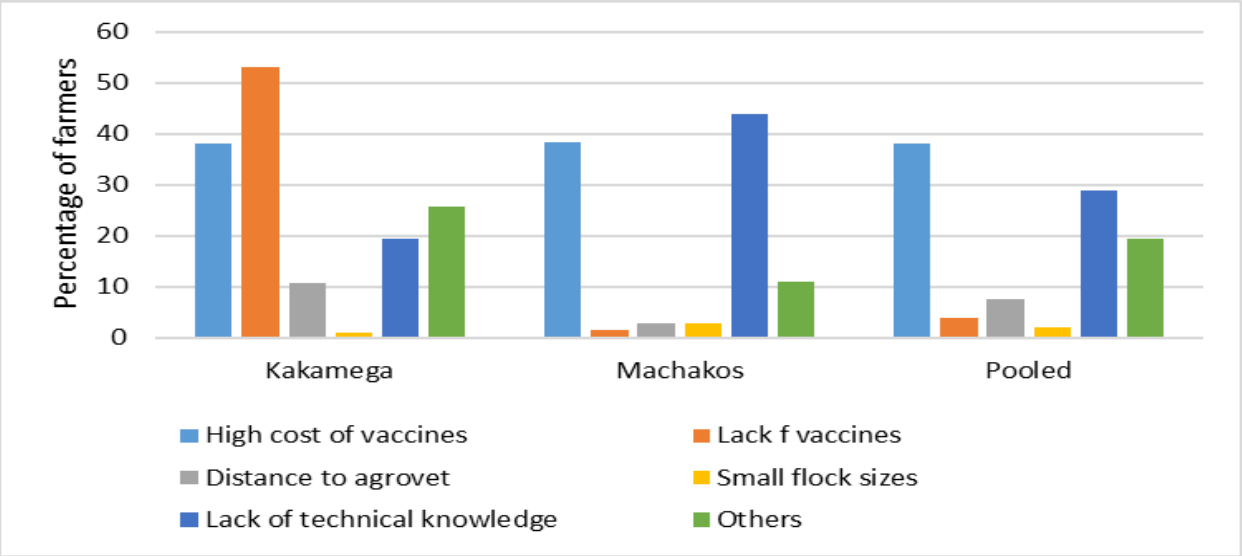

Figure 17: Challenges facing Newcastle disease vaccination among farmers

Source: Survey Data (2018).

4.4 Chicken transportation and marketing practices

This sub-section presents the different marketing practices and transportation modes used by chicken traders in LBMs in Kakamega, Machakos and Nairobi Counties. The practices used by the traders include origin of birds, sources of birds, mixing of birds, housing and form of birds sold in the markets.

4.4.1 Origin of chicken

Table 9 shows that approximately two thirds (69.6 percent) of the farmers in the pooled sample sourced their chicken from within the Counties they traded. However, there was a statistical difference between the three Counties. In Kakamega, there was a high proportion of farmers (49.6 percent) who sourced their stock form neighboring Counties. These Counties include Nandi and Uasin Gishu Counties. Most of the traders across the three Counties highlighted the

mixture of birds from different sources. Birds from different sources were collected and placed in the same cages during transportation and housing in the live bird markets.

Table 9: Chicken marketing practices used by traders

Characteristics	Kakamega (n = 119)	Machakos (n = 105)	Nairobi (n = 112)	Pooled Traders (n = 336)	Significant difference
Origin (% within county)	50.4	81.9	78.6	69.6	0.000***
Market channel (% direct channel)	64.7	58.1	47.3	56.8	0.027**
Mix of birds (% yes)	91.6	86.7	93.0	90.5	0.264
Form of birds (% live)	99	93.3	66.0	86.3	0.000***
Housing during the day (% yes)	30.3	24.7	65.2	40.2	0.000***

*Note: ***, **,* significance at 10%, 5% and 1%, respectively.*
Source: Survey Data (2018).

4.4.2 Source of birds

Table 9 shows that most of the traders (56.8 percent) in the pooled sample used direct channels to source their stock. There was a statistical difference between the three Counties. Direct sourcing of chicken involved traders using their own stock at home or sourcing their birds at the farm gate. In contrast, most traders in Nairobi (52.7 percent) used indirect channels to source their chicken. Traders sourced their chicken from middlemen/ brokers and fellow traders. This is consistent with Munyua et al. (2012) who found that most of the birds sourced by traders were supplied by middlemen.

4.4.3 Forms of birds sold

The most dominant form of birds sold in the pooled sample was live birds with 86.3 percent of the traders selling live chicken in the markets. There was a statistical difference between the Counties. In Kakamega and Machakos Counties, the proportion of traders that sold chicken in live form was very high. This shows that most consumers preferred chicken in its live form compared to slaughtered chicken. Most markets in Kakamega and Machakos are held on specific

days hence farmers move to different markets with the live birds to sell. This can be due to the lack of slaughter and other facilities (Murekefu, 2013).

4.4.4 Housing of chicken

In the pooled sample, three-fifths of the traders did not provide housing for their chicken in the market places. This was generally the status of housing by traders in Kakamega and Machakos Counties where birds were rarely housed. However, most traders in Nairobi (65.2 percent) provided housing and shelter for their birds (*See Table 9*). The traders kept their birds in special cages and shades within the markets. This shows that traders in Nairobi had the incentive to provide housing for their birds in live bird markets, compared to traders in Kakamega and Machakos Counties.

4.4.5 Transportation of chicken

Figure 18 shows the different modes used to transport chicken by traders to live bird markets. The most dominant transport mode in the pooled sample was the use of motor vehicle with 46.9 percent using this mode. Traders generally used pick-up trucks, lorries and public service vehicles (*matatus*) to transport chicken to live bird markets. However, farmers in Machakos and Kakamega preferred the use of motor cycles and bicycles to transport their chicken to live bird markets. Bicycles and motor cycles are the most convenient forms of transport in the two Counties hence the reason for use. Studies like Okello et al. (2010) and Aila et al. (2014) the transportation process relies on bicycles, public transport vehicles like *matatus*, open carriers and hand carts. High mortality of chicken is experienced during transportation of chicken.

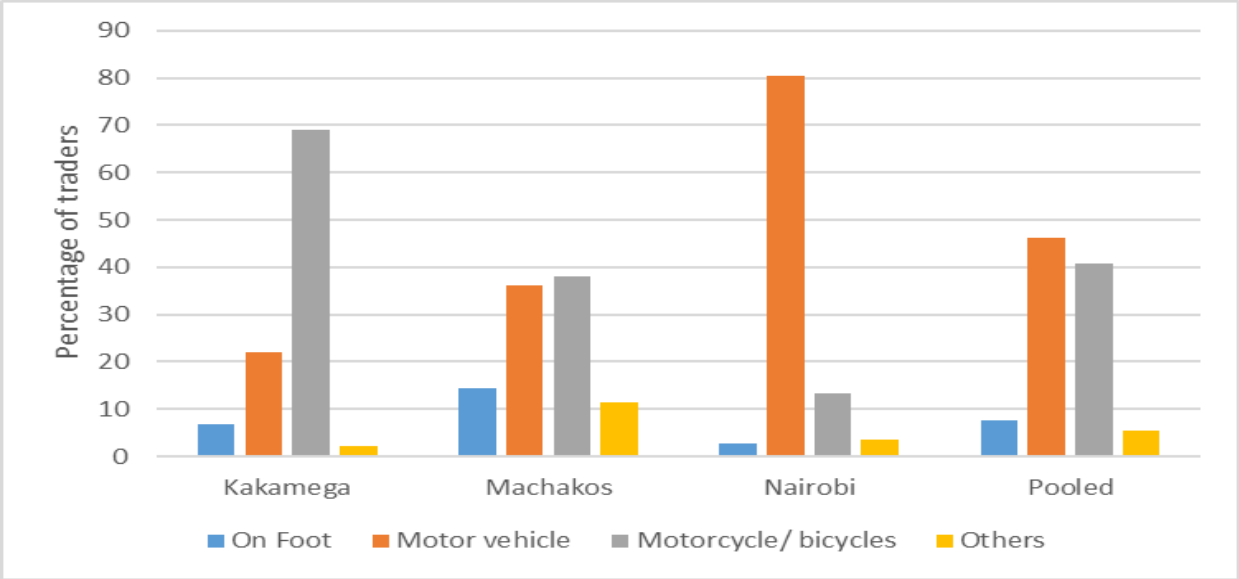

Figure 18: Forms of transportation used by chicken trader

Source: Survey Data (2018).

4.4 Challenges in the chicken subsector

4.4.1 Challenges faced by farmers in chicken production

Disease ranked as the biggest challenge faced by chicken farmers during production. Farmers in both Counties highlighted the persistent threats of diseases (*see Figure 19*). A high incidence of disease is the major constraint to chicken production in Africa. Diseases account for a substantial amount of losses to farmers. This is consistent with several other studies like King'ori et al. (2010), Ochieng et al. (2013) and Mutua (2018). The ND was listed as the most devastating disease by the farmers in both Kakamega and Machakos Counties.

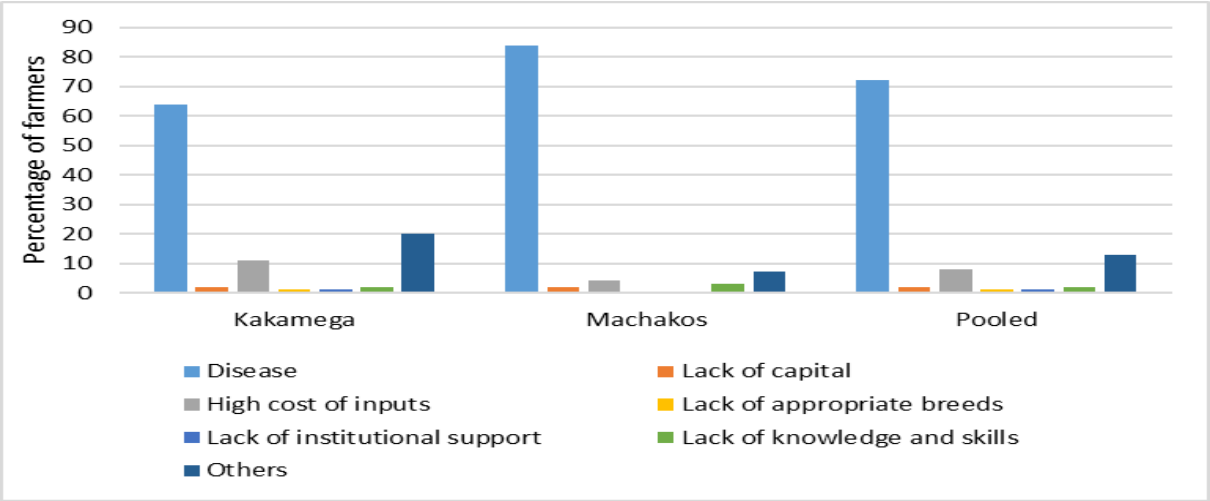

Figure 19: Challenges faced by chicken farmers

Source: Survey Data (2018).

4.4.2 Challenges faced by traders in chicken marketing

Results from Figure 20 show that lack of institutional support ranked as the biggest challenge faced by chicken farmers. Farmers lack institutional support to facilitate marketing activities, resulting in poor marketing practices. As previously highlighted in Table 3, there was low access to credit support and farmer training. Such services are essential in enabling farmers to improve their marketing activities.

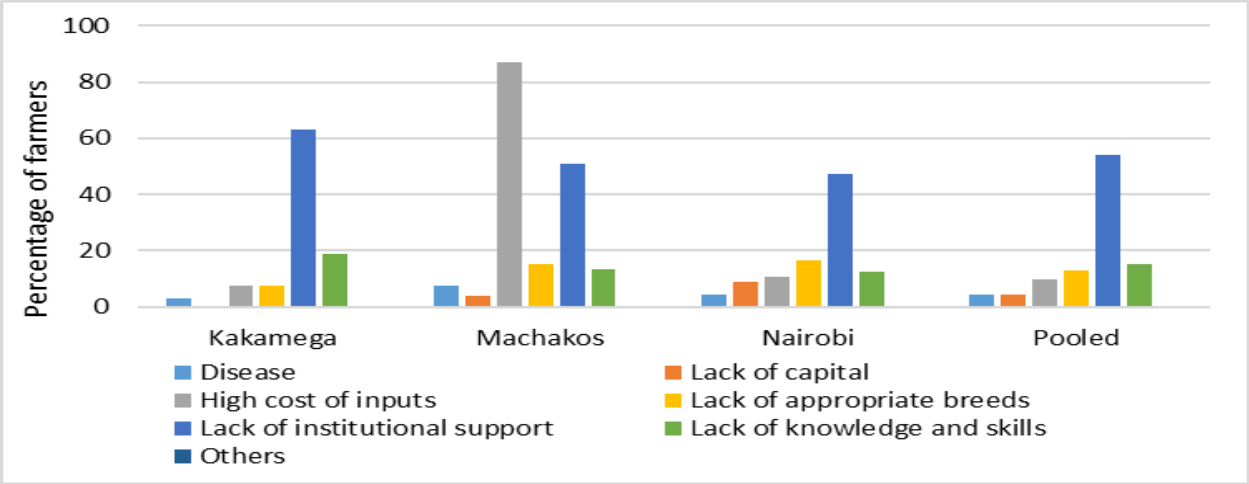

Figure 20: Challenges faced by chicken traders

Source: Survey Data (2018).

4.5. Awareness of Newcastle disease

This sub-section provides a discussion on the level of awareness by farmers and traders on ND, as well as a comparison on awareness between respondents in the different Counties.

4.5.1 Awareness of Newcastle disease and symptoms among farmers

Table 10 shows that awareness to the disease was slightly higher in Kakamega (81.2 percent) compared to Machakos (68.7 percent). For this study, farmers who had knowledge about ND and could positively identify the disease as ND based on the signs and symptoms consistent with it were deemed aware of ND There was a statistical difference between the two Counties with the proportion of farmers who were aware of the disease and symptoms higher in Kakamega compared to Machakos.

Table 10: ND awareness among chicken farmers

Characteristics	Kakamega (n = 192)	Machakos (n = 140)	Pooled Farmers (n = 332)	Significant difference
Awareness to ND (% yes)	88.5	86.4	87.6	0.576
Awareness to ND and symptoms (% yes)	81.2	67.8	75.6	2.831***

Note: *** denotes significance between Counties at 1 percent.

Source: Survey Data (2018).

The ND was commonly identified by the local name as *"muyekha"* in Kakamega *and "mavuii"* in Machakos and was listed as the most devastating disease that kills most of the chicken reared by the farmers. Studies like Otim et al. (2007) have suggested that owners of flock know the clinical signs associated with ND as they consider it the most important chicken disease.

4.5.2 Awareness on Newcastle disease and symptoms among traders

Table 11 shows that awareness of ND was highest among traders in Machakos (81.9 percent) and lowest among traders in Nairobi (63.4 percent). There was a statistical difference in level of awareness between the three Counties.

Table 11: ND awareness among chicken traders

Characteristics	Kakamega (n = 119)	Machakos (n = 105)	Nairobi (n = 112)	Pooled Traders (n = 336)	Significant difference
Awareness to ND (% yes)	77.3	81.9	63.4	74.1	0.004***
Awareness to ND and its symptoms (% yes)	66.4	71.4	51.8	63.1	0.000***

Note: *, **, * denote significance at 1, 5 and 10 percent.**

Source: Survey Data (2018).

The ND commonly identified by the local name as *"muyekha"* in Kakamega, *"mavuii"* in Machakos and "*kihuruto*" among the *Kikuyu* community in Nairobi was listed as the most common disease experienced by the chicken traders in the markets.

Awareness to both the disease and the symptoms associated with the disease was at 63.1 percent in the pooled sample. There was a statistical difference between the three Counties with the proportion of traders who were aware of the disease higher in Machakos compared to Kakamega and Nairobi. In comparison, chicken farmers were more aware of ND compared to the traders in the respective Counties. In Machakos, traders were more aware of ND compared to farmers.

4.5.3 Disease prevention measures applied by chicken farmers

Farmers generally use different strategies and methods to prevent disease entry and outbreaks among their flocks. Figure 21 highlights the different strategies used by farmers in Kakamega and Machakos to prevent diseases. Vaccination and treatment of the flock was the most commonly used disease preventive strategy with approximately 44 percent of farmers in the pooled sample using this strategy. This was consistent in both study areas. In Kakamega, more than half of the farmers used this strategy compared to approximately a third in Machakos. Vaccination is deemed as the most appropriate measure in preventing ND outbreak. It is generally recommended that routine vaccination be carried out among the flock to protect the

birds from the disease outbreaks. Isolation of sick birds from healthy birds was also a common practice carried out by farmers in both Machakos and Kakamega.

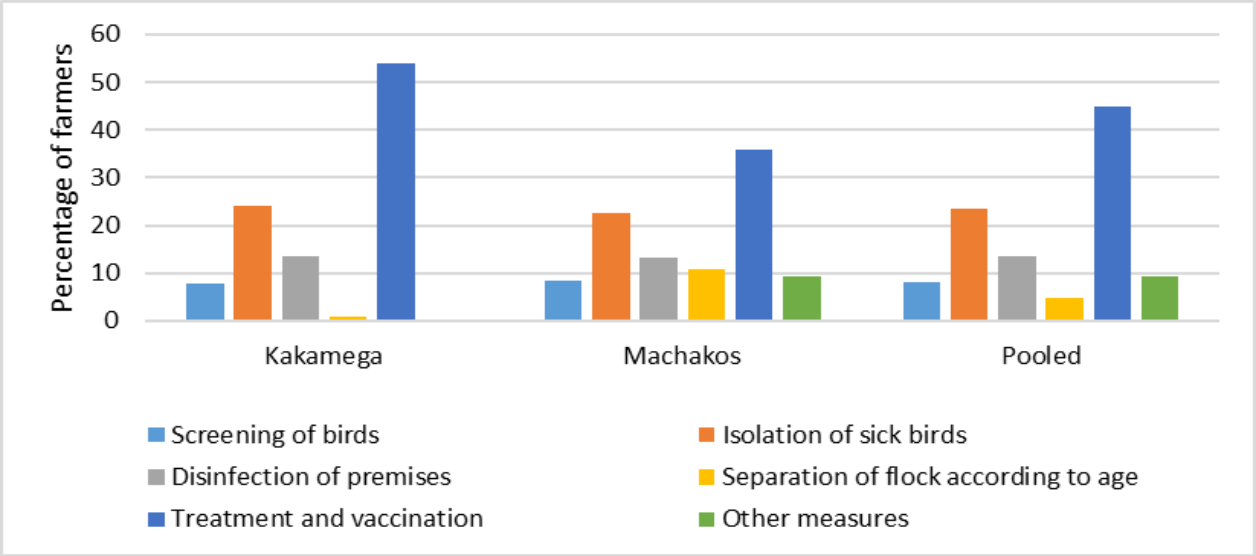

Figure 21: Disease prevention measures used by chicken farmers

Source**:** Survey Data (2018).

4.5.4 Disease prevention measures used by chicken traders

Results from Figure 22 show that screening of birds was the most commonly used disease preventive strategy with approximately 42.3 percent of traders in the pooled sample using this strategy. The proportion of traders that used this measure was higher in Nairobi compared to Kakamega and Machakos. Traders would check for signs and symptoms associated with diseases among the birds. Vaccination and treatment were also a measure commonly used by the trader's birds from falling sick is deemed as the most appropriate measure in preventing ND outbreak. Traders would administer drugs and medication to birds in the market place. Those buying the chicken have the intention of slaughtering them for food, without the knowledge that the birds have been treated. This is one of the challenges and concerns regarding food quality and safety by consumers.

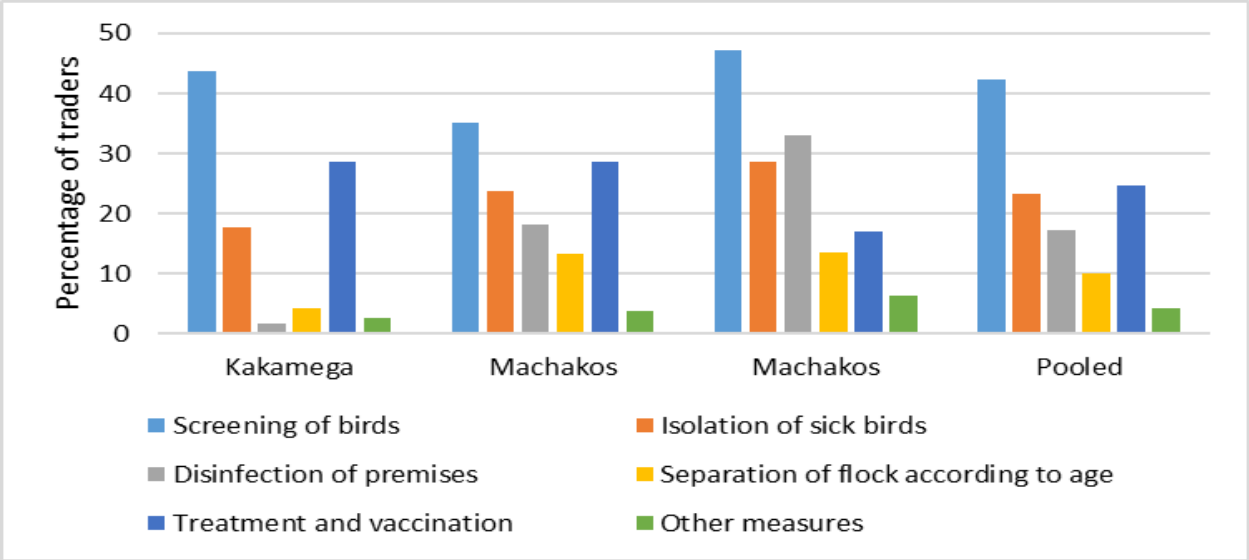

Figure 22: Disease prevention measures used by chicken traders

Source**:** Survey Data (2018).

4.5.5 Newcastle disease outbreaks

This sub-section provides a discussion on ND outbreaks among farmers and traders in the respective Counties. The ND is generally viewed as the most prevalent and fatal chicken disease in Kenya. The relationship between ND awareness and outbreaks is discussed as well.

4.5.5.1 Newcastle disease outbreaks among chicken farmers

As shown in Table 12, half the farmers (50.6 percent) in the pooled sample had experienced ND outbreaks among their flock. The proportion of farmers that had experienced the disease was higher in Machakos compared to Kakamega. These results indicate that ND outbreaks were common among farmers in Machakos compared to Kakamega. Responses from the farmers who had experienced ND outbreaks showed that the most common symptom observed was the discharge of greenish diarrhea by the chicken. Other symptoms observed include the increased breathing and gasping by birds, twisted necks, loss of appetite and the sudden death. These symptoms were consistent with the clinical signs of ND infections.

Table 12: ND outbreaks and symptoms experienced by farmers

Characteristics	Kakamega (n= 192)	Machakos (n= 140)	Pooled Farmers (n= 332)
Newcastle disease outbreaks (% yes)	46.9	55.7	50.6
ND Symptoms experienced (%)			
Loss of appetite	23.4	36.6	25
Drop in egg production	11.5	8.7	9.3
Increased respiration ad gasping	29.2	39.4	29.2
Greenish Diarrhea	40.6	48.1	38.5
Twisted necks	22.4	38.5	25.0
Sudden death	23.9	28.8	22.8

Source: Survey Data (2018).

From Table 13, Shinyalu sub-county recorded the highest number of farmers who had experienced outbreaks of ND (63.9 percent) in Kakamega County. Similarly, farmers in Shinyalu also recorded the highest flock sizes (approximately 50 birds) compared to the other sub-counties within Kakamega County. Navakholo recorded the least number of farmers who had experienced ND outbreak (20 percent), while also recording the lowest flock sizes (approximately 20 birds), compared to the other sub-counties within Kakamega. From this, it is evident that most farmers who had large sizes of flock were likely to experience outbreaks of ND, compared to those who had smaller flock sizes. According to Adene and Oguntande (2006), small flock sizes do not permit adequate contact among infected birds for disease spread hence less outbreaks.

The close proximity of Shinyalu sub-county to Kakamega forest increases the likelihood of farmers within the sub County experiencing more ND outbreaks compared to the other sub Counties in Kakamega. Interaction between chicken and the wild birds found within the forest creates an environment for spread of ND as wild birds are known carriers of the ND virus. This result in farmers experiencing higher outbreaks compared to those in sub Counties located further from the forest like Butere and Mumias sub-counties.

Table 13: Relationship between flock size and disease outbreaks within sub Counties

Kakamega (n = 192)			Machakos (n = 142)		
Sub County	**Mean Flock Size**	**Experienced ND outbreaks (% Yes)**	**Sub County**	**Mean Flock Size**	**Experienced ND outbreaks (% Yes)**
Butere	32 (35)	31.3	Katangi	30 (55)	66.7
Ikolomani	38 (40)	50.0	Kathiani	104 (100)	70.7
Navakholo	20 (15)	20	Kola	30 (35)	18.7
Shinyalu	50 (67)	63.9	Masii	98 (200)	50
Lurambi	41 (43)	46.8	Mwala	20 (15)	56.3
Mumias	22 (16)	50			

Note: Standard deviations are in parenthesis

Source: Survey Data (2018).

In Machakos County, Kathiani sub-county recorded the highest number of farmers who had experienced outbreaks of ND (70.7 percent). Similarly, farmers in Kathiani also recorded the highest flock sizes (approximately 104 birds) compared to the other sub-counties within Machakos County. Kola recorded the least number of farmers who had experienced ND outbreak (18.7 percent). From this, it is also evident that most farmers who had large sizes of flock were likely to experience outbreaks of ND, compared to those who had smaller flock sizes.

4.5.5.2 Newcastle disease outbreaks among chicken traders

As revealed in Table 14, more than half of the traders (58.9 percent) had experienced ND outbreaks among their flock in the live bird markets. The proportion of traders who had experienced the disease was higher in Kakamega (62.2 percent) compared to Machakos (54.3 percent) and Nairobi (59.8 percent). These results highlight that ND outbreaks were common among traders in live bird markets in Kakamega compared to the other Counties.

Table 14: ND outbreaks and symptoms experienced by farmers

Characteristics	Kakamega (n= 119)	Machakos (n= 105)	Nairobi (n= 112)	Pooled Traders (N= 336)
Newcastle disease outbreaks (% yes)	58.9	54.3	62.2	58.9
ND Symptoms experienced (%)				
Loss of appetite	16	15.2	37.1	22.6
Drop in egg production	1.0	5.4	15.2	6.8
Increased respiration ad gasping	36.1	29.5	41.8	35.8
Greenish Diarrhea	53.8	38.4	59	50.4
Twisted necks	8.4	23.2	35.2	21.8
Sudden death	20.2	11.6	28.7	20

Source**:** Survey Data (2018).

Responses from the traders who had experienced ND outbreaks showed that the most common symptom observed was the discharge of greenish diarrhea by the chicken with half of the traders having observed it. Other symptoms observed includes the increased breathing and gasping by birds, twisted necks, loss of appetite and the sudden death of birds. These symptoms were consistent with the clinical signs of ND infections in chicken.

4.5.5.3 Relationship between ND awareness and outbreaks

Results from Figure 23 show that chicken farmers in Kakamega County were more aware of ND compared to chicken traders. In Machakos, traders were more aware of the disease compared to the farmers. Generally, ND awareness among farmers was highest in Kakamega County compared to Machakos County. Awareness was highest among traders in Machakos County and lowest in Nairobi County. In relation to ND outbreaks, traders experienced more outbreaks of ND in Kakamega and Nairobi Counties compared to farmers. However, traders in Machakos experienced less outbreaks compared to the farmers. This shows the relationship between awareness to ND and outbreaks. Farmers and traders who were aware of ND were less likely to experience outbreaks compared to those not aware. Awareness is an important aspect in the control of ND. Farmers and traders who are aware of ND are likely to put in place measures to prevent the outbreaks of ND.

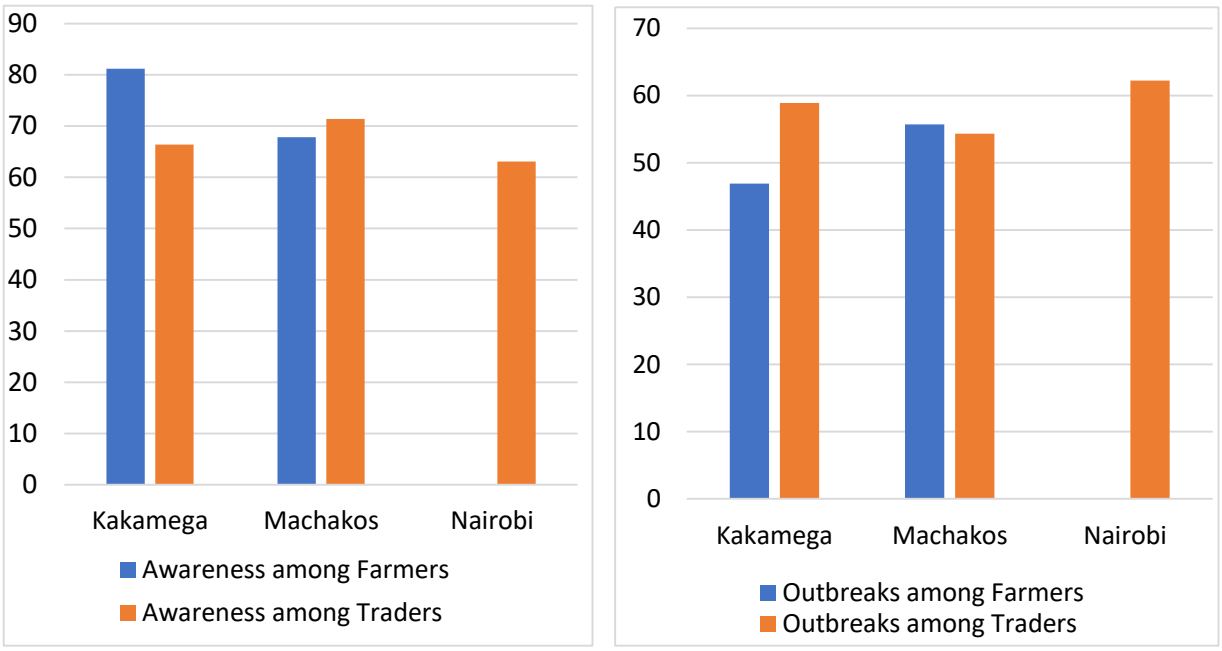

Figure 23: Comparison between ND awareness and outbreaks among farmers and traders.

Source: Survey Data (2018)

4.5.5.4 Response measures used by farmers during outbreaks

Results from Figure 24 show that majority of the farmers (64 percent) in the pooled sample responded to ND outbreak by seeking treatment and vaccination of the birds. During outbreaks, farmers would seek advices from agrovets regarding treatment solutions and vaccines, immediately farmers noticed symptoms consistent with ND. Vaccination after outbreaks against ND is not an appropriate measure as it does not treat an already infected flock. Some farmers did not have any response measures during outbreak of the disease. They would let the birds die, and salvage the remaining birds after the outbreaks.

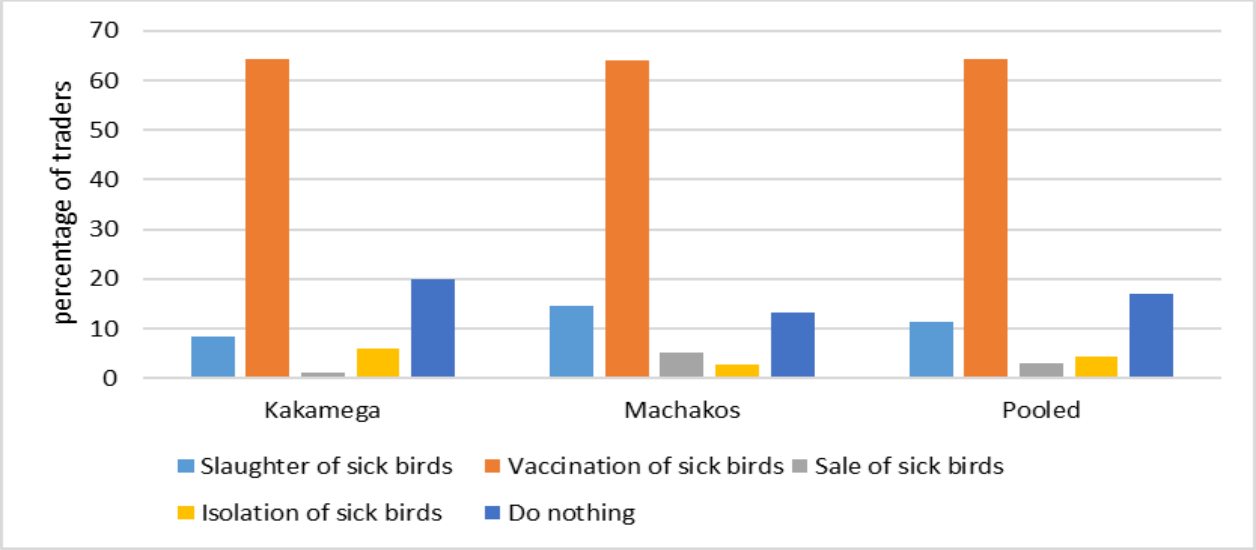

Figure 24: Disease response measures among chicken farmers

Source**:** Survey Data (2018).

4.5.5.5 Response measures used by traders during outbreaks

As highlighted in Figure 25, more than a third of the traders (35.2 percent) in the pooled sample responded to ND outbreak by seeking treatment and vaccination of the birds. This response measure was common among traders in both Counties, though the proportion was slightly higher among traders in Machakos County (40.7 percent) compared to Nairobi (35.7 percent) and Kakamega (30.8 percent). During outbreaks, traders would seek treatment solutions and vaccines immediately they noticed symptoms consistent with ND among their flock. There was also the slight use of other response measures such as the slaughter of sick birds. According to Otim et al. (2007), the sale and salvage slaughter are some of the actions taken during suspected ND outbreaks.

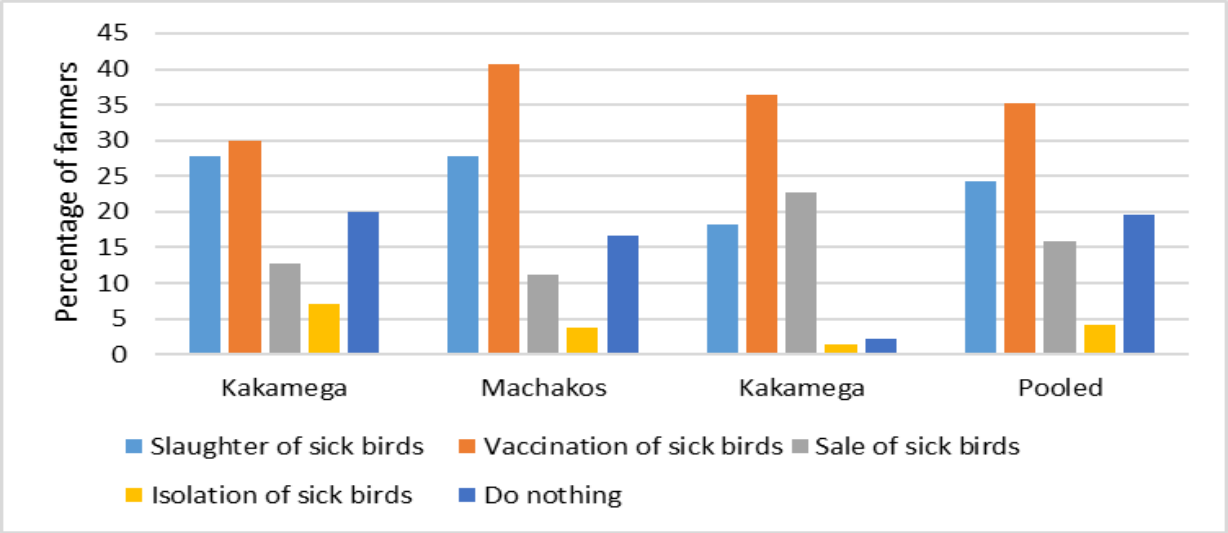

Figure 25: Disease response measures used by chicken traders during outbreaks

Source: Survey Data (2018).

4.6 Factors influencing awareness of ND

In this section, binary logit regression model was used to determine the socio- economic and institutional factors that were hypothesized to influence the likelihood of chicken farmers and traders being aware of ND in Kenya.

4.6.1 Factors influencing Farmers' awareness of ND

Table 15 indicates the factors that were hypothesized to influence farmer's probability of being aware of ND. These variables were used in the binomial logit model. Farmers who were able to positively identify ND based on the signs and symptoms consistent with ND were deemed to be aware of the disease. It was hypothesized that farmers' probability of being aware of ND is a function of a set of factors that included region, household type, gender, farming experience, motive of rearing, access to extension, access to training, access to credit, group membership, age, education level and marital status.

Region was found to have a negative effect on farmers being aware of ND in Kakamega at 10 percent. However, this was contrary to what was expected. Farmers in urban locations were less likely to be aware of ND compared to farmers in rural locations. This can be attributed to the fact that in most urban households, poultry is not a prioritized enterprise whereas in rural areas, chicken production is an important enterprise in terms of income and food provision.

As expected, household type had a positive effect on awareness of ND among farmers in Kakamega as well as in the pooled sample. Likelihood of awareness was higher in female headed households compared to male headed households. In SSA, chicken plays an integral part in female headed households where women are involved in the daily husbandry and management of the chicken. This increases the likelihood of women headed households being aware of ND. According to Mack et al. (2005) and Islam et al. (2015), poultry is mainly owned and managed by women and are essential in female headed households. This increases the likelihood of awareness.

Access to training had a positive effect on farmers' awareness of ND in Machakos County as well as for the pooled sample. Farmers who accessed trainings on animal health were likely to be aware of the disease compared to those who had not accessed. Trainings on animal health are relevant as they provide farmers with the knowledge and information regarding disease, the symptoms, prevention and treatment measures. This makes the farmers more aware of the disease compared to those who lacked access. The null hypothesis is therefore rejected and it is concluded that training had a significant effect on farmers' awareness of ND.

Table 15: Factors influencing farmers' awareness of ND

	Kakamega (n = 192)		Machakos (n = 140)		Pooled Farmers (n = 332)		
Variables	**Coef.**	***p*-value**	**Coef.**	***p*-value**	**Coef.**	***p*-value**	**Dy/dx**
Region	-1.173	0.044**	0.954	0.183	-0.106	0.799	-0.017
Household type	1.341	0.088*	1.157	0.105	1.222	0.016**	0.201
Gender	-0.238	0.604	-0.414	0.365	-0.226	0.458	-0.037
Experience	-0.660	0.167	0.831	0.107	-0.037	0.906	-0.006
Motive	-0.574	0.201	-0.223	0.661	-0.481	0.118	-0.079
Extension	0.960	0.073	0.269	0.596	0.683	0.047*	0.112
Access to training	0.009	0.983	1.369	0.010***	0.728	0.025**	0.120
Access to credit	0.335	0.54	1.557	0.017**	0.858	0.030**	0.141
Group membership	1.333	0.004***	0.128	0.786	0.604	0.050*	0.099
Age	0.238	0.595	0.316	0.497	0.096	0.742	0.015
Education level	0.368	0.421	0.075	0.864	0.145	0.621	0.022
Marital status	1.227	0.048**	0.106	0.871	0.720	0.093*	0.118
Constant	-0.065	0.943	-0.894	0.36	-0.250	0.688	
Log likelihood	**-60.415**		**-37.944**		**-107.913**		
Pseudo R^2	**0.183**		**0.1923**		**0.188**		
Prob> chi2	**0.034**		**0.026**		**0.002**		
***F*-value from Chow test: 4.36**							

Note: ***, **, * denote significance at 1, 5 and 10 percent respectively.
Source: Survey Data (2018).

As expected, credit had a positive effect on awareness of ND among farmers in both Machakos and the pooled sample. Farmers who had access to credit were more likely to be aware of ND compared to those without access. Access to both formal and informal credit is considered a factor that influences probability of awareness. Farmers seek credit as a source of additional income to invest in proper practices to address the challenge of disease. This makes farmers with access to credit more aware of ND.

Group membership had a positive effect on ND awareness among farmers in Kakamega and the pooled sample. Farmers who belonged to groups were likely to be more aware of ND compared to those who did not belong to groups. This was expected because, through collective action, group members benefit from access to information regarding chicken production and group

trainings on production. The presence of strong farmer groups exposes farmers to issues relating to animal health. According to Branckaert et al. (2000) and Ochieng et al. (2012), groups enhance collective action as members benefit from information sharing, group-based vaccination, input purchase and advocacy for better practices. This increases awareness among the farmers.

Marital status had a positive effect on ND awareness among farmers in Kakamega as well as the pooled sample. Married farmers were more likely to be aware of ND compared to those not married. Married farmers in Kakamega have the incentive to take part in poultry management due to the cultural expectations that married people especially women should rear and manage poultry in their households. Through the regular engagement in chicken production in their households, the farmers become aware of risks associated with chicken production such as diseases like ND. This increases their likelihood of being aware of ND. Marriage is considered' as a formal organization with an established structure of information flow, comparable to that of membership to a formal group, that increases sharing of information among its members.

4.6.2 Factors influencing Traders' awareness on ND

Table 16 indicates the factors that were hypothesized to influence farmer's probability of being aware of ND. As previously stated, traders who were able to positively identify the disease as ND based the signs and symptoms consistent with ND was deemed to be aware of the disease. Trading experience, group membership, age, gender and marital status were found to significantly influence ND awareness in the pooled sample. In Kakamega, group membership and age were found to significantly influence ND awareness. In Machakos, group membership, gender and marital status were found to significantly influence awareness. In Nairobi County, group membership and gender were found to influence ND awareness.

Table 16: Factors influencing ND awareness among chicken traders

	Kakamega (n = 119)		Machakos (n = 105)		Nairobi (n = 112)		Pooled Traders (n = 336)		
Variables	**Coef.**	***p*-value**	**Coef.**	***p*-value**	**Coef.**	***p*-value**	**Coef.**	***p*-value**	**Dy/dx**
Trade description	-0.253	0.722	1.044	0.198	0.356	0.705	0.455	0.279	0.074
Licensing	0.438	0.746	0.674	0.349	-0.062	0.94	0.693	0.105	0.114
Experience	0.59	0.282	0.496	0.475	0.455	0.448	0.576	0.073*	0.094
Training	0.408	0.499	-0.237	0.813	-0.533	0.418	0.120	0.757	0.019
Group membership	1.73	0.003***	1.47	0.040**	1.66	0.004***	1.34	0.000***	0.221
Credit	-0.70	0.283	0.389	0.599	-0.44	0.467	-0.387	0.28	-0.063
Age	0.046	0.038*	-0.024	0.47	0.024	0.225	0.023	0.053*	0.003
Gender	0.673	0.319	1.33	0.057*	1.200	0.022*	1.05	0.001***	0.173
Education	0.67	0.226	-1.11	0.121	0.136	0.802	0.074	0.808	0.012
Marital status	0.811	0.332	2.89	0.001***	1.000	0.113	1.39	0.000***	0.23
Market location	0.289	0.587	0.620	0.412	-0.471	0.729	0.110	0.751	0.018
Constant	-0.897	0.61	2.635	0.109	1.432	0.505	-0.019	0.981	
Log likelihood	**-53.863**		**-36.306**		**-50.164**		**-149.723**		
Pseudo R^2	**0.185**		**0.259**		**0.183**		**0.189**		
Prob> chi2	**0.050**		**0.008**		**0.016**		**0.000**		
***F*-value from Chow test: 6.36**									

Note: ***, **, * denote significance at 1, 5, and 10 percent, respectively.

Source: Survey Data (2018).

Experience in chicken marketing had a positive effect on ND awareness among chicken traders in Kakamega County. Traders who had more than 5 years in chicken trading were likely to be more aware of ND compared to those with less than 5 years. This can be attributed to the fact that traders with more years of trading experience are more exposed and efficient in marketing hence have access to information regarding aspects like diseases and marketing practices.

As expected, group membership had a positive effect on ND awareness among chicken traders across the three Counties. Traders who belonged to groups were likely to be more aware of ND compared to those who did not belong to groups. Group membership enhances collective action, as members benefit from information sharing regarding better chicken trading practices as well as access group trainings regarding diseases and improved practices. This exposes traders to issues relating to animal health.

Age of the trader had a positive influence on awareness on ND among chicken traders in both Kakamega and the pooled sample. Older traders were more likely to be aware on Newcastle disease compared to younger traders. Older farmers have more experience in marketing and trading activities. This gives the older traders the prospect of being more aware of the challenges facing chicken marketing and trade like ND, compared to the young farmers. This makes them more aware of ND. The null hypothesis is rejected and we conclude that age had a significant effect on ND awareness among traders.

As expected, gender had a positive effect on awareness on ND among farmers in Machakos and Nairobi as well as in the pooled sample. Likelihood of awareness was higher among male traders compared to female traders. Chicken trade and marketing is a male dominated enterprise. This increases the likelihood of men being aware of ND. According to Ochieng et al. (2013) and Bett et al. (2009), men are involved in the marketing of chicken. This increases the likelihood of

awareness among male traders. The null hypothesis is therefore rejected and we conclude that gender had a significant effect on ND awareness among traders.

Marital status had a positive effect on ND awareness among traders in Machakos as well as the pooled sample. Married traders were more likely to be aware of ND compared to those not married. Married traders have more family responsibilities therefore engage more in chicken trade to supplement their income and provide for their families' extra needs. Through the regular engagement in trade, the traders become more aware of diseases affecting chicken like ND.

4.7 Effects of choice of chicken value chain practices on perceptions of ND outbreaks

In this section, a Likert scale was used to determine farmers' and traders' perception on ND during outbreaks. The Likert scale comprised 5 levels of perception: very severe, severe, neutral, not severe and not very severe. The practices used by chicken farmers and traders were identified and the chi-square test used to determine the association between ND perception and the practices. Practices with chi-square values of $p<0.05$ were considered significant.

4.7.1 Effects of choice of chicken management practices on perceptions of ND outbreaks

Table 17 shows the relationship between chicken management practices used by farmers and the perception on ND during the outbreaks. At 5 percent level of significance, there was association between perception on ND and the channel used to source for birds by farmers. As revealed, most farmers who had experienced ND outbreak perceived the disease as very severe. Majority of the said farmers relied on other channels such as middle men and other traders for their stock, compared to the direct channel. This shows that farmers who used other forms of channels were likely to experience very severe outbreaks of ND. According to Okello et al. (2010), the use of multiple middle men is also a common channel used by to source chicken, providing an avenue for disease outbreaks and spread.

Table 17: Association between chicken management practices and ND perception

Practices	1	2	3	4	5	Total	Pr values
Breed composition							
0= Single breed	102	30	5	4	4	145	P.chi2 = 2.8318
1= Multiple breeds	7	1	0	1	0	9	Pr = 0.586
Flock size							
0= 50 birds and below	87	28	5	3	4	127	P.chi2 = 5.518
1= Above 50 birds	22	3	0	2	0	27	Pr = 0.239
Age of birds							
0= Same age	63	21	5	1	1	92	P.chi2 .= 7.1830
1= Mullti age	46	10	0	4	3	62	Pr = 0.127
Market channels							
0= Otherwise	62	21	5	1	1	90	P.chi2 .= 9.6530
1= Direct channel	47	10	0	4	3	64	Pr = 0.047**
Form of shelter							
0= Otherwise	46	12	4	1	2	65	P.chi2 .= 4.1936
1= Special	63	19	1	4	2	89	Pr = 0.380
Frequency of cleaning							
0= Otherwise	38	25	3	3	2	112	P.chi2 .= 1.0560
1= Daily	71	6	2	2	2	42	Pr = 0.901
Means of feeding							
0= Otherwise	64	22	3	5	1	95	P.chi2 .= 6.9265
1= Use of feed troughs	45	9	2	0	3	59	Pr = 0.140
Mode of administering							
0= Outside shelter	88	22	4	2	3	119	P.chi2 .= 5.4335
1= Inside shelter	21	9	1	3	1	35	Pr = 0.246
Record keeping							
0= No	94	27	5	1	3	130	P.chi2 .= 17.4076
1= Yes	15	4	0	4	1	24	Pr = 0.002***
Biosecurity							
0= No	20	1	2	0	2	25	P.chi2 .= 10.6155
1= Yes	89	30	3	5	2	129	Pr = 0.031**
Vaccination of flock							
0= No	36	6	1	2	3	48	P.chi2 .= 6.2467
1= Yes	73	25	4	3	1	106	Pr = 0.181
Production system							
Free range	71	18	4	1	1	95	
Intensive	5	3	0	1	0	9	P.chi2 .= 14.8064
Semi intensive	20	8	0	2	1	31	Pr = 0.252
Mixed	13	2	1	1	2	19	

Note: ***, **, * denotes significance at 1, 5 and 10 percent respectively.

1, 2, 3, 4, 5 perception as very severe, severe, don't know, not severe, not very severe respectively.

Source: Survey Data (2018).

Record keeping had an association with perception on ND by farmers. Most farmers who had experienced ND outbreaks perceived the disease as very severe. Similarly, most of the farmers who perceived the disease as very severe did not keep farm records. This shows that most farmers who did not practice recode keeping were likely to perceive the disease as very severe during outbreaks.

4.7.2 Effects of choice of marketing practices on traders' perception of ND outbreaks

Table 18 shows the relationship between the chicken marketing practices used by traders in LBMs and the perception on ND during outbreaks. Form of birds had an association with perception on ND among chicken traders. Most chicken traders perceived ND as very severe. Similarly, majority of the farmers who regarded the disease as very severe sold live birds in the market. Traders who sold live chicken were generally likely to experience more ND outbreaks compared to traders who sold slaughtered chicken. Live sick birds are considered a means of ND virus. According to Okello et al. (2010), the movement of live birds poses a challenge in preventing outbreaks. From this, farmers who sell live birds are likely to experience very severe outbreaks compared to those who sell slaughtered birds.

Mode of transportation had an association with perception on ND among chicken traders. Most chicken traders perceived ND as very severe. Similarly, the use of motor vehicles, bicycles and motorcycles were the most common modes of transport used. Traders who used motor vehicle, bicycles and motorcycles to transport chicken were likely to perceive ND as very severe during outbreaks, compared to other modes. In chicken marketing, there is lack of specialized transport systems. The lack of measures during transportation results in the greater exposure of birds to

infectious disease. Nyaga (2007) highlights that transportation is considered a source of biosecurity breach thus influencing outbreaks of diseases like ND.

Table 18: Association between chicken marketing practices and ND perception

	Perception						
	1	**2**	**3**	**4**	**5**	**Total**	**Pr values**
Breed composition							
0= No	28	3	1	2	0	34	P.chi2 .= 6.5262
1= Yes	103	35	1	12	6	153	Pr = 0.163
Sale in other markets							
0= No	31	10	0	8	1	50	P.chi2 .= 8.2725
1= Yes	99	28	2	6	5	140	Pr = 0.82
Source of birds							
0= Otherwise	41	12	1	9	5	68	P.chi2 .= 12.4940
1= Direct channel	90	26	1	5	1	125	Pr = 0.014**
Form of birds sold							
0= Slaughtered	21	1	0	1	3	26	P.chi2 .= 12.1169
1= Live	110	37	2	13	3	165	Pr = 0.017*
Transportation							
Foot	6	6	0	0	0	12	
Motorcycle/ bicycle	53	11	1	12	5	82	P.chi2 .= 28.2157
Motor vehicle	67	19	1	1	0	88	Pr = 0.005***
Others	5	2	0	1	1	9	
Market type							
0= Otherwise	15	1	0	4	1	21	P.chi2 .= 7.6078
1= Open air	116	37	2	10	5	170	Pr = 0.107
Origin of birds							
0= Outside county	95	19	0	4	1	21	P.chi2 .= 8.6073
1= Within county	36	19	2	10	5	170	Pr = 0.072*
Sale of other poultry							
0= No	95	27	1	12	6	141	P.chi2 .= 4.0054
1= Yes	36	11	1	2	0	50	Pr = 0.405
Mix of birds							
0= No	11	0	0	0	0	11	P.chi2 .= 5.3461
1= Yes	120	38	2	14	6	180	Pr = 0.245
Designated slaughter							
0= No	90	37	2	5	1	135	P.chi2 .= 30.8443
1= Yes	41	1	0	9	5	50	Pr = 0.0000***
Slaughter of birds							
0= No	66	27	2	3	2	100	P.chi2 .= 25.2707
1= Yes	65	11	0	0	4	90	Pr = 0.001***
Disposal of waste							
0= No	75	32	2	3	1	113	P.chi2 .= 24.1817
1= Yes	56	6	0	11	5	78	Pr = 0.023**
Biosecurity							

Note: ***, **, * denotes significance at 1, 5 and 10 percent respectively.

1, 2, 3, 4, 5 perception as very severe, severe, don't know, not severe, not very severe respectively.

Source: Survey Data (2018).

Origin of birds had an association with ND perception among chicken traders. Most of the traders who had experienced ND outbreaks perceived the disease as very severe. Similarly, most of farmers who perceived the disease as very severe sourced their birds from other Counties, compared to within their Counties of trade. Traders who sourced their birds from other Counties were likely to perceive the disease as very severe. Traders who source from other Counties mostly rely on brokers and middle men for their source hence the likelihood of getting sick birds due to the use of multiple middle men. Mandefro et al. (2012) highlights that birds from different origin create avenue for dispatching and exchange of pathogens.

Availability of a designated slaughter point within markets had an association with ND perception among traders. Most of the traders sold their chicken in markets that lacked designated slaughter points. Consequently, most of the traders who sold their chicken in markets that lacked designated slaughter points perceived ND as very severe during outbreaks. This reveals that traders who sold chicken in markets that lacked designated slaughter points were likely to experience very severe outbreaks. Lack of designated slaughter point results in poor hygiene practices when traders slaughter birds within the market. Poor waste disposal of feathers and chicken parts from slaughtered birds provide an avenue for disease spread. Mulisa et al. (2014) reveals that inappropriate disposal of carcasses is factors associated with outbreaks. This may result in very severe outbreaks.

Disposal of waste was found to have an association with ND perception among traders. Most of the traders did not practice the disposal of waste. Consequently, most of the traders who did not practice the disposal of waste perceived ND as very severe. This reveals that farmers who did not practice waste disposal were likely to perceive the disease as very severe during outbreaks. Lack of and poor disposal of chicken waste such as droppings, feathers and chicken parts from

slaughtered birds provide an avenue for disease spread. Birds come in contact with wastes that form intermediate hosts of various diseases, contributing to very severe outbreaks. Mulisa et al. (2014) reveals that inappropriate disposal of infected birds, carcasses and fecal matter are factors associated with outbreaks.

Provision of housing to chicken within the market place was also found to have an association with ND perception among traders. In most live bird markets, traders do not provide housing or provide makeshift houses and cages to confine the birds. This provides and avenue for spread of viruses within the market place as the birds come into contact with waste, external parasites and disease carrying pathogens This increases the likelihood of disease outbreaks and mortalities

4.8 Effects of production systems and management practices on frequency of ND outbreaks

A PRM was used to estimate the effects of production systems and management practices that were hypothesized to influence on the frequency of ND outbreaks. Farmer attributes were also included in the model to estimate whether there would be a change and improvement in the results. The estimated pseudo r values indicated an improvement in the results after the attributes were included (*See Table 19*), compared to the results without the attributes (*See Table 20*).

The pseudo-R^2 values for the PRMs in this study were low (See table 19 and 21). According to Mittlbock and Heinzl (2005), the PRM is often used as approximation for the logistic regression model in analyzing epidemiological data sets. However, R-squared measure for the logistic regression quantifies the predictability of single events, whereas in the PRM the R-squared measure quantifies the predictability of event rates. Therefore, there is considerable amount of latent arbitrariness which in the end limits the sensible use of the Poisson R-squared measure in epidemiological settings.

Table 19: Management practices, farmer attributes and their effects on frequency of ND outbreaks

	Kakamega (n = 192)		Machakos (n = 140)		Pooled Farmers (n = 332)		
Practices	**Coef.**	***p*-value**	**Coef.**	***p*-value**	**Coef.**	***p*-value**	**Dy/dx**
Breed composition	-.039	0.011**	-.007	0.810	-.012	0.594	-.010
Flock size	.094	0.448	-.483	0.135	.166	0.064*	.138
Age of birds	.138	0.128	.136	0.134	.124	0.049**	.1036
Source of birds	-.092	0.309	-.137	0.035**	-.099	0.117	-.083
Form of housing	-.391	0.086*	-.369	0.228	-.428	0.007***	-.356
Housing composition	-.021	0.374	-.019	0.349	-.024	0.099*	-.020
Frequency of cleaning	-.481	0.055*	-.337	0.015**	-.191	0.096*	-.055
Means of feeding	-.019	0.292	-.022	0.273	-.018	0.160	-.015
Mode of administering feed	-.002	0.911	-.031	0.215	-.012	0.426	-.010
Record keeping	-.023	0.306	-.069	0.721	-.066	0.605	-.158
Screening of birds	-.308	0.051*	-.037	0.093*	.030	-0.035**	-.025
Vaccination	-.039	0.311	-.007	0.810	-.012	0.594	-.010
Production system							
Intensive	-.266	0.465	-1.183	0.261	-.343	0.295	-.268
Semi intensive	-.391	0.162	.285	0.312	-.102	0.594	-.089
Mixed	-.520	0.152	-.733	0.081*	-.581	0.025**	-.406
Farmer attributes							
Extension access	-.057	0.001***	-.004	0.029**	-.034	0.009***	-.028
Experience	.021	0.260	-.012	0.532	.009	0.481	.008
Training on animal health	.026	0.161	.004	0.827	.015	0.266	.013
Gender	-.010	0.553	.025	0.168	.005	0.672	.004
Constant	.167	0.844	.755	0.464	.416	0.426	
Log likelihood	**-179.369**		**-142.245**		**-336.649**		
Pseudo R^2	**0.139**		**0.133**		**0.099**		
Prob> chi2	**0.000**		**0.001**		**0.000**		
AIC	**398.739**		**324.489**		**713.299**		
***F*-value from Chow test: 1.75**							

Note: ***, **, * denotes significance at 10, 5 and 1 percent respectively

Source: Survey Data (2018).

Table 20: Chicken marketing practices and their effects on frequency of ND outbreaks

	Kakamega (n = 192)		Machakos (n = 140)		Pooled Farmers (n = 332)		
Practices	**Coef.**	***p*-value**	**Coef.**	***p*-value**	**Coef.**	***p*-value**	**Dy/dx**
Breed composition	-.039	0.311	-.011	0.753	-.002	0.936	-.004
Flock size	-.094	0.448	-.089	0.434	-.134	0.079*****	-.139
Age of birds	.138	0.128	.141	0.113	.065	0.030******	.112
Source of birds	-.092	0.309	-.090	0.310	-.048	0.106	-.095
Form of housing	.391	0.086*****	.560	0.010**	.397	0.005*******	.413
Housing composition	-.021	0.374	-.027	0.225	-.022	0.079*****	-.023
Frequency of cleaning	.481	0.055*****	.584	0.018**	.043	0.759	.059
Means of feeding	-.019	0.292	-.023	0.204	-.022	0.067*****	-.019
Mode of administering feed	-.002	0.911	-.014	0.520	-.021	0.120	-.018
Record keeping	-.308	0.051*****	-.377	0.012**	-.211	0.058*****	-.194
Biosecurity	.023	0.306	.034	0.114	.028	0.023******	.029
Vaccination	-.039	0.311	-.011	0.753	-.002	0.936	-.004
Production system							
Intensive	-.266	0.465	-.304	0.396	-.343	0.295	-.289
Semi intensive	-.391	0.162	-.341	0.214	-.102	0.594	-.013
Mixed	-.520	0.152	-.576	0.102	-.581	0.025******	-.403
Constant	-.230	0.764	0.588	0.564	-.291	0.271	-.289
Log likelihood	**-188.153**		**-143.810**		**-342.945**		
Pseudo R^2	**0.097**		**0.123**		**0.082**		
Prob> chi2	**0.000**		**0.000**		**0.000**		
AIC	**406.305**		**317.620**		**715.895**		

Note: ***, **, * denotes significance at 10, 5 and 1 percent respectively

Source: Survey Data (2018).

Breed composition had a negative effect on ND frequency in Kakamega. Farmers who reared single breeds of chicken were likely to experience less ND outbreaks compared to those who reared multiple breeds. Some breeds like the exotic and cross breeds are more susceptible to diseases compared to indigenous breeds. The mixing of multiple breeds together increases the risk of exposure to disease and spread of disease within the flock, increasing the frequency of outbreaks Similar results were reported by Munyua et al. (2012) which reckons that trading multiple breeds in the same market could promote disease transmission among birds.

At 10 percent level of significance, flock size was found to have a positive effect on the frequency of ND outbreaks in the pooled sample. Farmers with large flock sizes were likely to experience more outbreaks of ND compared to those with smaller flock sizes. Stocking density increases the likelihood of disease spread from one bird to others. According to Tomo (2009), ND is transmitted through physical contact, thus birds in large flock sizes have a higher chance of infecting each other because of contact. Adene and Ogutande (2006) also report that smaller flock sizes do not permit adequate contact among infected birds for disease spread.

Age of the birds was found to have a positive effect on the frequency of ND outbreaks among farmers in the pooled sample. Farmers with multi-aged birds were likely to experience more outbreaks of ND compared to those with same-aged birds. A mix of young birds/ chicks together with older birds creates an environment for disease spread as young birds are more susceptible to diseases. Multi aged birds also create challenges for effective administration of vaccines within the flock, compared to single-aged flocks. According to Dimitrov et al (2017), multi-age birds of village flocks is one of the impediments to preventing outbreaks of ND.

Marketing channels had a positive effect on the ND frequency in Machakos (5 percent) as well as in the pooled sample. As compared to direct sourcing of chicken, traders who used other channels were likely to experience more outbreaks of ND. Marketing of chickens in live bird markets is generally characterized by undefined market channels where birds are sourced from diverse sources. The use of multiple middle men is also a common channel used by traders to source chicken. This provides an avenue for disease outbreaks. Akinwumi et al. (2009) documents that collectors and distributors mix poultry and deliberately sell sick birds to retailers thus encouraging outbreaks of disease. The null hypothesis is rejected and it is concluded that marketing channels had a significant effect on the frequency of ND outbreaks.

Form of housing was found to have a negative effect on the frequency of ND outbreaks in Kakamega as well as the pooled sample. Farmers who provided special housing for their flock were likely to experience more outbreaks of ND compared to those who provided other forms such as makeshift shelters or shared shelters with the birds. Housing of chicken under special shelters reduces the risk of birds being exposed to disease causing pathogens. Farmers with undefined housing are likely to experience more outbreaks as the bird generally come into contact with disease carrying pathogens. According to Njagi (2008), good housing reduces disease transmission by reducing contact of chicken with infectious agents. The null hypothesis that housing had no significant effect on the frequency of ND outbreaks is therefore rejected and we conclude that housing had a significant effect on the frequency of ND outbreaks.

Flock composition under housing had a negative effect on the frequency of disease outbreaks in Kakamega. Farmers who separated their flock according to the age or the sex of the birds were likely to experience lesser ND outbreaks compared to those who did not separate their flock. Younger birds are often considered more susceptible to disease compared to older birds. A mix of birds in the shelter provides avenues for disease spread to the susceptible flock. Separation of flock reduces the likelihood of birds contracting ND hence a reduction in the frequency of outbreaks. Kusina et al. (2001) highlights that the existence of various age groups in the flock may contribute to disease spread as younger birds are more susceptible to diseases.

The frequency of cleaning chicken shelter was found to have a negative effect on the frequency of ND outbreaks in both Kakamega and Machakos. Farmers who frequently cleaned the shelter for chicken on a daily basis experienced less outbreaks compared to those who did not. Routine cleanliness reduces the risk of disease spreading pathogens coming into contact with birds in the

shelter. Odemero and Okpara (2016) report that adherence to practices such as routine cleanliness will reduce mortality from diseases.

Screening of birds had a negative effect on the frequency of ND in Machakos as well as the pooled sample. Farmers who screened their birds for disease symptoms were likely to experience less outbreaks compared to those who did not screen birds. The screening of birds enables farmers to identify birds which exhibited signs and symptoms consistent with diseases like ND. The absence of such measures and flaws in the measures lead to disease introduction and outbreaks. Aila et al. (2014) found that the dominance of indigenous poultry systems with such limited measures provides a challenge in preventing poultry disease outbreaks in Kenya. The null hypothesis is rejected and it is concluded that screening of birds had a significant effect on the frequency of ND outbreaks.

Production system had a negative effect on the frequency of ND in Machakos and the pooled sample. Compared to the free-range production system, farmers who used a mixed system of production were likely to experience less outbreaks of ND. In the free-range system, birds are exposed to disease causing agents due to the scavenging nature of the birds as the movement of birds is rarely controlled. However, in the mixed system, birds are at times allowed to scavenge but the movement is regulated. This reduces the likelihood of birds coming into contact with pathogens that may spread diseases. This reduces the frequency of ND outbreaks.

Extension access was found to have a negative effect on the frequency of ND outbreaks in all the two counties. Farmers who had access to extension services were likely to experience less outbreaks of ND, compared to those without access. Extension enables individuals to access information regarding diseases, thereby increasing farmers' knowledge on disease detection Regular visits enhance the adoption of management intervention packages as it provides

information, skills and knowledge regarding aspects like disease control (Ochieng et al., 2011). Akintunde and Adeoti (2016) also reported that extension increases the knowledge of disease prevention. This helps to reduce the frequency of ND outbreaks.

4.9 Effects of transportation and marketing practices on frequency of ND outbreaks

Table 21 shows the production systems and management practices that were hypothesized to have an influence on the frequency of ND outbreaks. Trader attributes were also included in the model to estimate whether there would be a change and improvement in the results. The estimated pseudo R values indicated an improvement in the results after the attributes were included (*See Table 21*), compared to the results without the attributes (*See Table 22*).

As expected, breed composition had a negative effect on ND frequency in Kakamega, Nairobi as well as in the pooled sample. Traders who sold single breeds of chicken were likely to experience less ND outbreaks compared to those who sold multiple breeds. Mixing of different breeds increases the likelihood of outbreaks occurring as it creates a challenge in disease monitoring. This increases the risk of disease exposure which increases the frequency of disease. Similar results were also reported by Munyua et al. (2012).

Marketing channels had a positive effect on the ND frequency in Kakamega, Machakos as well as in the pooled sample. As compared to direct sourcing of chicken, traders who used other channels were likely to experience more outbreaks of ND. Marketing of chickens in live bird markets is generally characterized by undefined market channels where birds are sourced from diverse sources. The use of multiple middle men is also a common channel used by traders to source chicken. Akinwumi et al. (2009) documents that collectors and distributors mix poultry and deliberately sell sick birds to retailers thus encouraging outbreaks of disease.

Table 21: Chicken marketing practices and trader attributes, and their effect on frequency of ND outbreaks

	Kakamega (n =119)		Machakos (n =105)		Nairobi (n =112)		Pooled Traders (n =336)		
Variable	**Coef.**	***p*-value**	**Coef.**	***p*-value**	**Coef.**	***p*-value**	**Coef.**	***p*-value**	***Dy/dx***
Breed composition	.677	0.019**	.069	0.839	.723	0.004***	.496	0.001***	.586
Sale in other markets	.016	0.491	.007	0.806	-.001	0.706	.006	0.589	.007
Market channel	-.043	0.028**	-.055	0.024**	-.005	0.782	-.028	0.008***	-.033
Form of birds	1.043	0.988	-.102	0.030**	-.012	0.511	-.032	0.065*	-.037
Transportation mode									
Motorcycle/bicycle	.936	0.016**	.657	0.124	.785	0.259	.090	0.695	.102
Motor vehicle	-.329	0.279	.332	0.427	.368	0.603	.123	0.569	.141
Others	-.481	0.434	.116	0.820	1.277	0.110	-.075	0.805	-.078
Market type	.020	0.826	-.028	0.617	0.312	0.312	-.026	0.166	-.030
Origin of birds	-.031	0.056*	-.027	0.350	0.073*	0.073*	-.024	0.028**	-.028
Sale of other poultry species	.002	0.924	.041	0.263	0.092	0.009***	.028	0.014**	.033
Mix of birds	.117	0.014**	.033	0.367	0.318	0.318	.058	0.004***	.069
Designated slaughter point in the market	-.513	0.304	-.404	0.531	0.901	0.901	-.039	0.822	-.047
Slaughter of birds in market	.023	0.515	.113	0.020**	0.033**	0.033**	.033	0.035**	.039
Waste disposal	-.135	0.001***	.001	0.986	0.692	0.692	-.021	0.194	-.025
Screening of birds	-.014	0.435	.001	0.975	0.884	0.884	-.003	0.787	-.003
Housing of birds	.038	0.060*	.046	0.141	0.364	0.364	.031	0.010**	.037
Trader Attributes									
Access to training	-.005	0.808	-.058	0.047**	-.006	0.816	-.006	0.638	-.007
Licensing	-.084	0.021**	-.012	0.559	-.017	0.552	-.001	0.896	-.002
Trade description	-.008	0.712	-.034	0.163	-.009	0.700	-.012	0.355	-.014
Gender	.017	0.477	-.014	0.544	-.050	0.007***	-.028	0.009***	-.034
Constant	-.552	0.390	-.042	0.962	-1.133	0.252	-.239	0.522	.007
Log Likelihood	**-167.857**		**-124.019**		**-148.507**		**-479.449**		
Pseudo R^2	**0.166**		**0.105**		**0.124**		**0.071**		
Prob>Chi^2	**0.000**		**0.015**		**0.004**		**0.000**		
AIC	**379.713**		**292.039**		**341.015**		**1086.875**		
***F*-value from Chow test: 2.10**									

Note: ***, **, * denote significance at 10, 5 and 1 percent, respectively.

Source: Survey Data (2018).

Table 22: Marketing practices and their effect on frequency of ND outbreaks

	Kakamega (n =119)		Machakos (n =105)		Nairobi (n =112)		Pooled Traders (n =336)		
Variable	**Coef.**	***p*-value**	**Coef.**	***p*-value**	**Coef.**	***p*-value**	**Coef.**	***p*-value**	***Dy/dx***
Breed composition	.600	0.032**	.089	0.777	.673	0.005***	.489	0.001***	.578
Sale in multiple markets	.016	0.419	.009	0.732	-.006	0.736	.000	0.996	.000
Market channel	.041	0.033**	.038	0.086*	.011	0.539	.029	0.005***	.034
Form of birds	1.036	0.988	.089	0.041	.014	0.524	.034	0.050**	.039
Transportation mode									
Motorcycle/bicycle	.902	0.018**	.668	0.090*	.326	0.605	.004	0.985	.005
Motor vehicle	-.261	0.368	.263	0.500	-.228	0.722	-.042	0.834	-.050
Others	-.420	0.491	-.035	0.944	.648	0.376	-.138	0.640	-.156
Market type	.0282	0.757	-.048	0.373	-.010	0.680	-.018	0.321	-.021
Origin of birds	-.026	0.088*	-.015	0.602	-.046	0.040**	-.022	0.032**	-.025
Sale of other poultry species	.001	0.942	.028	0.432	.060	0.007***	.025	0.023**	.029
Mix of birds	.100	0.026**	.004	0.891	.033	0.359	.052	0.008***	.062
Designated slaughter point in the market	-.461	0.327	-.390	0.520	-.047	0.847	-.071	0.684	-.083
Slaughter of birds in market	.014	0.646	-.119	0.015**	-.069	0.082*	-.029	0.061*	-.034
Waste disposal	-.125	0.001***	.013	0.723	-.020	0.550	-.022	0.169	-.026
Screening of birds	-.010	0.555	-.001	0.953	-.002	0.917	-.002	0.858	-.002
Housing of birds	.041	0.039**	.033	0.257	.031	0.131	.031	0.009***	.036
Log Likelihood	**-170.668**		**-127.918**		**-153.652**		**-483.352**		
Pseudo R^2	**0.1521**		**0.076**		**0.093**		**0.064**		
Prob>Chi^2	**0.000**		**0.017**		**0.011**		**0.000**		
AIC	**375.336**		**289.836**		**341.304**		**1000.704**		

Note: ***, **, * denote significance at 10, 5 and 1 percent, respectively.

Source: Survey Data (2018).

Form of birds sold (live) had a positive effect on the frequency of ND in Machakos as well as in the pooled sample. Traders who sold live chicken were likely to experience more ND outbreaks compared to traders who sold slaughtered chicken. Live bird markets represent a major source of infected poultry as sick birds come into contact with susceptible birds. In Machakos, most markets are held on specific days hence the constant movement of traders and birds to the different markets. This increases the likelihood of disease spread from the infected to the susceptible birds. According to Okello et al. (2010), movement of live birds poses a challenge in preventing disease outbreaks. Similar results have also been reported by Alexander (2004) and Otim et al. (2007).

Mode of transportation had a positive effect on ND frequency in Kakamega (5 percent). Traders who used bicycles and motorcycles to transport chicken to the markets were likely to experience more outbreaks compared to those who used other modes. In chicken marketing, there is lack of specialized transport systems. Traders in Kakamega use bicycles and motorcycles so as to reduce on the cost of transporting the birds. More often than not, the birds are tied upside down and transported. The lack of proper measures to reduce spread of diseases during transportation results in the greater exposure of birds to infectious disease. According to Nyaga (2007), transportation is considered a source of biosecurity breach thus influencing outbreaks of diseases like ND. The null hypothesis that mode of transportation had no significant effect on the frequency of ND outbreaks is therefore rejected and we conclude that mode of transportation had a significant effect on the frequency of ND outbreaks.

The number of origin of birds was found to have a negative effect on ND frequency in Kakamega, Nairobi as well as the pooled sample. Traders who sourced their birds from a single origin were likely to experience less outbreaks of ND compared to those who sourced

their birds from multiple origins. Traders who source birds within the County of trade have more incentive to inspect birds for diseases compared to those who source from other Counties. Those who source from multiple origins mostly rely on brokers and middle men for their source hence the likelihood of getting sick bird. Sourcing of birds from a single origin helps reduce the frequency of ND outbreaks. According to Mandefro et al. (2012), birds from different origin create avenue for dispatching and exchange of pathogens. This is also consistent with Mulisa et al. (2014).

The sale of other poultry species was found to have positive effect on ND frequency in Nairobi as well as in the pooled sample. Traders who sold chicken together with other poultry species were likely to experience more outbreaks of disease compared to those who only sold chicken. Sale of other types of poultry together with chicken increases risk of disease transmission as some poultry varieties like ducks and pigeons are carriers of disease pathogens. The practice also leads to difficulties in disease monitoring hence increase in frequency of ND outbreaks within markets. This is consistent with Munyua et al. (2013) which highlights that sale of multiple poultry species leads to transmission of diseases.

Mixing of birds from different places was found to have an effect on ND frequency in Kakamega as well as in the pooled sample. Traders wo mixed birds from different sources together were likely to experience more outbreaks compared to traders who separated their flock. Birds from the different and unknown sources are mixed together during transportation and at the market, without screening. Traders also mix newly acquired bird together with those that have been in the market longer. This results in the interaction between sick birds and healthy birds, increasing the frequency of ND. According to Swai et al. (2011), mixing of chicken during transit and at point of sale in markets is a source of disease spread. This result is also consistent with those found by Munyua et al. (2012) and Ogali et al. (2018).

The slaughter of birds within the market was found to have a positive effect on the frequency of ND outbreaks among traders in Machakos, Nairobi as well as in the pooled sample. In most markets within Machakos and Nairobi, customers preferred to have their chicken slaughtered after purchase due to lack of time to prepare the chicken at home. In such markets, chicken is slaughtered in unhygienic environments where there is lack of clean equipment and running water to wash the carcasses. Heads, legs and intestines from the slaughtered birds are mixed together and sold to other traders and customers. The use of such practices and the lack of inspection during slaughter create a conducive environment for the spread of diseases like ND. Similar results have been reported by Carron et al. (2015).

Disposal of waste was found to have a negative effect on ND frequency in Kakamega at 1 percent level of significance. Traders who disposed waste were likely to experience less outbreaks compared to traders who did not. Poor disposal of chicken waste such as droppings, feathers and chicken parts from slaughtered birds provide an avenue for disease spread. Proper disposal of the wastes reduces the likelihood of birds coming into contact with disease spreading pathogens. This reduces the likelihood of disease spread hence reduced frequency of ND outbreaks. Njagi et al. (2010) and Mulisa et al. (2014) have highlighted inappropriate disposal of infected birds, carcasses and fecal matter was as factors associated with outbreaks.

Provision of housing to chicken within the market place was also found to have an effect on ND frequency in Kakamega as well as in the pooled sample. In most live bird markets, makeshift houses and cages are used to confine the birds. Such houses have poor sanitation and lack adequate ventilation. This provides an avenue for spread of viruses within the market place as the birds come into contact with waste, external parasites and disease carrying pathogens. This increases the likelihood of disease spread hence increase in the frequency of ND outbreaks.

At 5 percent level of significance, training was found to have a negative effect on the frequency of ND outbreaks experienced by traders in Machakos. Farmers who had undergone training regarding chicken marketing and handling were likely to experience less outbreaks of ND compared to those who had not undergone training. Trainings of traders on disease process, animal health and management practices are relevant in improving chicken production. According to Ochieng et al. (2013), trainings facilitate the adoption of management interventions in rural areas.

At 5 percent level of significance, licensing of trader was found to have a negative effect on the frequency of ND outbreaks in Kakamega. Traders who had licenses to practice chicken trading in LBMs were likely to experience less outbreaks of ND compared to those without licenses. Licensed traders have the incentive to comply with hygiene and sanitation standards hence employ implement biosecurity measures and better practices. Compliance with the standards results in reduced outbreaks of ND. Lack of compliance provides an avenue for disease spread hence increased outbreaks of diseases in LBMs.

As expected, gender of the trader had a negative effect on the frequency of ND outbreaks at 5 percent in Nairobi as well as the pooled sample. Male traders were likely to experience less outbreaks compared to female traders. Chicken trade and marketing is mainly a male dominated enterprise hence male traders are mostly involved in the day to day management and marketing of chicken. This increases the likelihood of men being aware of ND, its outbreaks and preventive measures, hence the use of better practices within the LBMs. This reduces the frequency of ND outbreaks. Ochieng et al. (2013) and Bett et al. (2009), report that men are involved in the marketing activities of chicken.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSIONS AND RECOMENDATIONS

5.1 Summary

The main objective of this study was to assess the effects of chicken value chain practices on ND outbreaks in Kenya. Results showed that chicken production was dominated by women while chicken trade and marketing was dominated by men. Results also show the low access to institutional and support services like credit, extension and trainings among the chicken farmers. Similarly, access to credit and trainings were also very low among the chicken traders.

The results also showed that most farmers and traders had attained above primary level of education. This highlights the relatively good literacy levels among the farmers and traders. The average land size in both Kakamega and Machakos was relatively small with farmers owning small parcels of land. This made poultry the appropriate enterprise of choice among the farmers due to its low space requirements. Farming experience among chicken farmers and trade experience among chicken traders was also high with majority of the respondents having practiced chicken farming and chicken trading for more than five years respectively.

The study also analyzed awareness among farmers and traders on Newcastle disease. The results showed that farmers were more aware of ND compared to the traders. Results from the logit model showed that the likelihood of chicken farmers being aware of ND in the pooled sample was positively influenced by household type, access to extension, access to training, credit access, group membership and marital status. Therefore, we rejected the null hypothesis and concluded that training influenced farmers' awareness on ND Results from the traders' logit model showed that the likelihood of chicken farmers being aware of ND in the pooled sample was positively influenced by experience, group membership, age, gender and marital status.

Similarly, the null hypothesis was rejected and it was concluded that gender and age significantly influenced traders' awareness on ND.

Chi-square results showed significant association between chicken management practices used by farmers such as source of chicken and record keeping and perception on ND during outbreaks. From these results, we rejected the null hypothesis and concluded that there was association between management practices used and perception on ND. Among chicken traders, results showed significant association between practices like market channels used, mode of transportation used to transport chicken, origin of birds, availability of designated slaughter point in markets, slaughter of birds within the markets and housing of birds and perception on ND during outbreaks. Similarly, the null hypothesis was rejected and it was concluded that there was association between marketing practices used and perception on ND.

This study also assessed the effect of production systems and management practices on the frequency of ND. PRM results showed that practices like flock composition under housing, form of housing, screening of birds, use of mixed production systems and vaccination had significant effects on the frequency of ND outbreaks. Based on the results, we rejected the null hypothesis and concluded that screening of birds and form of housing had negative effects on frequency of ND outbreaks. From the PRM to assess the effect of transportation and marketing practices on frequency of ND outbreaks, breed composition, market channel and origin of birds Sale of other poultry, mix of birds, slaughter of birds in the market place and housing of birds were found to have significant effects on the frequency of ND outbreaks. Therefore, the null hypothesis was rejected and it was concluded that transportation and market channels had significant effects of the frequency of ND.

5.2 Conclusion

The socioeconomic characteristics reveal the gender difference in chicken production and marketing with women dominating chicken production while men dominate chicken marketing. Access to institutional support among farmers and traders is very low. This shows the need to prioritize credit access, trainings and extension support for chicken farmers and traders so as to improve chicken production and marketing activities. There is need to increase credit access among farmers and traders through improve supply of credit product. There is also the need for investment in targeted trainings for farmers and traders so as to improve their capacity and knowledge regarding chicken.

From the results, farmers in sub Counties that had close proximity to the forest or migratory corridors for wild birds experienced more ND compared those in the other sub Counties. Farmers with large flocks also experienced more outbreaks compared to those with small flock sizes. From this, we can conclude that flock size and the close proximity to forests and interaction with wild birds play a role in outbreaks of ND.

Results from this study validate the contribution of value chain practices on outbreaks of ND in Kenya. The variables demonstrate the need to sensitize farmers and traders on the role of value chain practices on the spread ad outbreaks of diseases like ND. This will help farmers and traders adopt better practices that will help reduce the outbreaks of diseases.

5.3 Policy Recommendations

One objective of the Kenya Veterinary Policy is to establish effective and efficient governance structures for the provision of veterinary and support services to improve productivity. Based on the findings from this study, Counties like Kakamega and Machakos that have prioritized chicken as a value chain to increase investments in institutional and support services such as extension services and trainings through financial support for effective delivery of services.

Extension and support services in the three Counties are generally demand-driven and beneficiary-led. The relevant Counties should implement programs to recruit and deploy extension officers. This will help improve the dissemination of information regarding chicken disease, good management and husbandry technologies and practices as well as improved marketing practices to chicken farmers and traders respectively. This can be done through the development and full implementation of the frameworks and programs providing extension support through capacity buildings, as proposed by the Counties' CIDPs.

Credit service providers need to create affordable services and packages that target small-scale chicken farmers and traders. With collective action high across the three Counties, farmers and traders can use groups and cooperatives to access credit through group lending. Legal frameworks should also be developed to facilitate the creation of more farmer and trader cooperatives to provide easy access to affordable credit by farmers and traders. This will help increase adoption of credit by farmers and traders, thereby increasing investment in the chicken value chain. County governments should also establish funds that are tailored for agricultural activities where chicken farmers and traders can borrow and make payments. This will help improve the livelihoods of chicken farmers and traders who lack the finance to invest in better production and marketing.

Awareness of the disease and control is a major step in preventing outbreaks of ND and mitigating the effects associated with its outbreaks. There is need to create awareness among chicken farmers and traders on aspects like disease detection and symptoms of ND, disease response strategies as well as mitigation measures during outbreaks. Counties through their respective agricultural and veterinary departments should collaborate with private extension providers and development partners to develop innovative ways of disseminating the information regarding ND so as to improve coverage among farmers and traders. The information can be disseminated through the use of Information Communication Technologies

(ICT) such as text messages on mobile phones, radios and television. Farmers' and traders' workshops and use of display posters in public places like shopping centers can also be used to disseminate the information.

Farmers should be sensitized through trainings on the need to adopt and invest in better feeding practices for chicken as well as proper housing for chicken. Adoption of the practices will reduce the likelihood of birds coming into contact with disease spreading pathogens such as germs and wild birds. This can be done through group trainings where participants can be trained on better value chain practices that help reduce disease outbreaks.

Farmers whose farms were located near forested areas or along migratory routes of wild birds should be sensitized on the need to provide special shelters and adoption of intensive or semi intensive production systems. This will help reduce the movement of chicken thereby limiting their interaction with wild birds, which are known carriers of the virus.

Vaccination is generally seen as the most effective tool in combating ND. However, some farmers did vaccinate their flock against ND. Counties in collaboration with the veterinary department and local agro-veterinary input suppliers can implement joint vaccination campaigns and trainings to sensitize farmers on the importance of vaccination their flocks so as to improve immunity against ND. The campaigns should target aspects such as type of vaccines, schedules and stages of vaccination, mode of vaccine administration as well as handling of vaccines along the chain. County governments should also develop relevant infrastructure such as vaccine storage facilities at sub-Counties so facilitate efficient cold chain systems to ensure good quality and effective vaccine delivery system.

Most markets in Kakamega, Machakos and Nairobi lacked basic infrastructure such as shelters, designated points for slaughtering of birds and waste disposal equipment. The County governments should invest in market infrastructure through construction and provision of market facilities such as designated slaughter points and shelters to house birds and waste disposal equipment such as waste bins within the markets.

There is also need of authorities in charge of markets to ensure the enforcement and compliance of biosecurity, sanitation and hygiene practices within the markets. Enforcement of good practices will help reduce the spread of disease-causing pathogens that arise in flaws in the practices. This can be done through regular inspection and monitoring of live bird markets by animal health officials to ensure compliance by traders to sanitation and health regulations. Trade licenses should be given to traders who comply with the standards, while noncompliance should be deterred through revocation of the licenses.

There is need to train traders on screening of birds from different sources for signs and symptoms of diseases. This will reduce the likelihood of traders getting sick birds from different sources and origin. This will help reduce the interaction between susceptible and healthy birds which may lead to increased outbreaks of diseases.

5.4 Contribution to Knowledge

This study showed the gender difference along the chicken value chain, whereby production chicken is dominated by women while chicken trade is dominated by women. This study also highlighted the difference in the socio economic and institutional characteristics between farmers and traders in the different Counties. This study also highlighted the different practices used by chicken farmers and traders collectively as well as in the different Counties.

The study contributes to literature on ND by identifying the level of awareness among chicken farmers and traders in Kenya as well as the factors that influence their likelihood of being aware

of ND. The study also showed the various disease prevention strategies as well as the response measures used by both farmers and traders during ND outbreaks. Furthermore, this study contributes to existing literature by emphasizing on the role played by production practices as well as marketing practices on ND outbreaks in different Counties.

5.5 Areas for Further Research

The study revealed the low adoption of conventional ND vaccination by farmers. Further research could assess the factors contributing to the low adoption as well as the willingness of farmers to adopt vaccination. This will highlight the perceptions of farmers regarding vaccine pricing. This study did not adequately collect information on the impact of the ND outbreaks on the livelihood of farmers and traders. Future research can investigate the impact of ND outbreaks on incomes and food security.

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APPENDICES

Appendix 1: Variance inflation factors for variables farmers' logit model

Variable	VIF
Household type	1.73
Marital status	1.69
Extension	1.23
Group membership	1.21
Training	1.18
Gender	1.18
Education	1.17
Credit access	1.16
Age	1.16
Experience	1.14
Motive	1.06
Mean VIF	**1.26**

Appendix 2: Variance inflation factors for variables in traders' logit model

Variable	VIF
Market location	1.31
Licensing	1.29
Marital status	1.18
Experience	1.17
Age	1.16
Education	1.13
Gender	1.10
Credit access	1.09
Group membership	1.06
Training	1.03
Mean VIF	**1.15**

Appendix 3: Variance inflation factors for variables in farmers' PRM

Variable	VIF
Source of birds	8.67
Age of birds	8.43
Form of housing	1.42
Production system	1.39
Mode of feed administration	1.38
Access to animal health training	1.31
Access to extension	1.30
Flock size	1.29
Housing composition	1.26
Means of feeding	1.23
Frequency of cleaning shelter	1.21
Education level	1.18
Screening of birds	1.17
Vaccination	1.16
Experience	1.13
Breed composition	1.13
Gender	1.10
Mean VIF	**2.10**

Appendix 4: Variance inflation factor for variables in traders' PRM

Variable	VIF
Slaughter of birds	3.25
Disposal of waste	3.08
Designated slaughter point within market	2.04
Housing of birds	1.77
Form of birds	1.61
Market type	1.46
Sale in other markets	1.35
Origin of birds	1.33
Market channels	1.26
Transportation mode	1.25
Breed composition	1.22
Disposal of waste	1.22
Sale of other poultry	1.20
Education level	1.20
Gender	1.19
Mix of birds	1.17
Trade description	1.15
Screening of birds	1.13
Access to animal health training	1.10
Mean VIF	**1.53**

Appendix 5: Estimation of goodness-of-fit for farmers' PRM

Goodness-of-fit test	
Deviance goodness-of-fit	= 301.766
Prob > chi2(307)	= 0.211
Pearson goodness-of-fit	= 295.217
Prob > chi2(307)	= 0.271

Appendix 6: Estimation of goodness-of-fit for traders' PRM

Goodness-of-fit test	
Deviance goodness-of-fit	= 306.941
Prob > chi2(314)	= 0.643
Pearson goodness-of-fit	= 314.000
Prob > chi2(314)	= 0.651

Appendix 7: Household Survey Questionnaire

A Socio-Economic Analysis of the Effect of Chicken Value Chain Practices on Newcastle Disease Outbreaks in Kenya

INTRODUCTION

The Department of Agricultural Economics, University of Nairobi in collaboration with KALRO, DVS-Kenya, KWS and USDA are conducting a research on chicken production and Newcastle disease in Kenya. This questionnaire is meant to collect data on chicken production systems, management practices, chicken marketing systems and farmers' awareness in relation to Newcastle disease. Information obtained is strictly for academic and research purposes only and responses obtained will be treated with confidentiality. This interview is voluntary and will take approximately 1 hour. Your participation will be highly appreciated.

Do you participate in **rearing** of chicken? (1= Yes; 0= No). If NO, terminate interview.

General information:

Date: **Questionnaire Number:**

County: Sub County:

Location: Village: Region: (0=Rural; 1=Urban)

SECTION A: HOUSEHOLD IDENTIFICATION

1. Please fill the table below.

Type of household (1= Female headed household; 0= Male headed household) (Cross check with respondent on who the main household decision maker is)	
Name of respondent	
Gender of respondent (1= Female; 0= Male)	
Relationship to household head (1= Household head, 2= Spouse, 3= Son, 4= Daughter, 5= Relative, 6= Others)	

SECTION B: CHICKEN PRODUCTION PRACTICES

2. Please fill in the table below about chicken in your farm.

Type	**Duration of rearing** 1= < a 1 Year 2= 1-2 years 3= 3-5 years 4= >5 years	**Production System** 1= Free range 2= Intensive 3= Semi Intensive; 4= Mixed System	**Motive** 1= For Sale 2=Food 3=Culture 4=Others (Specify)	**Flock size**	**Category of flock size** 1= <10 birds 2= 10- 20 birds 3= 21-30 birds 4= 41-50 birds 5= >50 birds	**Age of birds** 1= Multi age birds 2= Birds of the same age	**Source of birds** 1= Market purchase 2= Other farmers 3= From Middlemen 4= Own litter 5= Gifts 6= Others
Indigenous							
Exotic (Broilers and layers)							
Improved varieties)							
Others (specify)							

3. Challenges faced in chicken production.
   Please rank the challenge you face in order of importance

Type of chicken	**Challenges**						
	Rank 1	**Rank 2**	**Rank 3**	**Rank 4**	**Rank 5**	**Rank 6**	**Rank 7**
Indigenous							
Exotic (Broilers and layers)							
Improved varieties							
Others (specify)							

Codes for Challenges; 1= Diseases; 2= Lack of capital; 3= High cost of inputs; 4= Lack of appropriate breeds; 5= Lack of extension and veterinary support; 6= Lack of knowledge and skills; 7= others (specify)

SECTION C: CHICKEN MANAGEMENT PRACTICES

4. Household roles and responsibilities regarding the welfare of chicken.

Gender	**Who makes decisions regarding the management aspects of the chicken**			**Who performs the management aspects regarding the chicken**		
	Feeding	**Cleaning**	**Vaccination**	**Feeding**	**Cleaning**	**Vaccination**
Female Adult						
Male Adult						
Joint spousal decision						
Children						
Hired labour						

5. Provision of shelter for the chicken

Type of poultry	**Provision of housing** 1=Yes 0=No	**If yes to housing, when is it provided** 1=Night 2=Day 3= Day and Night	**Form of housing** 1= Special Shelter / cages 2= Shared Shelter with owner 3= Makeshift shelters 4= Others	**Composition under housing** 1= Separate according to age 2= Separate according to sex 3= Mix of birds	**Frequency of cleaning shelter** 1= Daily 2= Weekly 3= Twice a week 4= Never	**Method of cleaning** 1= Changing bedding/ sweeping 2= Use of water only 3= Use of disinfectants 4= Mix of methods 5= Others
Indigenous						
Exotic						
Improved varieties						
Others						

6. **Feeding and watering routines**

Type of chicken	**Frequency of daily Feeding** 1= Once 2= Twice 3= > Twice 4= Never	**Form of feeds** 1= Kitchen leftovers 2= Commercial feeds 3= Greens and Vegetables 4= Others	**Means of administering feed** 1. Broadcasting 2. Use of Feed Troughs 3. Mix of methods 4. Others	**Frequency of Watering** 1= Once 2= Twice 3= > Twice 4= Never	**Mode of administering feeds and water** 1. Inside shelter 2. Outside Shelter 3. Others
Indigenous					
Exotic (Broilers and layers)					
Improved breeds (KALRO Indigenous)					
Others (specify)					

7. Over the last one year, have you accessed extension services? (1= Yes; 0= No) If **yes**, fill the table below.

Source	**Access** 1= Yes 0= No	**Frequency of access** 1= Monthly 2= Once a year 3= Twice a year 4= Thrice a year	**Extension service (Select the most important)** 1= Vaccination and Disease Control 2= Watering and feeding 3= Government initiatives 4=Marketing 5= Others, specify	**Was the information relevant** 1=Yes 0=No
County Extension officer				
Researchers/ NGO				
Farmer to farmer				
Farm demo				
Media				
Others (specify)				

8. Over the last one year, have you received any form of training? (1= Yes; 0= No) If **yes**, fill the table below.

Type of training	**Access to training** 1= Yes 2= No	**Facilitator of training** 1= National government 2= County government 3= Donors/ NGO 4= Group/ cooperative 5= Others	**Frequency in the last 6 months** 1= Once 2= Twice 3= Thrice 4= More than thrice	**Payment for training** 1= Yes 2= No
Feeding				
Cleaning and hygiene				
Vaccination				
Transportation and welfare				
Pricing				

9. Do you keep Farm records? (1= Yes; 0= No) If **yes**, fill the table below.

Type of record	**Do you keep record** 1= Yes 2= No	**Frequency of keeping records** 1= Daily 2= Weekly 3= Monthly 4= Yearly
Type of farm inputs		
Purchase of inputs		
Feeding routines		
Type of feeds		
Cleaning and Sanitation		
Vaccination and treatment routines		
Marketing and sales		

10. Does the farm have any measures in place to prevent disease? (1=Yes; 0=No)

If **yes**, what biosecurity measures have been employed in your farm? If **no**, skip to **Q10**.

a. Screening of birds (1=Yes; 0=No)

b. Isolation of sick birds from healthy birds (1=Yes; 0=No)

c. Disinfection of premises (1=Yes; 0=No)

d. Separation of flock according to age (1=Yes; 0=No)

e. Isolation of sick birds from healthy birds. (1=Yes; 0=No)

f. Others (Specify)……. (1=Yes; 0=No)

SECTION D: NEWCASTLE DISEASE, FARMERS' AWARENESS AND PERCEPTION

11. Please fill the table below on awareness to chicken disease

Disease	**Awareness of the disease** 1= Aware 0= Not Aware	**If aware of the disease, name the source of awareness** 1=Groups 2= Radio/television 3=Internet 4= Extension officer 5= Farmer training/ School 6= Others (specify)	**If aware of the disease, are you aware of symptoms of the disease** 1= Aware 0= Not Aware	**If aware of the symptoms, name the source of awareness** 1= Groups 2= Radio/television 3=Internet 4= Extension officer/ Other farmers 5= Farmer training/ School 6= Others (specify)
Newcastle Disease				
Coccidiosis				
Fowl Pox				
Gumboro				
Others (specify)				

12. Vaccination history and schedule.

Have you vaccinated your flock against disease in the last 3 months (1= Yes, 0=No).

If **YES**, fill the table below. If **NO**, skip to Q14

Disease	**Type of vaccine** 1= Conventional 2= Traditional	**Frequency in last 3 months** 1= Once; 2=Twice 3= Thrice; 4= > Thrice	**Purpose of Vaccination** 1= Outbreak of disease 2= New stock of Birds 3= Routine Vaccination 4= Vaccination program 5= Others (specify)	**Who facilitated vaccination?** 1= Self 2= National government 3= County government 4= Local Vet/ Agro vet 5= NGO 6= Others	**Mode of administration** 1= With drinking water 2= Nasal 3= Injection 4= Others	**Challenges faced in Vaccination (Choose the most important)** 1= High cost of vaccines 2= Lack of vaccines 3= Distance to agro vet 4= Small flock size 5= Lack of technical knowledge 6= Others (specify)
Newcastle Disease						
Coccidiosis						
Fowl pox						
Gumboro						
Others (specify)						

13. When vaccination is carried out on your flock, what kind of information do you frequently require?

1. About the dosage
2. About the route of administration
3. About the withdrawal period
4. About the price
5. Other

14. If no to vaccination, please fill the table below

Disease	**Reason for not vaccinating** 1= Lack of awareness and knowledge 2= Lack of skills 3= High cost of vaccination 4= Distance to agro vet 5= Size of flock	**Are you willing to vaccinate chicken?** 1= Yes 0= No
Newcastle disease		
Coccidiosis		
Fowl Pox		
Gumboro		
Others		

15. Have your birds suffered from disease in the last one year? (1= Yes; 0=No).

If no, skip to section D.

If yes, what were the signs and symptoms exhibited by the chicken? (Please tick against the symptoms)

Symptoms consistent with Newcastle disease
1.Loss of appetite 2.Drop in egg production 3. Increased respiration and gasping 4.Diarrhea (Greenish) 5.Twisted necks 6.Sudden death of birds
Symptoms consistent with Coccidiosis
1.Bloody and watery Diarrhea 2.Weight loss and depression 3.Lack of appetite 4.Ruffled feathers 5.Poor Weight gain
Symptoms consistent with Fowl Pox
1. Depression 2. Poor growth 3. Poor egg production 4. Warty, spreading eruptions on comb and wattle 5. Deposits on mouth and throat
Symptoms consistent with Gumboro
1. Sudden Death 2. Purple discoloration of wattles, comb and legs 3. Soft shelled eggs 4. Swelling of head, eyelids, combs and wattle 5. Lack of energy and appetite

16. Outbreak pattern of the disease

Disease	**Frequency of outbreaks (Yearly)** 1= Once 2= Twice 3= Thrice 4= More than Thrice	**Season of outbreak** 1= Dry season 2= Rainy season 3= Both Dry and rainy seasons	**Number of deaths**	**Duration before seeking intervention** 1= Less than 1 hour 2= 1-2 hours 3= 12-24 hours 4= More than 24 hours	**Mitigation measures** 1= slaughter sick birds 2= Vaccinate sick birds 3= Sell of sick birds 4= Isolation of sick birds 5= Do nothing	**Major Challenge in mitigating diseases (Rank the top 3 challenges)**	**Seriousness of disease** 1= Very Serious 2= Serious 3= Don't know 4= Not serious 5= Not very serious	**Do you think disease can be controlled ?** 1= Yes 2= No
1.Newcastle Disease								
2.Coccidiosis								
3.Fowl Pox								
4.Gumboro								
5.Others (specify)								

Codes for challenges; 1= High costs of veterinary Inputs, 2= Distance to agro vet, 3= Lack of information on disease, 4= Lack of skills and technical knowledge

17. Newcastle disease in **Question 16**, please express your attitude towards the following statements regarding disease

Newcastle disease	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
There is little I know about the disease					
Disease is the major cause of losses in my farm					
The cost of vaccinating against the disease is very high					
Visits by veterinary and extension officers have helped in managing the disease					
Vaccines have been effective in combating the disease					
Management practices used have contributed to the disease spread					

SECTION E: CHICKEN MARKETING PRACTICES BY FARMERS

18. Do you sell your chicken? (1= yes; 0= No)

If **yes**, fill the table below. If **No**, skip to **Section E**.

Type of chicken	**Main Reason for selling** 1=Disease 2=Income 3=Reduce stock 4=Others	**Who decides when to sell the chicken** 1= Male adult 2= Female adult 3= Joint spousal decision 4= Relative 5= Others (specify)	**Marketing channel used** 1=Direct 2=Middlemen/broker 3= Farm gate 4=Others	**Form of birds sold.** 1=Live 2= Slaughtered	**Average Number of birds sold**
Indigenous					
Exotic					
Improved					
Others					

19. In Q31, in case of live birds, what is the main transport mode used to transport the birds to the market?

a. On Foot
b. Motorcycles/ Bicycles
c. Pick up/ Lorries
d. Public transport vehicle
e. Others (Specify)…….

20. Do you vaccinate the birds before selling? (1=Yes; 0= No)

21. What is the distance from the source to point farm point of sale?

a. Less than 1 km
b. 1-5 km
c. 5-10 km
d. More than 10 km

22. Usage of income from chicken enterprise

Usage	**Proportion of income**
Food and clothing	
School fees	
Chicken enterprise	
Other farm enterprise	
Savings	
Others (others)	

23. When selling of the birds, how important are the following characteristics in your decision to sell?

Characteristics	**Very Important**	**Important**	**Neutral**	**Not Important**	**Not very important**
Quantity					
Price					
Health of bird					
Size of birds					

SECTION F: SOCIO-DEMOGRAPHIC CHARACTERISTICS

24. Do you keep any other forms of livestock? (1=Yes,0=No)

If yes, fill the table below

Livestock Form	**Number**
Cattle	
Goats	
Sheep	
Donkey	
Others	

25. Have you received any form of credit in the last one year? (1=Yes; 0=No)
    If **Yes**; please fill the table below; If **No**, skip to **Q 27**

Source of Credit	**Amount Received**	**Category of amount** 1= <10,000 Ksh 2= 10,001- 20,000 Ksh 3= 20,001- 30,000 Ksh 4= 30,001- 40,000 Ksh 5= >40,000 Ksh	**Enterprise** 1= Chicken production 2= Other Livestock 3= Crop production 4= Non-farm activities	**Purpose** 1= Purchase of inputs 2= Personal/ Hhld expenses 3= Treatment/ Medication 4= Purchase of stock
Microfinance/Bank				
Group/Cooperative				
Neighbor/Friend				
Government				
Others (specify)				

26. What were the reasons for not receiving credit?
    1. Lack of security/ collateral
    2. Lack of access to credit
    3. Lack of information on credit
    4. High interest rates on credit
    5. Others (specify)

27. Membership to development group.

Are you a member of any development group? (1= Yes; 0= No). If yes, fill the table below

Type of Group	**Member to group** 1= Yes, 0=No	**If yes, duration of Membership** 1= Less than 1 year 2= 1-2 years 3= 3-5 years 4= More than 5 years	**Most (one) important function of the group;** 1=Supply of stock and inputs 1= Marketing of output 3= Savings and credit 4= Training and extension 5= Other, specify	**Challenges in group** 1= Poor management/ misappropriation 2= Unable to pay membership fees 3= Group not profitable/ Defaulters 4= Others, specify
Family and friends				
Youth group				
SACCO/Credit group				
Farmer cooperative/input supply				
Producer or marketing group				
Women's group/Chama				
Others (specify)				

28. What is the distance to nearest agro vet in Km?

29. Total size of land owned by respondent in acres…….

30. Household composition and age Structure

Household Member	**Gender** 1= Male 2= Female	**Age**	**Age Category** 1= <18 years 2= 18- 30 years 3= 31- 40 years 4= 41-50 years 5= >50 years	**Education Level** 1= None 2= Primary 3= Secondary 4= Tertiary 5=University	**Marital Status** 1= Married 2= Divorced 3= Single 4= Widowed	**Relationship to Household head** 1= Household Head 2= Spouse 3= Child 4= Relative 5= Others	**Major income activity** 1=Famer 2= Salaried employee 3=Business 4= Casual Laborer 5=Other
Respondent							

31. Average Household Monthly Income

Income source	**Amount**	**Income category** 1= <5,000 Kshs 2=5,001- 15,000 Kshs 3= 15,001- 25,000 Kshs 4= 25,000- 40, 000 Kshs 5= >40, 000 Kshs	**Who controls the income earned in the household** 1= Male adult 2= Female member 3= Joint decision 4= Children 5= Relatives
Chicken enterprise			
Other farm enterprises			
Off farm activities (farm activities from other holder's farms)			
Non-farm activities (e.g handicrafts, carpentry)			
Remittances and gifts			
Safety nets			
Formal employment			
Others (specify)			

`END OF INTERVIEW. THANK YOU FOR YOUR TIME

Appendix 8: Traders' Survey Questionnaire

A Socio-Economic Analysis of the Effect of Chicken Value Chain Practices on the Spread and Severity of Newcastle Disease in Kenya

INTRODUCTION

This research survey is being conducted by the Department of Agricultural Economics, University of Nairobi in collaboration with KALRO, DVS-Kenya, KWS and USDA. The purpose of the study is to obtain opinions, views, experiences and suggestions regarding Newcastle disease in chicken. This questionnaire is meant to collect data chicken marketing practices and Newcastle disease. Information obtained is strictly for academic and research purposes only. Responses obtained will be treated with confidentiality. This interview is voluntary and will take approximately 1 hour. Your participation will be highly appreciated.

Do you participate in **selling** of chicken? (1= Yes; 0= No). If **NO**, terminate interview.

General information:

Date; **Questionnaire Number;**

County; (1=Kakamega; 2= Machakos; 3=Nairobi) Sub County;

Name of Market;

Location of Market; (1=Urban; 2=Peri urban; 3= Rural)

SECTION A; TRADER CHARACTERISTICS

1. Description of the trader?

Please fill the table below regarding the chicken trader.

Type of chicken	**Are you a licensed chicken trader?** 1= Yes 0= No	**Description of trade** 1= Regular 2= Seasonal	**Sale to other Markets** 1= Yes 0= No	**Average number of birds sold daily**	**Duration of rearing chicken** 1= < a 1 Year 2= 1-2 years 3= 3-5 years 4= >5 years
Indigenous					
Exotic (Broilers and layers)					
Improved varieties					
Others (specify)					

2. Description of trading activities.
   Please fill the table below regarding the activities

Breed	**Source of chicken (Marketing channel)** 1=Farm gate 2=Middlemen 3= Other traders 4= Own stock	**Form of birds** 1=live 2= slaughtered 3= Both	**Main Transport Mode** 1= On Foot 2= Vehicle 3= Bicycle/ motorcycle 4= Mix of modes 5= Others	**Type of customers** 1= Household 2= Brokers 3=Other traders 4= Hotels 5= Mixed customers 6= Others	**How do you price the chicken** 1= Market price 2= Seller decides 3= Buyer decides 4= Buyer and seller negotiations 5= Mix of methods
Indigenous					
Exotic					
Improved					
Others					

3. Description of Market\
   Please fill the table below about the market

Type of Market	**Authority in charge of market** 1= National government 2= County government 3= Private 4= Cooperative 5= None	**Market days** 1= Daily 2= Weekdays 3= Weekends 4= Specific days	**Origin of birds sold** 1= Within County 2= Other Counties 3= Mixed	**Average Number of chicken traders in the market**	**Availability of designated slaughtering unit** 1= Yes 2= No
Open air					
Closed					

4. Taste and Preferences for chicken
   Please fill the table below regarding the preference of chicken by customers

Breed	**Preference** 1= Yes 2= No	**Reason for preference** 1= Traditional/ authentic taste 2= Prices 3= Availability 4= Health concerns	**Important traits** 1= Size or Weight 2= Skin 3= Meat colour 4= Type/ colour of feathers 5= Mix of traits	**Purpose of chicken** 1= Cock for meat 2= Cock for breeding 3= Hen for meat 4= Hen for breeding 5= Mixture
Indigenous				
Exotic				
Improved				
Others (specify)				

5. Do you sell other types of chicken? (1=Yes; 0=No)
   If yes, which kind?
   a. Ducks
   b. Geese
   c. Turkey
   d. Guinea fowls
   e. Others
6. What is the main (one) challenge faced during marketing of the chicken?
   a. Lack of stock
   b. Government regulations/ institutions
   c. Lack of capital
   d. Lack of customers
   e. Disease outbreaks
   f. Others (Specify)

`SECTION B; HANDLING PRACTICES

7. Do you keep the birds you sell in the market place|? (1=Yes; 0=No)

8. Do you mix the birds from different sources together? (1=Yes; 0=No)

9. Are the birds housed during the day? (1= Yes; 0=No)

10. Where do you house the birds overnight?
    a. Take them home
    b. House them in the market
    c. Slaughter and freeze
    d. Others

11. Are the birds slaughtered in the market? (1= Yes, 0= No)
    If Yes, how is the waste disposed
    a. Burned/Incinerated
    b. Buried/ disposed I dustbin
    c. Left in the premise
    d. Mix of methods

12. Do you have measures in place to prevent disease? (1=Yes; 0= No)
    If **no**, skip to **question 13.** If **yes,** what biosecurity measures do you take to prevent disease outbreaks in the market?
    a. Vaccination of birds after buying (1=Yes; 0= No)
    b. Screening of birds before buying (1=Yes; 0= No)
    c. Sanitation and disinfection of premises (1=Yes; 0= No)
    d. Isolation of sick birds (1=Yes; 0= No)
    e. Separation of flock from different sources (1=Yes; 0= No)
    f. Mix of measures (1=Yes; 0= No)

SECTION C; NEWCASTLE DISEASE, TRADERS' AWARENESS AND PERCEPTION

13. Please fill the table below on awareness to chicken disease

Disease	**Awareness of the disease** 1= Aware 0= Not Aware	**If aware of the disease, name the source of awareness** 1=Groups 2= Media 3=Internet 4= Extension officer/ Other farmers 5= Farmer training/ School 6= Others (specify)	**Awareness of disease symptoms** 1= Aware 0= Not Aware	**If aware of the symptoms, name the source of awareness** 1=Groups 2= Media 3=Internet 4= Extension officer/ Other farmers 5= Farmer training/ School 6= Others (specify)
Newcastle Disease				
Coccidiosis				
Fowl Pox				
Gumboro				
Others (specify)				

14. Over the last One year, have birds suffered from disease while at the market? (1=Yes; 0=No)
If **yes**, what were the signs and symptoms of the disease suffered by the disease?
(Please tick against the symptoms)
If No, skip to Section D

Symptoms consistent with Newcastle disease
1. Loss of appetite 2. Drop in egg production 3. Increased respiration and gasping 4. Diarrhea (Greenish) 5. Twisted necks 6. Sudden death of birds
Symptoms consistent with Coccidiosis
1. Bloody and watery Diarrhea 2. Weight loss and depression 3. Lack of appetite 4. Ruffled feathers 5. Poor weight gain
Symptoms consistent with Fowl Pox
1. Depression 2. Poor growth 3. Poor egg production 4. Warty, spreading eruptions on comb and wattle 5. Deposits on mouth and throat
Symptoms consistent with Gumboro
1. Sudden Death 2. Purple discoloration of wattles, comb and legs 3. Soft shelled eggs 4. Swelling of head, eyelids, combs and wattle 5. Lack of energy and appetite

15. Please fill the table below regarding the disease mentioned?

Disease	**Frequency of outbreaks in the last 1 year (Yearly)** 1= Once 2= Twice 3= Thrice 4= More than Thrice	**Season of outbreak** 1= Dry season 2= Rainy season 3= Both dry and rainy seasons	**Number of deaths**	**Duration before seeking intervention** 1= Less than 1 hour 2= 1-2 hours 3= 12-24 hours 4= More than 24 hours 5= None	**Mitigation measures** 1= slaughter / bury sick birds 2= Vaccinate/ treat sick birds 3= Sell of sick birds 4= Isolation of sick birds 5= Do nothing	**Seriousness of disease** 1= Very Serious 2= Serious 3= Don't know 4= Not serious 5= Not very serious	**Do you think disease can be controlled** 1= Yes 2= No
Newcastle Disease							
Coccidiosis							
Fowl Pox							
Gumboro							
Others (specify)							

16. Please express your attitude towards the following statements regarding the disease mentioned in **question 15**.

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
There is little I know about the disease					
The disease is the major cause of losses					
Trainings on marketing and management have helped in managing the disease					
Marketing practices have contributed to the spread of the disease					

17. Do you perceive the disease to have high economic losses? (1=Yes; 0= No)

SECTION D; SOCIO-DEMOGRAPHIC CHARACTERISTICS

18. When selling of the chicken, how important are the following characteristics in your decision to sell?

Characteristics	**Very Important**	**Important**	**Neutral**	**Not Important**	**Not very important**
Health of birds					
Price					
Quantity					
Size of birds					

19. Have you accessed to any form of credit? (1=Yes; 0=No). If yes; please fill the table below:;

Source of Credit	**Amount (Kshs)**	**Category of Amount** 1= <10,000 Ksh 2= 10,001- 20,000 Ksh 3= 20,001- 30,000 Ksh 4= 30,001- 40,000 Ksh 5= >40,000 Ksh	**Enterprise** 1= Chicken 2= Household Activities	**If enterprise is chicken, what was it used for?** 1= Purchas of stock 2= Purchase of feeds 3= Market related payments 4= Management activities 5= Mixed
Bank/Microfinance				
Group/ Cooperative				
Friend/ Family				
Government				

20. Trader Training

Over the last one year, have you received any form of training regarding chicken. (1=Yes; 0=No). If yes, please fill the table below

Type of training	**Access to training** 1= Yes 2= No	**Facilitator of training** 1= Government 2= Donors/ NGO 3= Group/ cooperative 4= Others	**Frequency in the last 1 year** 1= Once 2= Twice 3= Thrice 4= More than thrice	**Payment for training** 1= Yes 2= No
Production and Management				
Health				
Marketing				

21. Do you belong to any development group? (1=Yes; 0=No)

If **yes**, please fill the table below regarding membership to group

Type of Group	**Member to group** 1= Yes, 0=No	**Duration of Membership**	**Most (one) important function of the group;** 1=Supply of stock and inputs 2= Marketing of output 3= Savings and credit 4= Training and extension 5= Other, specify	**Biggest (One) Challenge in group** 1= Poor management 2= Unable to pay membership fees 3= Group not profitable 4= Others, specify
Family and friends				
Youth group				
SACCO/Credit group				
Farmer cooperative				
Producer or marketing group				
Women's group/Chama				

22. Respondents characteristics

Age	**Age Category** 1= Less than 18 years 2= 18- 35 years 3= 36- 55 years 4= Above 55 years	**Respondent's Sex** 1= Male 2= Female	**Education Attained** 1= None 2= Primary 3= Secondary 4= Tertiary 5= University	**Marital Status of Respondent** 1= Married 2= Divorced 3= Single 4= Widowed

23. Average monthly Income from chicken marketing.

Income category	**Tick category**	**Amount**
Below Kshs 5,000		
Kshs 5,001- 10,000		
Kshs 10,001- 20,000		
Kshs 20,001- 30,000		
Kshs 30,001- 40,000		
Kshs 40,000- 50,000		
Above Kshs 50,000		

`THANK YOU FOR PARTICIPATING