INFLUENCE OF MANAGEMENT ON WELFARE AND PERFORMANCE OF BROILER CHICKENS IN SMALL SCALE INTENSIVE PRODUCTION SYSTEMS IN KIAMBU COUNTY, KENYA

BY

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DECLARATION AND APPROVAL

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I hereby declare that this thesis is my original work and has never been submitted in this or any other university for the award of a degree.

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APPROVAL

This thesis has been submitted for examination with our approval as the University of Nairobi supervisors.

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DEDICATION

I dedicate this work to my beloved family, especially my late mother Janet P. Oleru, late father Azaria K. Yensuk, my wife Hellen S. Solomon as well as my brothers and sisters who worked tirelessly to ensure that I attained this level of education.

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LIST OF ABBREVIATIONS AND ACRONYMS

°C	Degree Celsius
#	Number
AfDB	African Development Bank
CIA	Central Intelligence Agency
cm	Centimetre
CIWF	Compassion in World Farming Trust
DEFRA	Department of Environment, Food and Rural Affairs
DOC	Day Old Chicks
EFSA	European Food Safety Authority
EU	European Union
FAO	Food and Agricultural Organisation
FAOSTAT	Food and Agricultural Organisation Corporate Statistical Database
FAWC	Farm Animal Welfare Council
FCR	Feed Conversion Ratio
gm	Grams
GDP	Gross Domestic Product
ha	Hectare
IFAD	International Fund for Agricultural Development
ILRI	International Livestock Research Institute
kg	Kilo grams
km	Kilo metres
KARI	Kenya Agricultural Research Institute
KEBS	Kenya Bureau of Standards
KNBS	Kenya National Bureau of Statistics

KSPCA	Kenya Society for the Protection and Care of Animals
MT	Metric Tonnes
m	Metre
MOLFD	Ministry of Livestock and Fisheries Development
N	Population size
n	Sample size
e^2	Error term
OIE	Office International des Epizootics
%	Percentage
Fig.	Figure
SD	Standard Deviation
no	Number
NCD	New Castle Disease
NGO	Non-Governmental Organization
L	Litres
r^2	Pearson's Correlation Coefficient
PPM	Parts Per Million
GoK	Government of Kenya
RSPCA	Royal Society for the Prevention of Cruelty to Animals
SCAHAW	Scientific Committee on Animal Health and Animal Welfare
SPSS	Statistical Package for Social Sciences
USAID	United States Agency for International Development
UK	United Kingdom
US	United States

DEFINITIONS OF OPERATIONAL TERMS

Agro-vets - Is a business outfit where farmers can purchase agricultural and veterinary goods and services.

Animal welfare - Is its state as regards its attempts to cope with its environment

Broilers - Are chickens (*Gallus gallus/domesticus*) which are bred and raised specifically for meat production

Private vets - Are certified veterinarians delivering veterinary services to farmers for disease prevention and control

ABSTRACT

In Kenya, commercial broiler production is developing rapidly due to increasing demand for poultry meat and higher income for farmers. It is one of the popular animal enterprises and is ranked second to dairy farming in Kikuyu and Kabete sub-counties of Kiambu County. However, commercial broiler production is characterized by intensive operations in which broiler chickens are overstocked in deep litter systems. Ineffective cleaning of deep litter units result in ammonia build up which causes burns on feet, breasts and hocks with constant foot pad lesions, thus compromising the welfare of the birds and affecting production. Moreover, these issues are compounded by inadequate knowledge of welfare issues by farmers and their perceptions and attitudes on the same. Therefore, this study was undertaken to assess how management factors influenced welfare and performance of broiler chickens in Kiambu County, Kenya. The objectives of this study were to evaluate knowledge, attitudes and practices of farmers in relation to the welfare of broilers; to determine management factors that influence welfare of broilers in small scale production systems; and to evaluate the effects of welfare on performance of broiler chickens. A total of 120 broiler farmers were selected randomly from Kikuyu and Kabete sub-counties. They were interviewed using a semi-structured questionnaire to gather information on their socio-economic characteristics such as age, gender, marital status, education level, land size and years in broiler keeping. Information was also collected on farmers' knowledge, attitudes and practices in regards to broiler welfare. Management and resource-based measurements were taken to assess feeding and watering spaces, stocking densities, open spaces, house humidity, house temperatures and depth of litter. Levels of ammonia in the house and litter quality of the poultry, feet conditions of broilers were evaluated. Behaviour of broilers and characteristics of farm productivity were also assessed. Four focus group discussions were held, two in each sub-county of Kikuyu and Kabete, respectively. The results of this study showed that farmers

with knowledge on animal welfare were 54.7±0.50% and 93.6±0.24% in Kikuyu and Kabete sub-counties, respectively. Farmers accessed information on animal welfare through the media (61.0%), hatcheries (40.2%), agro-vet shops (37.8%) and government extension agents (30.5%). Good feeding, good health, suitable housing and appropriate behaviour were perceived to be very important indicators of broiler welfare by 88.3, 83, 82 and 48% of the farmers respectively. Most farmers (90.5%) vaccinated their birds against Gumboro and New Castle Disease, while *coccidiosis* was managed through sanitation practices such as cleaning and disinfection of poultry houses and equipment as well as treatment (22.6%) of sick birds with coccidiostat. About 29.8% of farmers isolated sick birds in order to prevent spread of diseases in their flocks. The mean feeding space was 10.69±1.86 cm/bird, while the linear watering space was 6.92±1.09 cm/bird. The feeding space was within the recommended range of 3-12 cm/bird depending on the age of broilers. Accordingly, broilers of 0-2 weeks, 3-4 weeks, and >4 weeks should have 3, 5 and 8-12 cm of feeding space/bird, respectively. The watering space was slightly above the recommended 1.3-5.0 cm/bird dependent on the age of the birds. The stocking density was 12.9±9.6 and 16.9±13.8 kg/m^2 in Kikuyu and Kabete sub-counties, respectively. This was within the recommended range of 10-30 kg/m^2 for broiler chickens raised in deep litter floor systems. The average humidity recorded in poultry houses was 49.1±0.58% and 49.6±0.57% in Kikuyu and Kabete, respectively. This was so close to the ideal humidity recommended for broiler chickens (50-65%). Conversely, the average temperature recorded in poultry houses at the time of study was 26.8±0.69 °C and 26.6±0.59 °C in Kikuyu and Kabete, respectively. This was within the recommended temperature (21.8-31.3 °C) for maximum weight gain for broilers aged 1-3 weeks. The mean open space of poultry houses in the two sub-counties was 2.38±2.27 m^2. Majority (46.6%) of broiler houses did not have detectable ammonia smell or eye irritation while moderate smell and eye irritation were reported in 43.5% of the houses. Only 9.8% of houses had a strong

ammonia smell and irritation to eyes. At least 88.7% of the flocks studied had a litter depth of 5-10 cm, while 88.6% of houses had dry litter. Disease incidences were reported by 57% of the farmers. *Coccidiosis* was the main cause of mortality followed by pneumonia at 82% and 13.1%, respectively. About 70% of farmers reported to have observed their birds expressing fear at least twice a week caused mainly by human disturbances. There was no significant correlation ($P>0.05$) between the live weight of broilers and feeding and watering spaces, litter quality, stocking density and breast blisters.

Findings from this study showed that about 74% of the farmers had knowledge on animal welfare and majority of them accessed information on animal welfare through the media, hatcheries, agro-vet shops and county extension agents. Vaccination and sanitation practices were the main mode of disease prevention for most farmers. Broiler welfare needs in terms of good feeding, good health, stocking density; house temperature, house humidity, and litter depth and litter quality were met. However, broiler welfare needs in terms of appropriate behaviour were compromised as none of the farmers provided facilities for expression of normal behaviour. The overall assessment of this study was that the welfare of broilers was enhanced (good) though some of their needs were not met. Therefore, this study recommends that the relevant authorities should step up country wide sensitization of farmers on welfare issues of poultry and other farm animals in order to increase sensitivity on the same and inform the necessary policies and legislation for sufficient enforcement of the existing legislative acts on livestock.

Keywords: poultry, deep litter, broiler welfare, production systems.

CHAPTER ONE: INTRODUCTION

1.1 Background information

Kenya is found within the East African region and has a surface area of 580,367 km^2 and a human population of over 47.6 million people (KNBS, 2019). Kenya has the leading economy among countries of the East African Community. The country's GDP represents 40% of the region's GDP, followed by Tanzania, Uganda, Rwanda and Burundi at 28%, 21%, 8%, and 3%, respectively (U.S Chamber of Commerce, 2016). According to the African Development Bank (2018), agriculture is the main driver of East Africa's development followed by industry. In 2017 alone, agriculture grew at 5%, whereas industry grew at 10.5% (African Development Bank, 2018).

Agriculture is the backbone of the Kenyan economy and is the most vital sector in the economy. It contributes roughly 26% of the GDP, and utilizes 75% of the national labour force (GoK, 2005 and 2010). It accounts for over 18 and 70% of formal and informal employment, respectively. It produces 65% of the nation's exports (GoK, 2010). Within agriculture, the livestock sub-sector contributes 17% of the agricultural GDP and 7% of the country's exports (GoK, 2010).

Over the last 40 years, there has been rapid improvement in animal production especially in ways in which animal products are produced, consumed and marketed. Progress in animal production in both developed and developing countries has been driven by poultry (Narrod *et al.*, 2012). In Kenya, the poultry industry is one of the foremost popular animal production endeavours contributing about 7.8% of the overall GDP (Tumwebaze, 2016; GoK, 2007).

Kenya has also over the last decade recorded high poultry numbers in such areas as Nairobi, Mombasa, Thika, Machakos, Kajiado and Kiambu Counties, where commercial farming is practiced by many farmers (Tumwebaze, 2016; GoK, 2007). The poultry industry is an important income creating activity in Kenya. Additionally, the annual poultry meat

consumption in Kenya rose sharply from 54.8 MT in 2000 to 91.4 MT in 2010 and it is expected to rise to 164.6 MT in 2030. In Nairobi, consumption is expected to rise from 6 to 30.5 MT (Maud *et al*., 2017; Robinson and Pozzi, 2011).

High growth rates and efficiency in feed conversion as well as high carcass yields have been the main objectives in intensive selection of broiler chickens. Moreover, commercial production often has intensive operations in which broiler chickens are kept in high densities in deep litter systems. The floors on which these birds are kept are covered with litter material that is removed at the end of each production cycle. This is followed with cleaning and disinfection procedures for the next crop of broilers. Ineffective cleaning of deep litter units results in ammonia build up in houses and this causes burns on birds' feet with severe and constant footpad lesions, thus compromising their welfare.

In Europe, the Council of the European Union has approved a directive that ensures the protection of broiler chickens (Adele and Federico, 2009). The directive provides for basic rules for the protection of birds kept for meat production and lays down requirements on practices of management with regards to stocking density, litter and air quality, light regiment, training and guidance for stock persons as well as monitoring procedures for farms and abattoirs. However, in Kenya, there are no legislations that are comparable to those in Europe. Nonetheless, the two livestock Acts namely the Prevention of Cruelty Act of 1963 and the Animal Diseases Act of 1965 would guarantee animal welfare in Kenya if enforced sufficiently (GoK, 2013).

The welfare of an animal is the manifestation of how it is able to cope with the situation in its environment (Broom, 2008). It includes all the mechanisms that the animal uses to avoid stressful conditions such as high temperatures and inadequate resource supply (e.g. feed and water). This induces behavioural and emotional reactions leading to, for instance, stereotypies (de Waal, 2012, and Koolhass *et al.*, 2011). Thus, broilers exhibit behavioural or emotional

reactions when subjected to uncomfortable situations especially under intensive production. Scientific evidence suggests that the intensive production of broiler chickens can subject the birds to severe health and welfare problems if not checked (SCAHAW 2000).

The issue of animal welfare goes back to early 1960s when the book written by Ruth Harrison, "*Animal machines*", resulted in the formation of the Brambell Committee by the British government in 1965 to investigate the assertions raised. The book was critical of the intensification of animal husbandry in the United Kingdom during that time (Brambell Committee, 1965 and Duncan, 2005). Today, farm animal welfare is subjected to scientific inquiry due to the identification of the 'five freedoms' animals are supposed to have.

The welfare of an animal encompasses the treatment received by the animal, for example, well-being, husbandry, and behaviour (OIE, 2014). Therefore, the animal is said to be in good welfare condition when it enjoys the five freedoms namely: (i) Freedom from hunger and thirst, (ii) Freedom from discomfort, (iii) Freedom from pain, injury and disease, (iv) Freedom to express normal behaviour and (v) Freedom from fear and distress (OIE, 2018).

Broiler welfare concerns have prompted many consumers in Europe to demand for increased supply of broilers which have access to daylight, fresh air and environmental enrichment and opportunity to outdoor exercise during the production cycle (SCAHAW, 2000). Conversely, a report by Lake Research Partners (2018) in the U.S. indicated that 77% of consumers were concerned about how animals were raised for human food and about their welfare. They check for food labels that show how animals were raised. This has led to the establishment of a certification scheme by traders that embrace animal welfare (Botreau *et al.*, 2007). Therefore, the consumers' perception of animal welfare can have a bearing on the type and brand of poultry products they purchase (Nicole and Davies, 2013).

1.2 Statement of the problem

In developing nations, the demand for meat, milk, and eggs is expanding as household incomes increase in formerly poor nations (FAO, 2009). The increase in incomes has empowered consumers to bear the added cost associated with the enhancement of quality in foods (ILRI, 2010). Moreover, this growing demand can only be met through intensive production systems, because such systems provide much of the volume of poultry and pig produced (Bruinsma, 2003). Breeding and intensive production of broilers bring to the fore management and welfare issues. It is to a great extent recognized that a large portion of welfare issues are triggered by environmental factors, hereditary factors as well as the interaction between them (European Food Safety Authority, 2010).

Good welfare is experienced by an animal that enjoys the five freedoms listed above. However, with the current increase in demand for meat in Kenya, production of broiler chickens has been intensified. Intensive broiler production is associated with overcrowding that leads to diseases, leg defects, accumulation of ammonia, dampness and increased temperatures which affect the expression of normal behaviour of the birds and compromise their welfare. Although Shukri (2018) assessed the production and welfare of layers in Kabete sub-county, there is very little work done on broiler chicken welfare issues in Kenya. Therefore, there is need to quantify the welfare issues in Kenya with a view of formulating measures to militate against them and also to evaluate producers attitudes, perceptions and practices that influence broiler welfare, in order to increase their sensitivity on the same and inform the necessary policies and legislation.

1.3 Justification

Animal welfare is a basic characteristic of a concept of food quality and consumers' preference is for animal products that are produced with regard for animal welfare (ASPCA, 2016). Nicol and Davies (2009) reported that animals are sentient beings that suffer from pain

or frustration in as much the same way as people do. The purpose of this study was to evaluate the welfare of broiler chickens in smallholder production systems in Kenya with a view of determining the knowledge, attitudes and practices in broiler welfare; and to evaluate the effects of welfare on broiler performance in Kiambu County, Kenya.

1.4 Objectives

1.4.1 Main objective

To evaluate the influence of management and other factors on welfare and performance of broiler chickens in small scale production systems in Kiambu County.

1.4.2 Specific objectives

1. To evaluate the knowledge, attitudes, and practices of farmers in relation to the welfare of broiler chickens.
2. To determine the management factors that influences the welfare of broilers in small scale production systems in Kiambu County.
3. To evaluate the effects of welfare on performance of broiler chickens.

1.5 Research questions

1. What is the level of knowledge, attitudes, and practices of farmers in regard to broiler welfare?
2. What are the management factors that influence welfare in small scale broiler production systems?
3. Does welfare influence broiler performance?

CHAPTER TWO: LITERATURE REVIEW

2.1 General

2.1.1 Poultry production in the world

Poultry refers to domestic fowls such as chickens, ducks, turkeys, geese, guinea fowls and ostriches, which are kept for eggs and meat production. Poultry is the fastest developing agricultural sub-sector. This is particularly so in developing countries. The poultry sector worldwide is anticipated to develop faster than any other livestock sector due to increasing demand for animal food products (Mottet and Tempio, 2017). This demand is driven by the increase in human population, rising earnings and urbanization. Poultry meat production is higher than that of any other farm animals in the world (FAO 2018). Between 2010 and 2017 poultry meat output increased by 21.3 MT (FAO, 2018). In 2016 alone, the production was 119.2 MT, which increased by 1.1% in 2017 to about 120.5 MT (OECD/FAO, 2018).

In USA, an estimated 22 MT of poultry meat output was recorded in 2017, which was a 2.4% increase from 2016. This increase was mainly due to an increase in demand from domestic and international consumers, improvement in genetic selection and the expanded capacity of the processing industries (USDA, 2019). Poultry meat output expanded over the same period in Russia (7%), but declined in the EU and China at -0.8 and -5.6%, respectively, due to the outbreak of highly pathogenic Avian Influenza (HPAI) in the early months of 2017 resulting in trade restrictions (FAO, 2018). The global chicken meat production is predicted to increase by 2% in 2019 as shown in Table 1.

FAO data show that poultry and pig meats were the highly consumed meats globally in 2018 with 16 kg per capita each, while bovine and ovine meats were consumed at 9 and 2 kg per capita, respectively (FAOSTAT, 2019). Chicken meat currently makes up 89% of the available poultry meat and by the year 2024, chicken meat consumption in developing countries could be 118.0 MT (Mitchell, 2016). The consumption in developing countries was

estimated to be 75.8 MT in 2018 (FAO, 2018). Angola and South Africa were the major importers of chicken meat in Sub-Saharan Africa in 2018 with importation volumes of 0.32 and 0.56 MT, respectively (FAO, 2018).

Table 1: Global poultry meat production in major producing countries

	Output (MT carcass weight equivalent)				
	2015	**2016**	**2017**	**2018**	**2019[a]**
World	116,342	119,239	120,516	122,500	-
USA	21,017	21,483	21,998	19,361	19,709
Brazil	13,636	13,391	13,645	13,355	13,800
EU	13,925	14,514	14,630	12,200	12,470
China	17,895	18,710	17,665	11,700	12,000
Russia	4,088	4,141	4,440	4,872	4,780
India	3,292	3,426	3,591	4,855	5,100
Mexico	3,002	3,116	3,234	3,485	3,600
Japan	2,132	2,345	2,359	-	-

Source: (OECD/FAO, 2018; USDA-FAS, 2019) 2019[a] = projected values

The tremendous increase in poultry production has been spearheaded by increases in the production of broiler chickens due to their fast growth compared to other poultry species. Broiler chickens have been genetically selected for fast growth and high meat production (FAWC, 1992). Knowles *et al.* (2008) reported that in the last five decades, broiler growth rates have increased by more than 300%, from 25 to 100 gm per day. Selection of broilers has been fundamentally integrated with economic characteristics, which has reduced costs of production (Emmans and Kyriazakis, 2000 and CIWF, 2005).

2.1.2 Poultry production in Kenya

Poultry rearing is one of the major livestock ventures in Kenya due to low capital requirement (Omiti and Okuthe, 2008). The poultry population in Kenya is estimated at 48

million birds (FAOSTAT, 2019). In an earlier report, the population was estimated at 37.3 million birds, composed of indigenous chickens (84.1%), broiler chickens (5.7%), layers (8.4%) and other birds (1.8%). The other birds were waterfowls, ostriches, pigeons, quails and guinea fowls (Omiti and Okuthe, 2008).

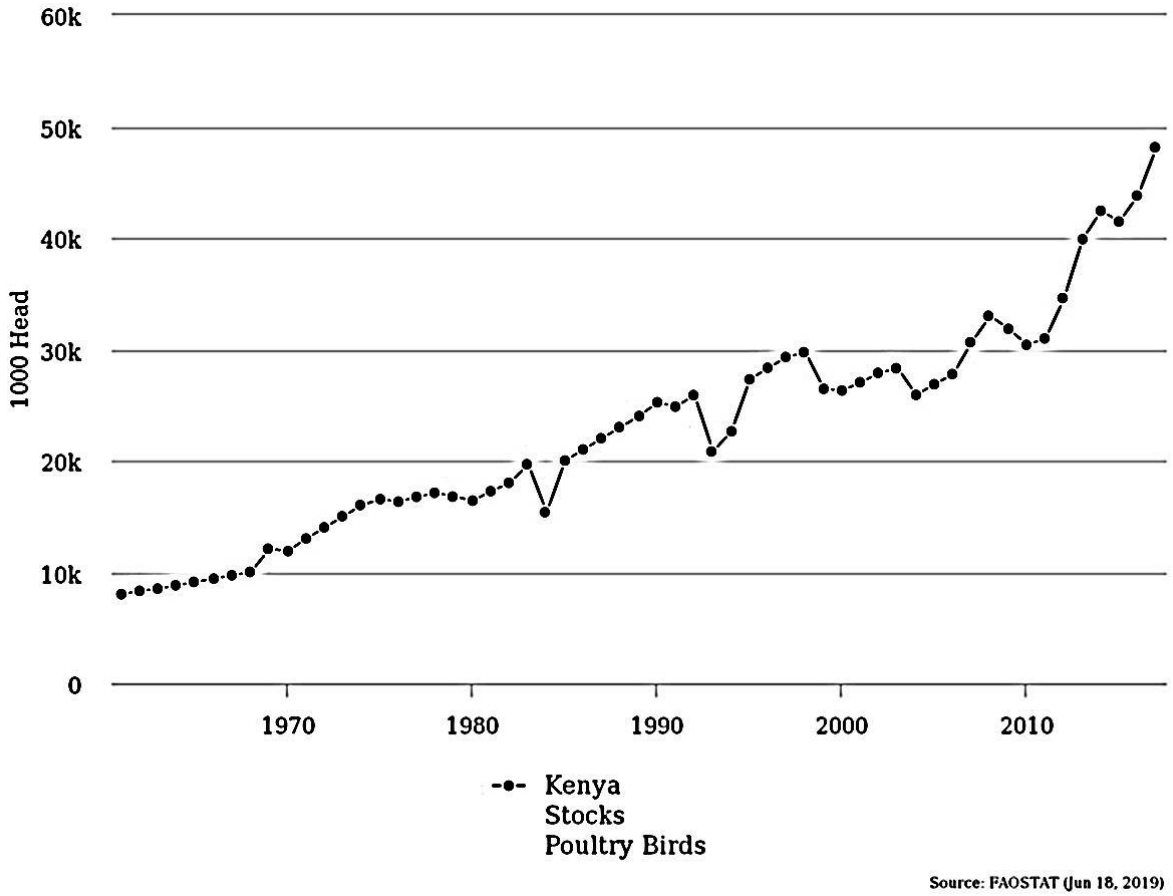

Figure 1: Trend in Kenyan poultry production from 1960 to 2019

According to Omiti and Okuthe (2008), Kenya had 23,661 broiler farms in 2006. Farmers who practice broiler farming obtain day old chicks from reputable hatcheries. Farmers mostly buy poultry feed from agro-vet shops and the quality of feed often vary which affects production. Commercial poultry production is concentrated within the urban towns of Nairobi, Kisumu, Nakuru, Mombasa and Nyeri where there is availability of markets, and also in peri-urban areas which include Kiambu, Kilifi, Maragua, Nakuru, Nairobi and Thika (Nyaga, 2007). This has led to the development of commercial hatcheries found within these

urban and peri-urban areas, which offer hybrid broiler and layer chicks to commercial farmers (Msami, 2008).

2.1.3 Poultry production in Kiambu County

Kiambu County formerly Kiambu District is one of the 47 administrative counties of Kenya which covers an area of about 1,324 km^2 with about 90% arable land (Okello *et al.*, 2010, and GoK, 2007). Commercial poultry production in the County is one of the major economic activities after dairy farming. Crop farming and pig rearing are also practised by farmers in the County (Mbugua, 2014, and Okello *et al.*, 2010). However, during the 1990s, coffee and tea were the major cash crops grown in the County, but due to poor market for these cash crops, people shifted to livestock production, notably dairy and poultry. This shift was driven mainly by the increasing demand for meat, milk and dairy products in neighbouring urban and peri-urban centres such as Nairobi, Thika and Kiambu (Okello *et al.*, 2010; and Omiti and Okuthe, 2008).

Currently, Kiambu County is home to over 1.8 million commercial poultry flock (Table 2). The farmers in the County keep various types of poultry such as chicken (broilers, layers and indigenous), ducks and turkeys. About 85% of chickens raised in the area are exotic, while the other 15% comprise of indigenous (traditional) chicken reared under backyard system (Okello *et al.*, 2010). The establishment of commercial hatcheries in Kikuyu and in the neighbouring Nairobi County act as impetus for the rapid development of commercial poultry industry in the area.

In Kiambu County, production of commercial broiler chickens falls under two systems, namely; contract and non-contract farming. Under the latter, farmers take full responsibility of production and management costs including marketing of their birds. The level of biosecurity under this system is low due to poor disease and waste management practices (Okello *et al.*, 2010). Under contract system, farmers enter into a formal arrangement with a

breeding company that ensure direct supervision and provision of inputs (such as feeds, day-old chicks and veterinary services), while housing and routine management are the responsibility of the farmer (Ngigi and Minot, 2010, and Okello *et al*., 2010). The level of biosecurity under contract system is very high because the contracting company sets strict biosecurity rules to be followed and adhered to by the farmer (Nyaga, 2007). In 2009, about 1,000 farmers were engaged in contract production with hatcheries in Kiambu County (Ngigi and Minot, 2010). Most of the poultry production in the County is concentrated in Kikuyu ward which has a total of 399,043 commercial poultry flock (Table 2).

Table 2: The commercial poultry population in Kiambu County, Kenya

Sub-county	**Commercial poultry population, number**
Kiambu East	185,126
Kikuyu	399,043
Kiambu West	186,631
Lari	29,186
Githunguri	110,202
Thika East	49,439
Thika West	191,810
Ruiru	168,294
Gatanga	144,862
Gatundu	366,834
Total	**1,831,427**

Source: (Country STAT Kenya, 2019)

2.1.4 Contribution of poultry industry to the economy of Kenya

The poultry sector is developing rapidly in Kenya and contributes about 7.8 per cent of the overall GDP (GoK, 2007; Tumwebaze, 2016). About two million people are employed in the sector in production and marketing of various inputs such as feeds, day old chicks and

veterinary services. Poultry meat is an important source of animal protein vital for human growth. It has sufficient nutrients, delicious taste, reasonable cost and it is accepted by all people with different backgrounds (Wahyono and Utami, 2018). Poultry meat moreover contains has less cholesterol compared to red meats (Prabakaran, 2003). Poultry also play vital cultural and social roles (e.g. gifts and rituals) amongst poultry farmers (Njenga, 2005, and Kimani, 2006).

2.1.5 Challenges facing the smallholder poultry industry in Kenya

Although the poultry industry in Kenya is developing rapidly, there are many challenges some of which are discussed below.

High cost of feeds: Good feeds are required for the bird to increase from 0.38 to 2.5 kg in six weeks. However, high cost of feeds (about 60-75% of production cost) frustrates many farmers with some mixing good quality feed with low grade ones, leading to poor bird performance in terms of growth. Due to reliance of many farmers on public transport, they pay more for a 50 kg bag of feed in order to cover transport cost (KARI, 2006; Ochieng *et al.*, 2013).

Marketing: Poultry farmers also have challenges of accessing markets due to inadequate marketing information. This is mainly compounded by lack of record keeping by many farmers. Moreover, middlemen commonly referred to as brokers buy chicken from the farmers at a low price (Kirwa *et al.*, 2010; Ochieng *et al.*, 2013), denying farmers the full profits of their labour.

Diseases and veterinary costs: Lack of effective biosecurity measures can predispose birds to many diseases that may spread to the farm through persons or vehicles entering the farm premises. On the other hand, high cost of veterinary services including vaccines affects many farmers as they cannot afford these services (KARI, 2006; Kirwa *et al*., 2010).

2.2 Knowledge, attitudes and practice of farmers in relation to welfare of broiler chickens

2.2.1 Concept of animal welfare

The concept of animal welfare goes back to the report of the Brambell Committee, which was commissioned by the British government to examine the assertions in the book written by Ruth Harrison, "*Animal machines*" in 1964. The book was critical of the intensive animal production systems practised in Britain at that time (Brambell Committee, 1965, Craig and Swanson, 1994 and Duncan, 2005). Brambell Committee recommended that animals should be accorded freedom to stand up, lie down, turn around, groom and stretch their limbs. By 1993, the Farm Animal Welfare Council of UK published five freedoms that animals must experience in order to have good welfare (Webster, 2016). These are: (i) Freedom from hunger and thirst, (ii) Freedom from discomfort, (iii) Freedom from pain, injury and disease, (iv) Freedom to express normal behaviour and (v) Freedom from fear and distress.

The criteria for assessing good welfare for broilers include good feeding, housing, health as well as appropriate behaviour (Table 3).

Table 3: The principles and criteria used to develop welfare assessment methods

Welfare principles[1]	Welfare criteria[1]		Measures[2]
Good feeding	1	Absence of prolonged hunger	Quantity of feed per bird per day, feeding space
	2	Absence of prolonged thirst	Drinker space
Good housing	3	Comfort around resting	Available perch space per bird
	4	Thermal comfort	Ambient temperature of the poultry house
	5	Ease of movement	Stocking density
Good health	6	Absence of injuries	Foot pad lesions
	7	Absence of diseases	Diseases and bird mortality
	8	Absence of pain induced by management procedures	Beak trimming
Appropriate behaviour	9	Expression of social behaviour	Cannibalism
	10	Expression of other behaviour	Use of nest boxes
	11	Good human-animal relationship	Fear of strangers
	12	Positive emotional state	Fear of new objects

Source: 1=Blokhuis, (2009) and 2= Nicol and Davies, (2013)

2.2.2 Knowledge, attitudes and practice (KAP)

Currently, the growing scientific assessments into cognition and emotional status of farm animals (animals' sentient status) provide sufficient information to the public about animal welfare (Hawkins *et al.,* 2019, and Clark *et al.,* 2016). This has increased public concern and outcry over animal husbandry practices leading to scrutiny of production systems particularly in Europe (Boissy and Erhard, 2014). This has led to the rise in number of vegetarians in some European countries (Knight *et al.,* 2004). Likewise, in America, there is rise in establishment of certification schemes by traders to check on food labels that indicate how animals for consumption were raised (Lake Research Partners, 2018 and Botreau *et al.,* 2007). Knowledge is key in improving the attitudes and perception of farmers, consumers

and the general public towards farm animal welfare (FAWC, 2011, and European Commission, 2007).

A study conducted by Gathanga (2013) at the Kenya Society for the Protection and Care of Animals (KSPCA) revealed that over 90% of the respondents admitted that cultural beliefs, religious practices, myths and traditions strongly influenced the attitudes of people towards animal welfare. Thus issues related to animal welfare should be incorporated into school curriculum in order to raise awareness and sensitize the young people on the same. Conversely, Wambui *et al.* (2018) reported that though many livestock farmers in Kenya might have adequate knowledge on welfare indicators and positive perception of animals, they had deprived their animals of good practices, likely influenced by socio-economic factors such as age, gender and level of education or experience.

The level of knowledge about broiler welfare is high among older people and singles that perhaps have more free time to read newspapers and listen to radios (Erian and Phillips, 2017). These groups of people eat chicken frequently and consider welfare of broilers more important than its cost (Erian and Phillips, 2017). Thus, the knowledge of the public on broiler welfare is highly connected to their attitudes and practices. Moreover, the media plays an important role in disseminating information on animal welfare as well as on factors that govern the choice of consumers on animal products such as health concerns, food trends, religious taboos and cultural beliefs (Popa *et al.*, 2011).

2.3 Welfare issues of broiler keeping

2.3.1 Nutrition and water supply

Nutrition not only maximises the broilers' production performance but also improves broiler health. An adequate feeding program improves the health and welfare of broilers subjected to conditions of stress. Under high temperatures, the diet of the broilers should be formulated with low crude protein content and should be supplemented with sufficient amount of

essential amino acids that will help in reduction of metabolic heat production of the birds during digestion (Manfreda *et al*., 1994). Manfreda and the associates also reported that the use of high amounts of ascorbic acid is ideal for alleviation of heat stress by the birds while enhancement of the immune system activity can be achieved by supplementing high levels of vitamin A and E.

Water is another critical nutrient in poultry production. It is used in several metabolic processes, in reduction of air temperature and facility sanitation. Water is needed for digestion, transport of materials from one place to another in the body, temperature regulation and lubrication of organs (Fairchild and Ritz, 2015). The consumption of water is affected by ambient temperature, production level, quality of water and temperature. Freedom from thirst can be realised through sufficient provision of water at all times. Thus, at high ambient temperature it is critical to provide water *ad libitum* to the broilers and ensure adequate provision of watering equipment. This will help in minimising stress in the flock.

2.3.2 Feeding and watering spaces

Feeders are pieces of equipment used for holding the feed while drinkers are used for providing water to the birds. Feeders and drinkers can be ordinary or automated and made from plastic or metal (Prabakaran, 2003). Sufficient feeding and drinking spaces should be provided to the broilers depending on their age (Table 4). Farmers using feeding toughs should ensure at least 10 cm/bird as feeding space, but when using circular feeders, 4 cm/bird of feeding space should be provided to the birds (Epol, 2017). If pan feeders are used, then the farmer should ensure 45 to 60 birds per pan (Aviagen, 2015). Pan feeders are better than troughs when it comes to space requirements and ease in movement of the birds. For drinkers, the farmer should avail one bell drinker for 100 birds and one nipple drinker for at least 12 birds dependent on the size of the birds (Epol, 2017). It is important to ensure that there is uniform distribution of feeders and drinkers throughout the floor of the house that

allow the birds to only walk short distances to access them. For, example a bird should walk for about 150 cm to a feeder and 300 cm to a drinker (Prabakaran, 2003). In adequate number of feeding and watering facilities deprive the weak birds from accessing feed and water affecting their health and welfare (Bessei, 2006).

Table 4: Recommended amounts of feed, feeding and drinking spaces for broiler chickens.

Age in weeks	Feed per bird (grams)	Feeding space (cm)	Drinking space (cm)
0-3	800-1,000	3	1.3
4-8	1,100-1,500	5	2.5
>8	1,500	10	5

Source: (Prabakaran, 2003 and Epol, 2017)

2.4 Housing

In developing nations, the focus has been on improving the poultry housing structures that allow for the provision of the conducive environment for body temperature control. This is especially critical for the young birds that cannot regulate their own body temperature during first two weeks of life (Glatz and Pym, 2015). The deep litter system is the most widely used system for raising broiler chickens (Prabakaran, 2003). Other systems such as the cage or wire slatted floor systems are not commonly used in broiler production due to the injuries they may cause to the birds or workers and difficulty in catching birds for marketing leading to welfare concerns (Prabakaran, 2003).

Despite the challenges quoted above, slatted floor systems and cages are extensively used in layer production. With the advancement in technology, modern broiler housing systems have been established and are adopted mostly by the large scale producers who have enough capital for investment. Broiler houses with automated ventilation systems have been introduced that allow automatic exchange of air in and out of the house (Glatz and Pym, 2015, and Prabakaran, 2003). In such houses, the relative humidity, lighting, air temperature,

ammonia levels, etc. are monitored automatically and they provide the birds with the best environment that enables faster growth with better feed utilization. For small scale farmers due to low capital, local materials are often used for the construction of poultry houses. These include iron sheets, timbers, wire mesh, bamboo or mud bricks. About 50-100 broilers of the same age group are often kept in one house (Glatz and Pym, 2015).

2.4.1 Stocking density

Stocking density is defined as the kilogram live weight or number of housed birds per m^2 floor space at the end of growing period. Broiler chickens farmed intensively are kept at high stocking density in an effort to increase profit from production. However, it is well understood that increasing the density compromises the welfare of the birds. McLean *et al*., (2001) reported that the stocking density above 30 kg per m^2 leads to reduction in growth due to heat stress. Moreover, overcrowding of broilers leads high dissipation of heat of metabolism together with increase in litter temperature that enhances microbial activity as a result of higher moisture and nitrogen contents causing heat stress. However, Grashorn and Kutritz (1991) reported that ventilation rate plays a vital role in minimising the adverse effects of stocking density.

Stocking density also impacts welfare criteria of housed birds mainly through the quality of litter and air. Dampness and litter temperature increase with increase in the age of broilers and increased stocking density. This causes inconvenience to the birds as they approach market age. Thus, observing and monitoring the physical conditions and behaviour of the birds is very important (Bessei, 2006). In broilers, the impact of stocking density on scratching behaviour and locomotion was enhanced after increasing the stocking density from 10 birds per meter square to higher densities (Bessei and Reiter, 1993; van der Haar and Blokhuis, 1990). Dawkins *et al*. (2004) noted that housing conditions such as house temperature, litter quality, and humidity were more indispensable than stocking density.

2.4.2 Litter

Litter is the bedding material used in the poultry houses. Farmers can choose litter material depending on cost and availability of the material locally. Materials such as wood shavings saw dust and chopped straw, coffee, ground nut and rice hulls are used as litter (Prabakaran, 2003). About 5-10 cm of litter height is considered sufficient and should be maintained as dry as possible by raking after every two weeks in order to break the caked material (Prabakaran, 2003). While raking, feeders and drinkers should be removed to avoid spillage. Litter quality is very vital for broilers' welfare due their constant interaction with it (Adele and Federico, 2009). The litter becomes dirty when the stocking density is high. Due to heavy body weight, broilers spend most of their time resting on their shanks and breasts (SCAHAW, 2000; CIWFT, 2005). The shanks and breasts are in constant contact with the litter that can result in contact *dermatitis*. CIWFT (2005) reported that at least three quarters of broilers around the world were affected by health problems that were compounded by the above forms of contact dermatitis in the past three decades. The skin of the birds becomes discoloured and progresses into ulcers with some form of discharge that is eventually covered with litter and faecal matter (SCAHAW, 2000). This then paves a way for bacteria to invade the bloodstream which causes joint inflammation of the bird. Hock burns and foot sores are forms of leg conditions that inflict severe suffering on the birds and bird having such disorders spend most of their time sitting due to walking inability induced by the painful legs (Su, Sørensen and Kestin, 2000). SCAHAW (2000) concluded that the poor quality of litter, weak legs and overcrowding are the causes of contact dermatitis that affect many broiler flocks. However, Grashorn and Kutritz (1991) reported that proper ventilation can prevent the build-up of excessive moisture in the litter.

2.4.3 House temperature

The manipulation or modification of control systems in the poultry house to avert bad weather conditions is necessary for farmers in order to satisfy the welfare needs of broiler chickens (Glatz and Pym, 2015). Extreme environmental conditions such as heat or cold stress, poor ventilation and air circulation can be controlled if the poultry house is appropriately designed. Thus, housing design that ensures proper control of the house temperature is important. Araújo *et al.* (2015) reported that the performance of broilers is greatly influenced by the ambient temperature especially towards the end of the growing period. When broilers are exposed to heat stress, their feed intake reduces, consequently impacting on their welfare and performance (Amaral *et al.,* 2011 and Araújo *et al.,* 2015). Therefore, manipulation of the environment where the birds are kept helps in preventing production lossess arising from heat stress (Adele and Federico, 2009, & Lin *et al.,* 2006). Accordingly, Lin *et al.* (2006) suggested that the control of light in the poultry house is paramount. They recommended that low light of less than 5 lux produces less heat in broilers in the last two weeks of the rearing period.

2.4.4 Ventilation

Ventilation allows for air exchange and also controls the temperature and humidity in the poultry house (Anon, 2019). Ventilation in the poultry house should be managed properly by observing the behaviour of the broilers in the whole house. There should be even distribution of the birds throughout the rearing area of the house and the birds should not be panting nor huddling together in one corner of the house (Aviagen, 2016). In small scale poultry production systems, broiler sheds are normally constructed with open sides to allow for natural ventilation. This is often carried out by hanging curtains or flaps that are lowered or raised depending on the climatic conditions prevailing in the area (Prabakaran, 2003).

2.4.5 Ammonia levels

The accumulation of ammonia in poultry houses is detrimental to the health and welfare of broiler chickens (CIWFT, 2005). Faecal uric acid decomposes to form ammonia and mixes with dust that comes from litter particles as well as from feed, manure, feathers and skin. The efficiency of ventilation, stocking density and the quality of litter determines the level of air pollution in broiler pens (SCAHAW, 2000). Broilers are constantly exposed to these contaminants and their damaging effects. SCAHAW (2000) reported that high ammonia levels are responsible for the occurrence of ascites and other respiratory ailments and the swelling if the eyes and the trachea in broiler chickens. High levels of dust are responsible for irritation of the respiratory tracts of chicken and the impairment of their resistance against diseases that lead to spread of infections (CIWFT, 2005). Wathes *et al.* (1997) in a study that was conducted in UK to ascertain the quality of air in broiler houses reported that the mean levels of ammonia concentrations were above the limits set in guidelines for animal welfare. Ammonia levels exceeding 25 ppm in air causes stress to housed birds (Prabakaran, 2003).

2.5 Health and disease

Poor housing can expose poultry birds to diseases which impacts negatively on their welfare and production. Hence the environment of the birds should be managed in consideration to the climate of the area (Nijhuis and Van, 2012). Foot pad lesions are commonly found in wet litter where there is poor management of watering facilities. High stocking density blocks air underneath deep litter systems, decreasing heat exchange between litter and ventilated spaces which increases the heat load of the birds. The stocking density effect on various types of foot lesions are heightened when the litter conditions are poor (Bessei, 2006). Fear, pain and distress are forms of suffering. Therefore, in order to optimise production and improve poultry welfare, it is important to minimise fear, pain and distress (Jones, 1996, & Duncan, 2004).

2.5.1 Behaviour of broilers

Animal behaviour is generally defined as the ways in which animals interact with each other and with their immediate environment (Broom, 2008). It includes the avoidance of predators, competition, reproduction and taking care of the young ones (Wikibooks, 2018). In order to enhance bird's welfare, facilities that allow expression of normal behaviour should be provided. These include perches and boxes for sand bathing. Davies and Weeks (1995) achieved 22% perching after adapting height of perches based on the growth of broilers, from 2.5 to 26 cm. But, according to Bessei (1992), broilers perched on a ramp found between drinker and feeder. They spent long hours sitting than birds without ramps. Bizeray *et al.* (2001) reported that barriers placed between drinkers and feeders have been used as perches by the birds. However, perches are not used in broiler production systems because of resultant kneel bone fractures (Bessei, 2007).

2.5.2 Enrichment of the environment

Various attempts have been made to increase activity of broilers by improving their environment**.** The use of litter, toys, lighting and sequential feeding programmes, perches and elevated platforms have been adopted (Adele and Federico, 2009). Presence of litter on the floor stimulates the behaviour of scratching in young birds; however, this behaviour decreases as the birds grow and mature (Bessei, 1992). It is unclear whether the decrease in scratching behaviour of older birds is caused by the reduction of general activity or by litter quality deterioration. The activity of broilers is increased when perches are provided (Bessei, 2006). Climbing, scratching and perching opportunities provided to the birds tend to increase their behavioural activities significantly, but low percentage of broilers tends to use perches and this can be increased by raising the height of perches gradually as well as increasing the stocking density. According to Bessei (2007), broiler rearing systems that adopted use of perches resulted in keel bone fractures and breast blisters compromising their welfare.

2.6 Effect of welfare on production

Birds that experience the five freedoms listed in chapter one are said to be in good welfare and perform better than the ones that lack these freedoms. Adequate nutrition in terms of the amount of energy, protein and micro and macro elements provided to the birds enhances better performance (Underwood and Suttle, 2000). Overcrowding leads to cannibalism that affects production and increases susceptibility to respiratory ailments, affecting productivity (Nicol and Davies, 2013).

Lara and Rastagno (2013) reported that the productivity of the birds is affected when they are exposed to high levels of environmental temperature that induces physiological, behavioural and immunological responses. Conversely, broilers exposed to prolonged heat stress showed marked reduction in feed consumption, lower body weight and higher ratio of feed conversion at the rate of -16.4, -32.6 and +25.5%, respectively (Sohail *et al*. 2012). However, in order to mitigate consistent detrimental effects of heat stress in broilers, it should be considered that stocking density has a potential limiting factor, from the perspective of welfare as well as production (Estevez, 2007).

CHAPTER THREE: MATERIALS AND METHODS

3.1 Introduction

In Kenya, issues related to the welfare of broiler chickens receive very little attention from consumers, producers, animal scientists, veterinarians and academia. This may be due to the insufficient enforcement of the available legislation (livestock Acts) by the government. Therefore, it is important to assess broiler welfare, in order to increase sensitivity on the same and inform the necessary policies and legislation. The objectives of this study were:

i. To evaluate the knowledge, attitudes, and practices of farmers in relation to the welfare of broiler chickens.
ii. To determine the management factors that influences the welfare of broilers in small scale production systems in Kiambu County.
iii. To evaluate the effects of welfare on the performance of broiler chickens.

3.2 Study area

The study was conducted in Kiambu County, one of the 47 administrative units of Kenya. The county is located in the central highlands of Kenya and borders Nairobi, Nakuru and Muranga to the South, West and North, respectively (Fig. 1). The county is divided into twelve sub-counties, namely Gatundu North, Gatundu South, Githunguri, Juja, Kiambaa, Kabete, Kiambu, Kikuyu, Lari, Limuru, Ruiru and Thika Town. These sub-counties are further divided into sixty wards (County Government of Kiambu, 2018).

According to the national population and housing census of 2009, Kiambu County covers an area of about 2,543.5 km^2 with 476.3 km^2 under forest cover. Ten years ago, the human population was 936, 411 people (KNBS, 2009). The population was projected to increase to 2,032,466 by 2017 (County Government of Kiambu, 2018).

The 2009 Kenya Population and Housing Census reported that 25.6% of the national commercial poultry flock was located in Kiambu County (KNBS, 2009, and GoK, 2010).

Within the county, Kikuyu Division had the highest number of the commercial poultry population of 399,043 birds, representing 6.4% of the national figure (KNBS, 2009). After the promulgation of the national constitution in 2010, Kikuyu Division was divided into Kikuyu and Kabete sub-counties. The County and sub-counties were therefore selected as study areas based on the poultry population and proximity to the University of Nairobi. The administrative units (wards) of Kikuyu and Kabete sub-counties are shown in Table 5.

Table 5: Administrative units of Kabete and Kikuyu sub-counties, Kiambu County, Kenya

Ward	**Area km^2**	**Human population**	**# of farmers**	**# of farmers sampled**
Kabete	10.1	30,657	7	5
Gitaru	13.5	29,177	50	37
Muguga	15.3	27,527	33	20
Nyathuna	17.8	28,771	15	9
Uthiru	3.5	24,295	13	7
Karai	27.6	20,420	18	15
Nachu	96.3	18,655	3	2
Sigona	24.5	26,823	14	11
Kikuyu	21	32,422	16	12
Kinoo	6.3	27,082	3	2

Source: (SoftKenya, 2011 and survey data, 2019)

The field survey was carried out to evaluate management factors influencing welfare and performance of broiler chickens in the ten wards listed in Table 6 above.

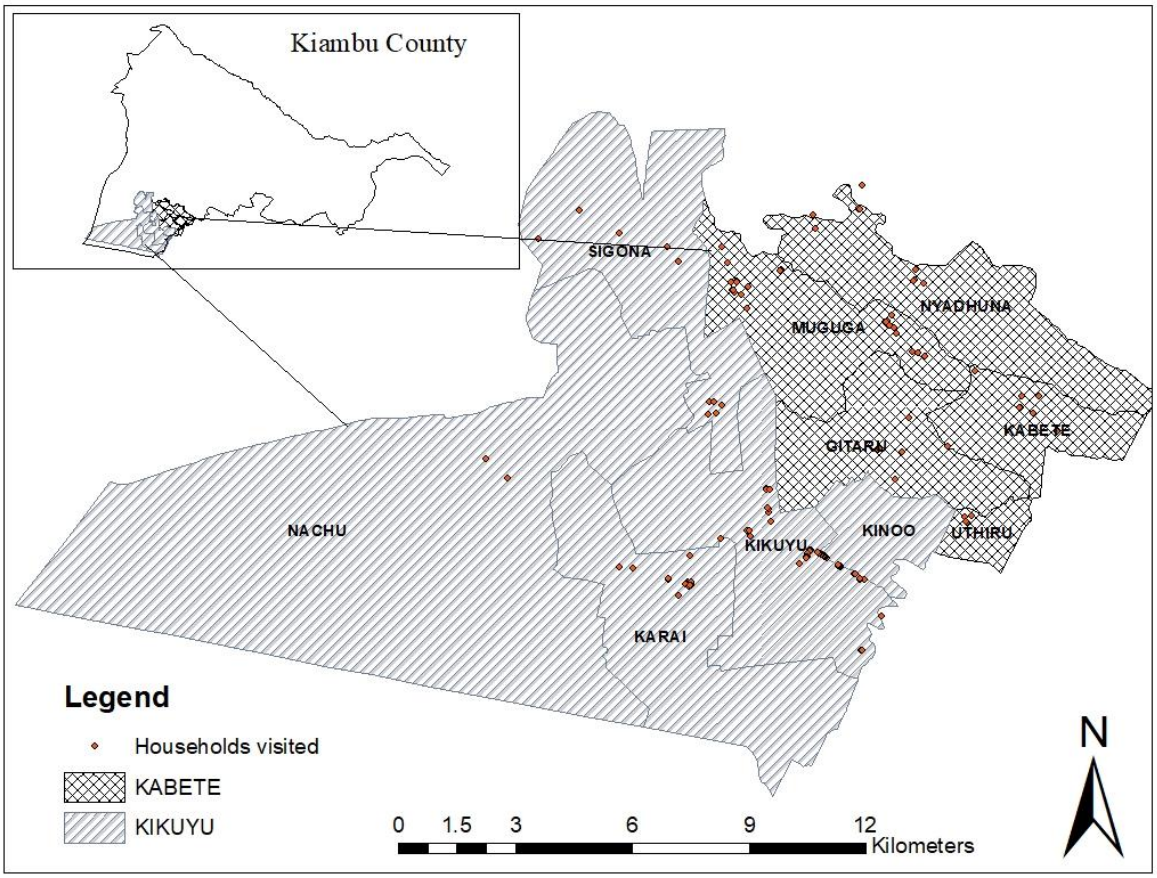

Figure 2: Map of Kiambu County showing the study areas.

3.3 Sample size and its determination

Simple random sampling was done to select 120 farmers who took part in the research from the total population of 172 farmers keeping broilers in the area. A sample of 120 farmers was used according to the formula of Yamane (1967:886). The number of broiler farmers in the area was 172 (County Government of Kiambu, 2018).

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

Where n = the sample size, N = the population size, and e = 0.05; the level of precision (error term). By solving for n, the sample size of 120 is obtained.

The sample size was drawn from the ten wards, five wards from each sub-county of Kikuyu and Kabete, respectively. It was determined based on the number of farmers keeping broilers in each ward, number of broilers in each household, accessibility and resources available. The

intention of the survey was to interview 30 farmers in each ward but due to seasonality of broiler keeping and poor market of broilers in some wards, farmers shifted to other more economically viable enterprises such as dairy, indigenous chickens farming and construction of residential houses for rent. Therefore, the data was collected from 42 and 78 farmers in Kikuyu and Kabete sub-counties, respectively. The number of farmers keeping broilers in Kikuyu sub-county was lower than that in Kabete during the time of the study. Thus, the sampling was done based on the number of farmers in each sub-county.

3.4 Data collection

Data was collected from primary sources and management records were also reviewed for secondary data. Information collected was described as in each specific objective below:

i. To evaluate the knowledge, attitudes, and practices of farmers in relation to the welfare of broiler chickens.

Survey was conducted to select broiler farmers randomly and interview them through semi structured questionnaire to gather information on the following: Demographic and socio-economic characteristics of the farmers. These included; age and gender of the farmer, farm and broiler ownership, farmer's status in the household, marital status, level of education, employment status, number of birds, age of the birds in weeks and land size of the farm in hectares. The level of knowledge, attitudes and practices to broiler welfare among farmers in small scale production systems were assessed as well. Also, data was collected on the characteristics of production including the farmer's experience in broiler keeping, number of birds from 0-3 weeks and 4-6 weeks, respectively. Number of broiler flocks per household, number of flocks kept by the farmer per year, type of poultry kept and ranking of other economic activities of the farmer was assessed. Information was also sought on date of placement of broilers, desirable market age in days, live weight of birds in kg, whether or not the farmer kept production records and challenges the farmer faced in broiler production. The

correlation between farmers' knowledge on animal welfare and socio-economic characteristics such as age, gender, land size, level of education and years in broiler keeping of the farmers was determined. Four focus group discussions (FGDs) were also were held with broiler farmers, two in each sub-county.

ii. To determine the management factors that influences the welfare of broilers in small scale production systems in Kiambu County.

Measurements and assessment were done on: Accessibility to feeds, amount of feed and feeding regime, that is, the quantity of feed available to the birds of 0-3 weeks and 4-6 weeks old, and the number of days it takes for providing 50/70 kg bag of feed. This was then compared for different farms in order to determine the optimal quantity of feed and feeding times to the birds. Types of feeding and watering equipment were also assessed. Likewise, feeding and drinking spaces were evaluated by calculating the space per bird, that is, number of feeders/drinkers times area per feeder/drinker and divided by the number of birds in the house. Tape measure was used for measuring house and ventilation dimensions. Water availability was also evaluated by assessing the amount of water available. Water temperature was determined by use of thumb to check whether the water was warm or cool. The quality of litter was determined using hand to determine moisture content, whether it was dry and flaky, or sticky on compaction. The temperature of the poultry house was measured using thermometer. Hygrometer was used for measuring relative humidity (RH). Floor area/space per bird was measured in order to determine the stocking density. Ammonia level was assessed by the level of irritation to eyes of the enumerators. Efforts were made to secure ammonia meter but could not succeed due to scarcity of the devise. A random sample of birds in each flock was assessed for foot pad lesions, breast blisters and hock burns. Farmers were evaluated on whether they observed fear and distress in their flocks and its frequency. Management records were sought for vaccinations and sanitation practices.

iii. To evaluate the effects of welfare on performance of broiler chickens.

Parameters that were assessed include; mortalities, live weight of birds (kg), age at market weight (days) and total feed consumed (kg/bird). The correlation between farmers' knowledge on broiler welfare and characteristics of production was determined. The welfare indicators in objective two above were correlated with one major performance indicator in objective three in order to determine the correlation coefficient between broiler welfare and production.

3.5 Data analysis

The obtained data was first systematically scrutinized before it was carefully entered into excel sheet and coded. The data was then imported into SPSS (Statistical Package for Social Sciences) version 21.0 for statistical analysis (Techopedia, 2018), where the frequencies, means and standard deviations, percentages and correlations were computed. Microsoft excel and word processing programs were used in preparing the summary tables and development of charts and graphs.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Socio-economic characteristics of broiler farmers in the study area

4.1.1 Age groups of the farmers

Figure 2 shows the age of the farmers who took part in the study. Majority of them (46.6%) were between 31-50 years of age, followed by those (39.3%) in the age bracket of 51 to 70 years. Farmers interviewed in the age group of 21-30 years and above 70 years were only 9.8% and 4.3%, respectively. The age group of 31-50 years is usually composed of energetic individuals who often show commitment to farming (Bunyatta and Mureiti, 2010). The age category between 21-30 years comprises of young people who are usually inexperienced and have newly ventured into poultry farming with little or no capital. On the other hand, the age group of 50 years and above mostly represents older adults who are retired and keep poultry for supplementing their pension. However, according to Teklewold *et al.* (2006), the age of the farmers may affect their level of adoption of modern poultry farming practices as older farmers are more rigid to the adoption of the latest technologies than their younger counterparts. Besides, this may influence their awareness of emerging trends in the sector, such as that of broiler welfare, which may limit the level of output from poultry production. There was no significant correlation between age of the farmers and their knowledge on animal welfare ($p>0.05$).

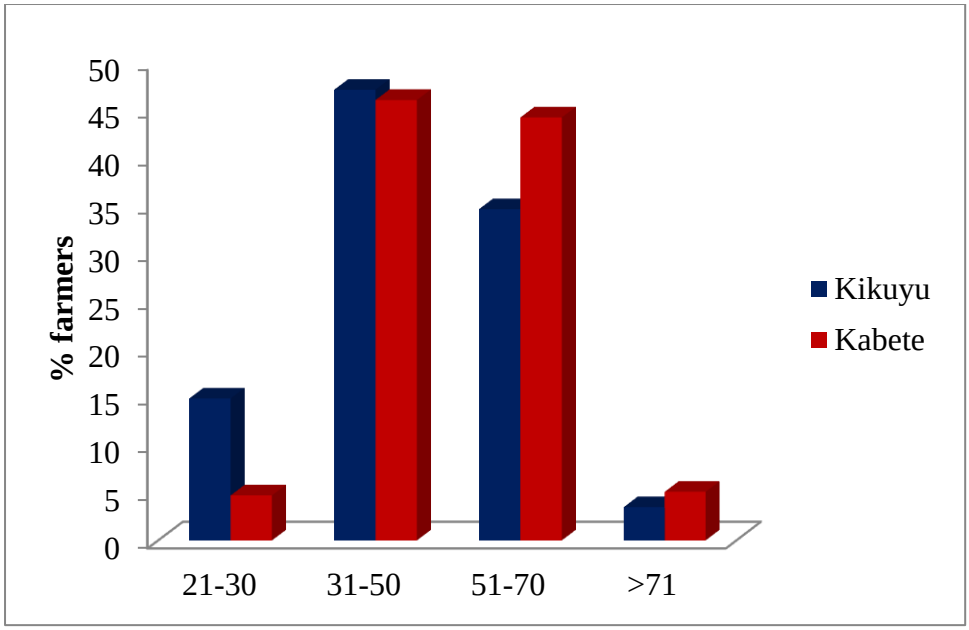

Figure 3: Age of farmers in the study area

4.1.2 Gender and marital status of the farmers

Gender representation and marital status of farmers in the study area are shown in Table 6. About 71% of the farmers were women, and the others were men. Recent studies have shown that women contribute about 43% of the labour force in the agriculture sector in developing nations (Team and Doss, 2011). Moreover, the role played by women in poultry management is of utmost importance as chickens are often managed and fed within the homestead (Guèye, 2000; Tung, 2005; and FAO, 1998). On average, above 90% of the farmers were married, while singles and widows/widowers were only 6 and 2%, respectively. Married farmers have higher chances of venturing into poultry farming than their single or widowed counterparts due to the availability of capital and labour as their partners and children may support them. The correlation between gender and farmers' knowledge of animal welfare was not significant ($p>0.05$). It might be because women were more than men on average and that they were better informed on animal welfare issues.

Table 6: Gender and marital status of respondents in the study area (%)

Category	Kikuyu (n=42)	Kabete (n=78)	Mean
Gender			
Female	56.91	85.22	71.07
Male	43.09	14.78	28.93
Marital status			
Married	91.55	92.06	91.81
Single	4.82	7.94	6.38
Widow/widower	3.63	0.00	1.81

4.1.3 Level of education of the farmers

The education level of the farmers in the study area is shown in Table 8. An average of 51% of farmers had attained secondary school education, while 32 and 17% of them had attained primary and post-secondary education, respectively. The level of education influences farmers' learning and problem-solving techniques as well as the decision making process, resulting in increased agricultural productivity (Ferreira, 2018; Steve *et al.*, 2014 and Davis *et al.,* 2010). In a study in Bureti sub-county, Kirui (2014) reported that farmers with post-secondary education had better returns than those who had a primary or secondary school. The correlation coefficient between the level of education and farmers' knowledge of animal welfare was r=-0.275 (Table 7). This implied that the relationship between the level of education and farmers' knowledge of animal welfare was significant (p=0.01).

Table 7: Correlation between level of education and farmers' knowledge on animal welfare

	Education level	Knowledge on animal welfare
Pearson Correlation	1	-0.275**
Sig. (2-tailed)		0.01
N	120	120

**. Correlation is significant at the 0.01 level (2-tailed).

Table 8: Education level of broiler farmers in the study area (%)

Education level	Kikuyu (n=42)	Kabete (n=78)	Mean
Post-secondary	22.97	11.47	17.22
Secondary school	42.82	58.48	50.65
Primary school	34.21	30.05	32.13
None	0.00	0.00	0.00

4.2 Characteristics of the farms

4.2.1 Land size

The size of land owned by the farmers in the study area is shown in Table 10. On average, the land size was 0.81±0.9 hectares per household. This was double the size of land owned by farmers in Kabete sub-county that was reported as 0.4±0.3 hectares by Shukri (2018). Indeed in this study, it was found that the average land size per family in the five wards that made up Kabete sub-county was 0.4±0.3, which was similar to the findings of Shukri (2018). However, data from the County Government of Kiambu (2018) indicated that Kabete sub-county is more densely populated than Kikuyu sub-county, thus land size shrinks as the human population increases (Muyanga *et al*, 2016; Muyanga and Jayne, 2014). The land size in Kikuyu sub-county was 1.18±1.44 ha/farmer, which was higher than that in Kabete. There was no significant correlation ($p>0.05$) between land size and the farmers' knowledge of animal welfare, where $r=0.251$ (Table 9). This implied that decreasing land sizes due to population pressure led to inefficiency in poultry production (such as high stocking density) with low economic benefits (Ogolla, 2016).

Table 9: Correlation between land size and farmers' knowledge on animal welfare

	Farmers' land size	Knowledge on animal welfare
Pearson Correlation	1	0.251
Sig. (2-tailed)		0.060
N	120	120

Table 10: Average land size of farmers in the study area

Land size (hectares/farmer)	Kikuyu (n=42)	Kabete (n=78)	Mean
Mean	1.18	0.44	0.81
SD	1.44	0.36	0.90

4.2.2 Farmers' experience in broiler farming

About 47% of farmers reported having kept broilers for a period of 1-5 years, while 22% had reared them for more than 15 years (Fig. 4). About 13% of farmers had six to ten years of experience in broiler farming, whereas 11% of them had less than one year experience and only 7% of them had 11-15 years of experience. This implied that more farmers had ≤5 years of experience in broiler farming, thus have learned management practices for ensuring good welfare of their birds. Long years of experience increases poultry productivity due to the knowledge gained on management (Adetayo *et al.*, 2013; and Fetuga, 1992).

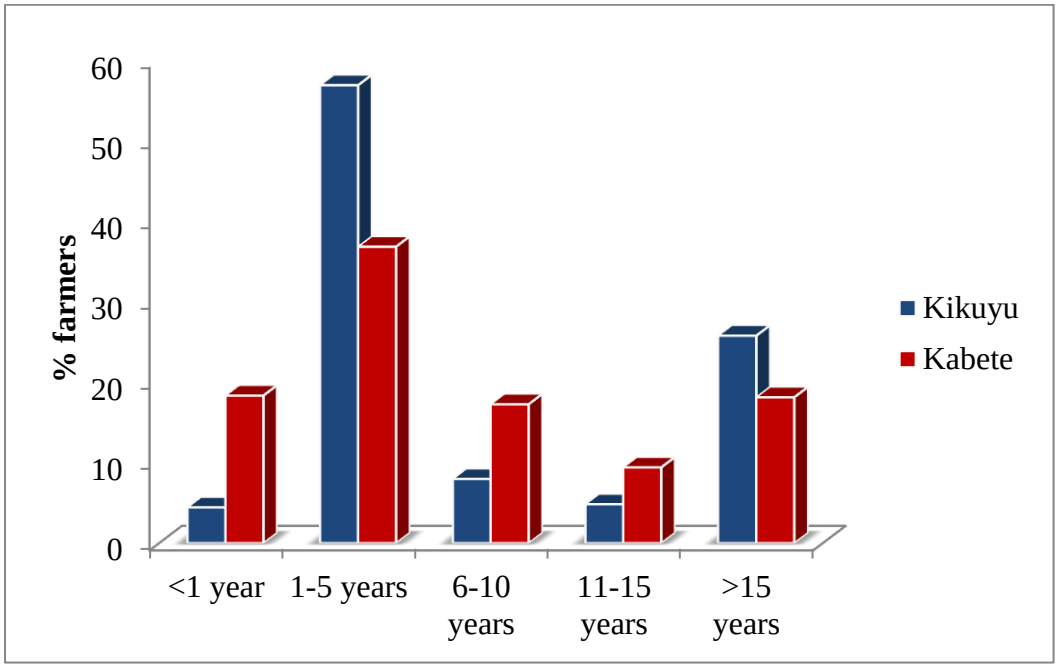

Figure 4: Number of years in keeping poultry by farmers

4.2.3 Constraints to broiler farming in Kiambu County

The challenges faced by broiler farmers in the study area are shown in Fig. 5 below. The major constraint faced by farmers was the high cost of feeds (87.2%) followed by diseases (62.4%). Lack of ready market for broilers and high veterinary costs constituted 20.9 and 9.4%, respectively. The high cost of feeds was reported to have caused frustration among the smallholder poultry farmers, forcing many of them to mix good and bad quality feeds together, leading to poor growth performance in birds (KARI, 2006; Ochieng, *et al.,* 2013). In relation to that, Okello *et al.* (2010) reported that feeds constitute about 65-70% of the total production cost in commercial poultry farming, hence to achieve better performance, farmers must ensure proper feeding of their broilers. During focus group discussion, farmers also reported that they were very sceptical about the quality of feeds supplied by feed millers in Kiambu County. Thus they urged the Kenya Bureau of Standards (KEBS) to intervene to guarantee the quality assurance of the feeds they purchase. In the meantime, farmers provided supplements (boosters) to their birds for improving the quality of the feeds. Diseases such as infectious bursal disease (Gumboro), New Castle Disease, coccidiosis, pneumonia, and water belly (ascites) were reported to be affecting broilers in the area (Fig. 7). However, lack of effective biosecurity measures can predispose birds to many diseases that may spread to the farm through persons or vehicles entering the farm premises (KARI, 2006). Ascites was reported to be causing carcass condemnation and high rate of mortality in rapid growing birds like broilers (SCAHAW, 2000; Olkowski *et al.,* 2001). Lack of ready market for broilers was another constraint facing farmers in Kiambu County. A complex mix of issues such as failure to honour agreements with suppliers and poor management of financial returns as well as inadequate marketing information are some of the problems farmers' battle with daily. Besides, some middlemen commonly referred to as brokers take advantage of this situation to flood local markets with live birds purchased cheaply from the farmers, affecting market

prices (Ochieng, *et al.*, 2013; Kirwa, 2010). Farmers also reported lack of storage facilities for slaughtered birds, competition from large scale farmers, and negative perception of consumers about broilers as well as inadequate extension services as the other challenges they were facing during the focus group discussions.

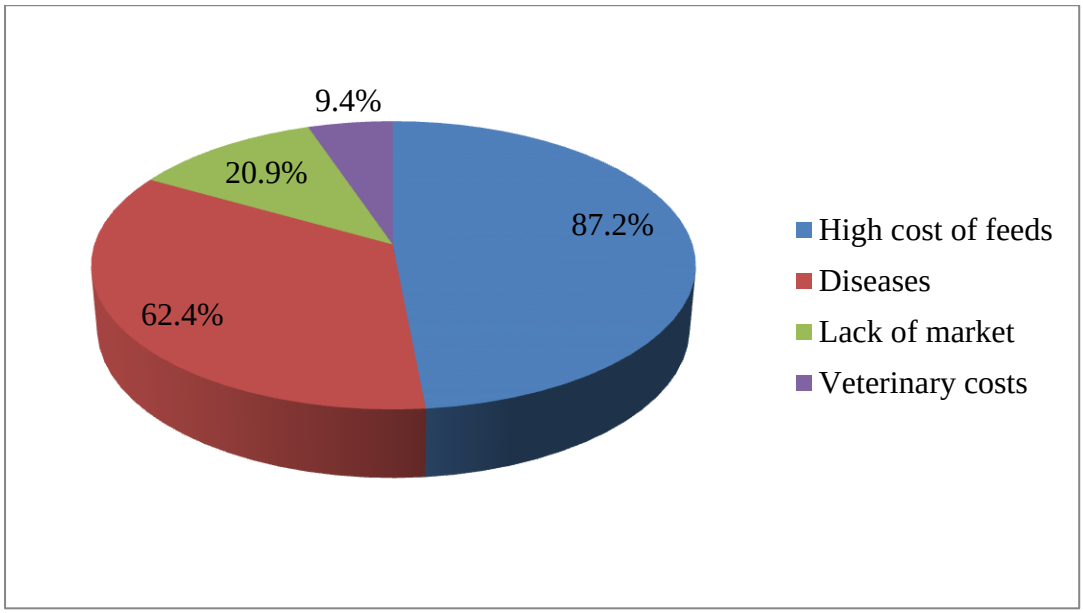

Figure 5: Challenges facing farmers in broiler production in the study area (%)

4.2.4 Marketing of broilers

Table 11 shows the marketing channels of broiler in the study area. A slight majority of farmers (28.78%) sold their live birds to individuals, whereas at least 28.65% of them sold their birds in restaurants and hotels. Nairobi County provided a ready demand for broilers where 15.7% of broiler farmers from the two sub-counties sold their birds to brokers (intermediaries) who then sold them to individuals. Approximately 50% of farmers in Nairobi County sold their broilers in open-air markets (Maud *et al.*, 2017). Only about 26.9% of farmers in the study area sold their live birds to local markets. Lack of storage facilities for slaughtered birds has limited the ability of farmers in the study area to access Nairobi city market. This was because transportation of live birds was more costly than the killed birds. The farmers reported this during focus group discussions.

Table 11: Broiler marketing channels reported by the farmers (%)

Market source	Kikuyu (n=42)	Kabete (n=78)	Mean
Individuals	25.53	32.02	28.78
Restaurants and hotels	33.56	23.73	28.65
Local markets	23.11	30.70	26.91
Nairobi	17.80	13.55	15.68

4.2.5 Importance of farming broilers in the study area

Most of the farmers (73.6%) reported income generation as the main benefit of farming broilers, while 46.7% reported improvement in food security at the household level (Fig. 6). About 28.7% of farmers reported having benefited from other services in broiler farming. These included but not limited to; quick turnover, less labour-intensive, low space requirement, and gaining experience in farming. By-products of broiler farming such as viscera were used in pig diets. Other chicken parts such as liver, heads, and legs were sold. This was validated during focus group discussions with the farmers. At least 23.7% and 1.4% of farmers identified chicken manure and employment creation, respectively, as some of the benefits of broiler enterprise. Chicken manure can be sold, fed to dairy cows or used for fertilizing crop gardens by the farmers. Raymond (2010) and Zublena *et al.* (1993) reported that chicken manure embedded in litter material has very high organic matter content and is also rich in nitrogenous compounds and other macro-nutrients such as calcium, phosphorus, and potassium and its addition to the soil leads to the improvement of soil structure.

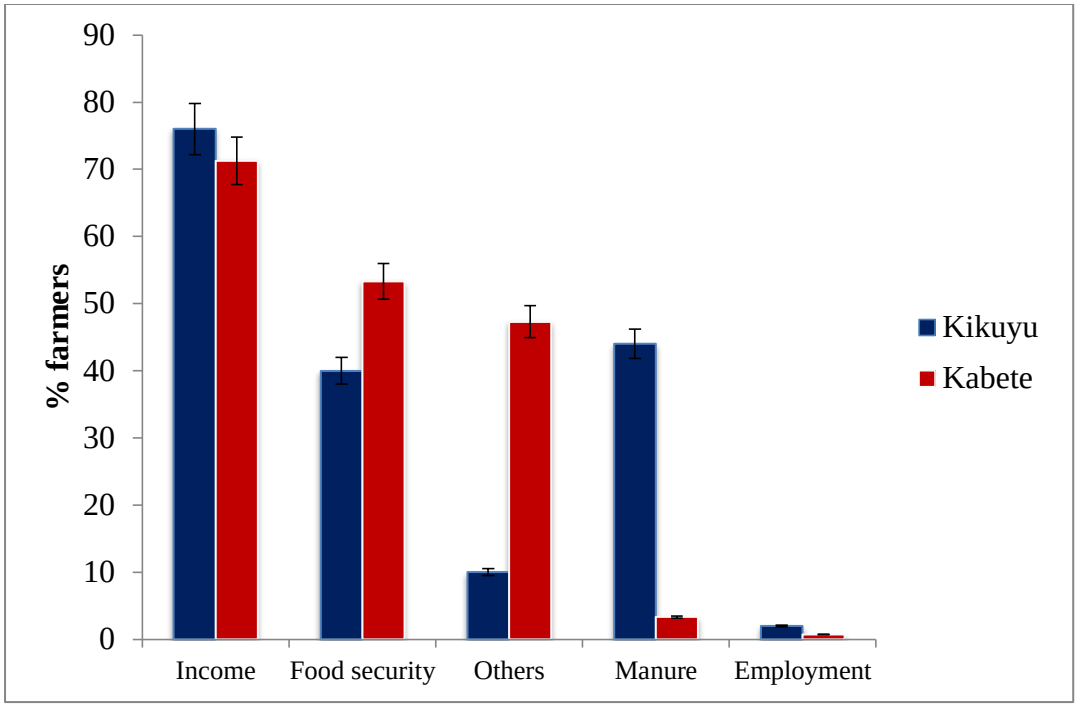

Figure 6: Importance of farming broilers in the study area

4.2.6 Ranking of farming activities by farmers in order of economic importance

The primary farming activities carried out in the study area are shown in Fig. 7 in order of economic importance to the farmers. At least 58.3% of the farmers engaged in dairy farming, while 56.7, 49.2, and 41.7% kept broilers, indigenous chicken and grew vegetables, respectively. The farmers also practiced maize farming, layer keeping, banana plantation, and pig farming at 32.5, 28.3, 23.3, and 20.9%, respectively. Dairy goats were kept by only 1.6% of farmers in the study area. In Kenya, above 56% of the total milk produced comes from the smallholder dairy farmers who own more than 80% of dairy cattle in the country (Odero-Waitituh, 2017; Peeler and Omore, 1997).

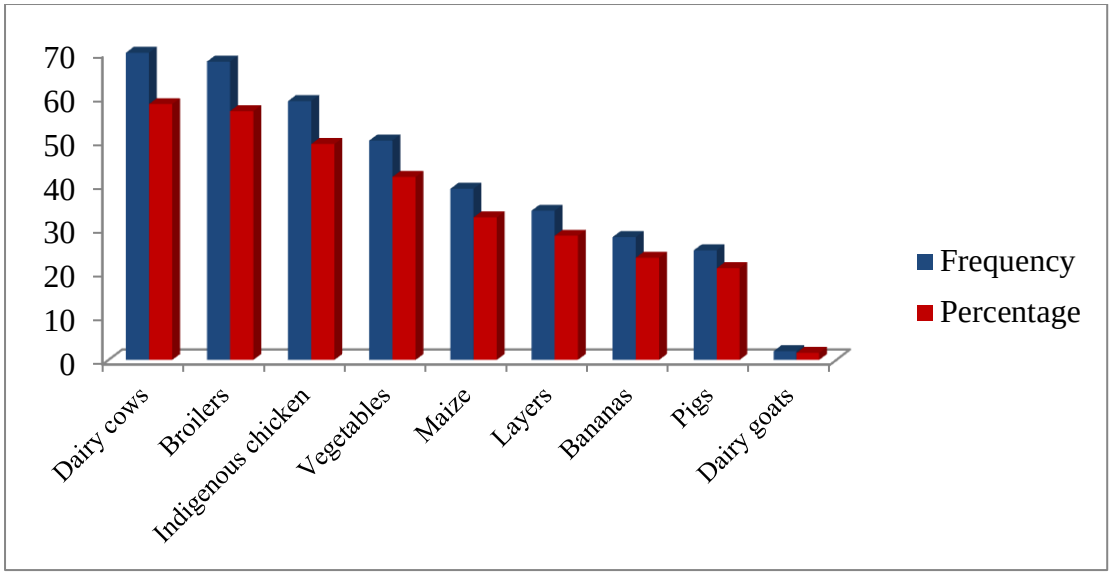

Figure 7: Ranking by farmers of farming enterprises in order of economic importance (%)

4.3 Knowledge, attitudes and practices of farmers in relation to broiler welfare

4.3.1 Knowledge of farmers on broiler welfare

Most of the farmers (74.2%) in Kikuyu and Kabete sub-counties were aware of broiler welfare, as shown in Figure 8. Only a small fraction (25.8%) of farmers was not aware of broiler welfare needs. The proportion (74.2%) from the two sub-counties was relatively higher than reported by Shukri (2018) who found that 59.0% of poultry farmers in Kabete sub-county were aware of animal welfare. The level of awareness about animal welfare in Kabete sub-county (93.6%) was much higher than in Kikuyu sub-county (54.7%). This difference might be due to the farmers' accessibility of extension services.

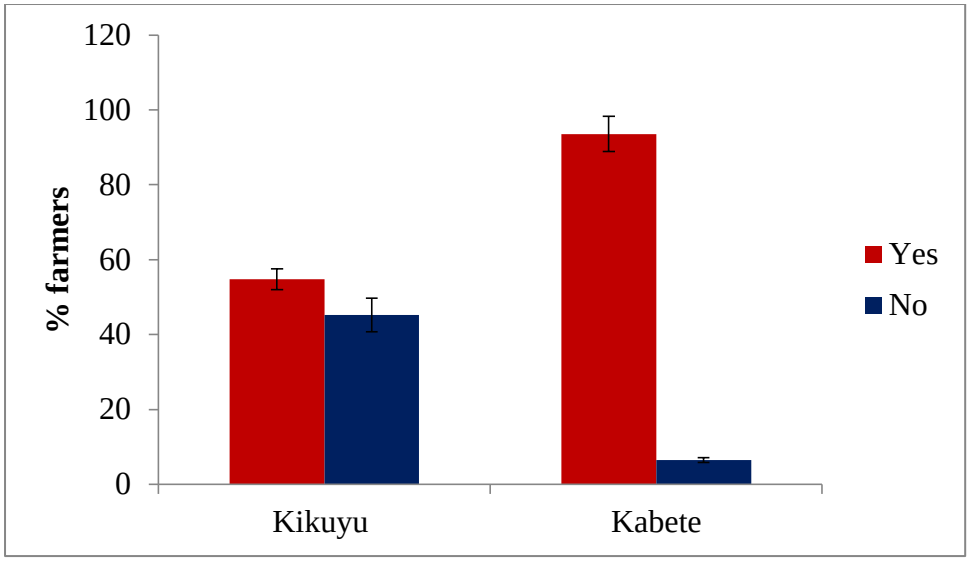

Figure 8: Number of farmers aware and not aware of animal welfare

The farmers obtained information on broiler welfare through the media, hatcheries, agro vets, and government extension agents, feed millers, social networks, and NGOs (Table 12). Media was the most important source of information representing 60.1%. Within the media, farmers identified two TV programmes, which are aired in the area, namely *Farmer's TV* and *Mugambo wa Murimi* as important sources. This was reported during a focus group discussion with the farmers. However, hatcheries, agro-vets, and government extension agents were also important in disseminating information at 40.2, 37.8 and 30.5%, respectively. Similarly, farmers also sought information on broiler welfare from feed millers, other farmers and NGOs at 15.9, 15.8, and 2.4%, respectively, in addition to field days. Electronic and print media were also used to disseminate information on animal welfare. This was in agreement with the study reported by OIE in 2017, which stated that information sharing that considers language barriers improves farmers' responses towards the health and welfare of their animals. Conversely, Craig, and Swanson (1994) reported that through the media, extension programs, and training, farmers could acquire information on animal welfare.

Table 12: Sources of information on animal welfare of respondents (%)

Sources	N*	Percentage of cases
Media[1]	50	61.0
Hatchery	33	40.2
Agro-vets	31	37.8
Government extension agents	25	30.5
Feed millers	13	15.9
Other farmers	19	15.8
NGOs	2	2.4

N* = number of respondents; Media[1] represents radio, TV and newspaper

Famers' attitude to broiler welfare was assessed using several indicators of welfare (Table 13). About 88.3±0.32% of farmers agreed that good feeding was a very important indicator of broiler chicken welfare. Also, 83, 82, and 48% of farmers indicated that good health, suitable housing, and appropriate behaviour, respectively were important indicators of good broiler welfare. This was in agreement with the study conducted by Hansson and Lagerkvist (2014) who concluded that identification of farmers' attitudes towards animal welfare improves their understanding on how to determine the living conditions of their animals.

Table 13: Perception of broiler welfare by respondents (%)

Parameter	Level of importance	Frequency	Percentage
Good feeding	Very important	106	88.3
	Important	14	11.7
Good health	Very important	99	82.5
	Important	13	10.8
	Slightly important	8	6.7
Suitable housing	Very important	98	81.7
	Important	15	12.5
	Slightly important	6	5.0
	Not important	1	0.8
Appropriate behaviour	Very important	57	47.5
	Important	26	21.7
	Slightly important	30	25.0
	Not important	7	5.8

4.3.2 Disease prevention and control practices

4.3.2.1 Measures put in place to control diseases in the study area

Most farmers managed commonly occurring diseases through vaccination (90.2%), isolating sick birds (29.8%), and treatment (22.6%) as shown in Table 14. Farmers also reported during a focus group discussion that sanitation practices such as cleanliness and disinfection were other important practices that they employed for disease prevention and control. Conversely, 91.4% of farmers sourced their drugs and vaccines from agro-vet shops, while a small proportion of farmers obtained theirs from hatcheries and private veterinarians at 6.6 and 1.5%, respectively. About 72.5% of farmers were supported by agro-vet shops in disease prevention and control. However, 13.9, 12.3, and 3.7% of farmers obtained their support from private and government veterinarians, and hatcheries, respectively.

Table 14: Management practices used by farmers in the study area.

Management practices	Kikuyu (n =42)	Kabete (n=78)	Mean
Disease prevention and control measures			
Vaccination	90	91.03	90.52
Isolating sick birds	32.2	27.38	29.79
Treatment	28.57	16.66	22.61
Sources of vaccines and drugs			
Agro-vet shops	86.36	96.43	91.4
Hatcheries	12.67	0.57	6.62
Private veterinarians	0	3	1.5
Who helps in disease prevention and control			
Agro-vet shops	74.58	70.52	72.55
Private veterinarians	13.61	13.97	13.79
Government vets	10	14.55	12.28
Hatcheries	1.82	5.56	3.69

Although there is no effective treatment against pneumonia as reported by Shankar (2008), at least 60% of farmers in Kikuyu sub-county managed their birds against this condition (Fig. 9). However, pneumonia can be prevented or controlled by avoiding moist litter and reducing stocking density in broiler pens (Shankar, 2008). Also, 40% of farmers in Kikuyu sub-county managed their birds against water belly (ascites). Water belly causes heart failure and affects liver function in broilers, and it is said to affect 5% of broilers in the world causing enormous mortality and carcass condemnation to broilers in modern farms (SCAHAW, 2000; and Olkowski *et al.,* 2001). The most common diseases encountered by farmers in the two sub-counties were Gumboro, New Castle Disease, *coccidiosis*, pneumonia, and water belly. Gumboro and New Castle Disease were controlled through vaccinations, while *coccidiosis* was managed through farm sanitation practices such as cleaning and disinfection of poultry houses and equipment. This was validated during a focus group discussion in Kiambaa

locality of Kabete sub-county on April 25, 2019. Water belly was not common, but when it occurred, mortality was high.

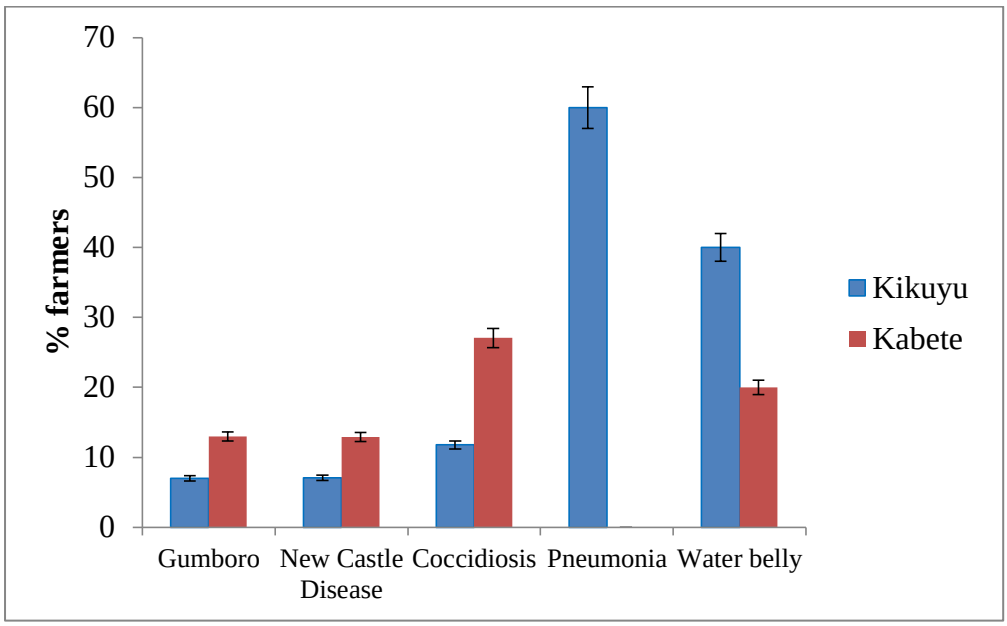

Figure 9: Diseases managed by farmers in Kikuyu and Kabete sub-counties (%).

4.3.3 Feeding practices

About 55.6% of respondents measured the amount of feed provided to their birds based on the age of the birds whereas, 41.4% of them determined the amount of feed by estimation (Fig. 10). However, due to high cost of feeds, only 40.9% of farmers gave feed *ad libitum* to their birds. This was in agreement with KARI (2006) and Ochieng *et al*. (2013) who reported that high cost of feeds (about 60-75% of production cost) frustrates many farmers who could not provide enough feed to their birds. Only 16 and 1.6% of farmers determined the amount of feed by weight and through manufacture's specifications, respectively.

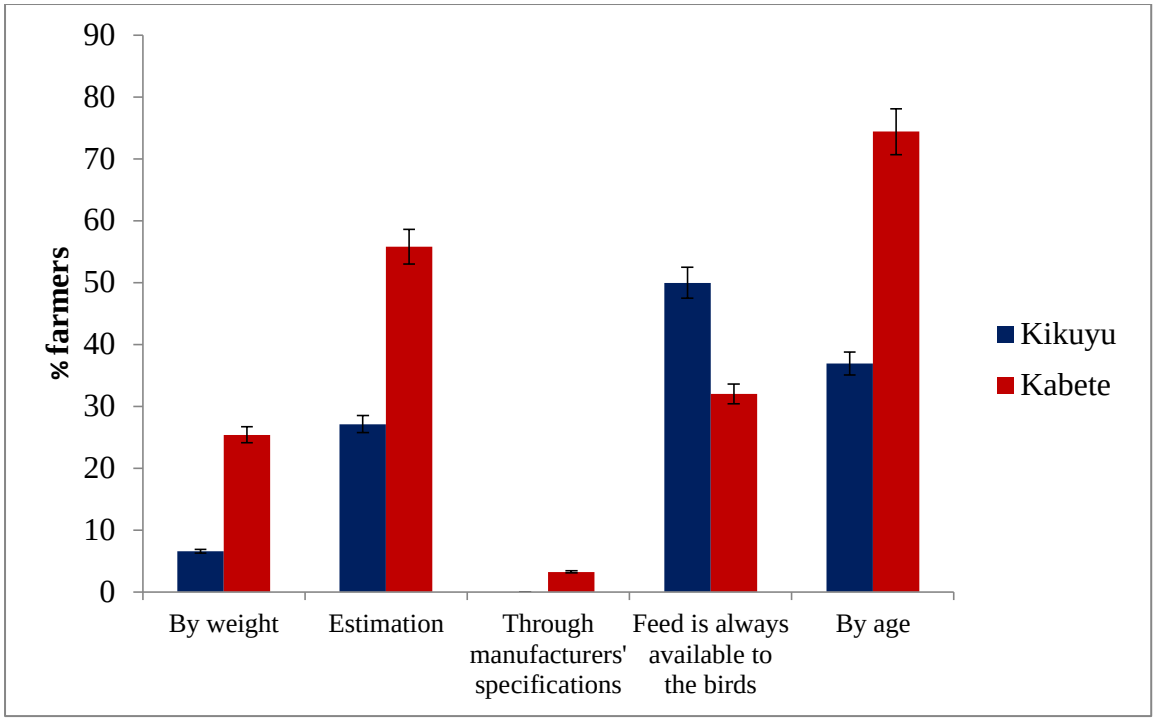

Figure 10: Ways farmers used to determine the amount of feed to their birds

4.4 Welfare indicators of broilers

4.4.1 Broiler welfare needs in terms of feeding

Intensive selective breeding enables broiler chickens to have enhanced appetite and attain a market weight of about 2 kg in just 42 days (CIWFT, 2005). To realize this, farmers in Kikuyu and Kabete sub-counties employed different feeding regimes depending on the individual's financial capacity. Farmers either fed their birds *ad libitum*, three times a day, twice or once a day (Fig. 11). Majority of respondents (48.2%) fed their birds twice a day, followed by 34. 8% of farmers who provided feed to their broilers *ad libitum*. Approximately 13 and 4% of farmers fed their broilers three times a day and once a day, respectively. Although the amount of feed needed to achieve the desired market weight has been reduced in broilers through selective breeding, many farmers reported high cost of feeds. Majority of respondents chose to feed their birds at least twice a day in order to reduce the cost of production. This was contrary to the findings of Adele and Federico (2009), who reported that feeding broilers three times a day improved their health and welfare under stressful

conditions. Also, Dei *et al.* (2012) revealed that a 3-hour feed restriction between 3-6 pm every day positively influenced feed intake in broilers and hence recommended that feeding broilers three times a day during hot days was beneficial in minimising heat stress.

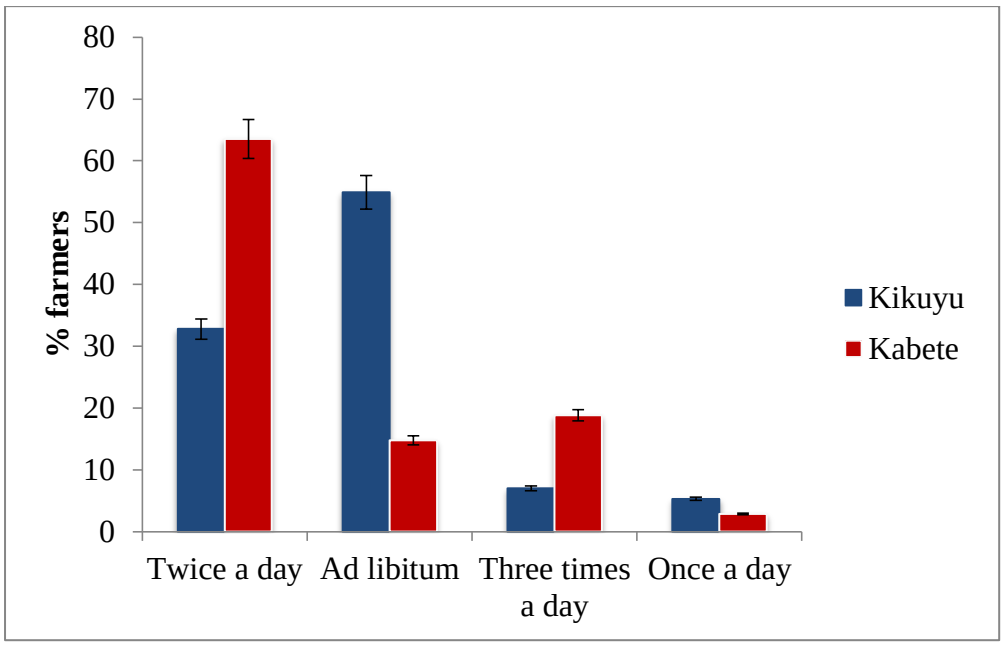

Figure 11: Feeding regimes used by farmers in the study area (%)

4.4.2 Feeding and drinking spaces

The feeding and drinking spaces in the flocks studied are in Table 15. The mean feeding space was 10.69±1.86 cm/bird in the study area. This was within the normal range of 3-12 cm/bird depending on the age of the broiler (Prabakaran, 2003; FAO, 2004 and FAO, 2011). Prabakaran (2003) further specified that broilers of 0-2 weeks, 3-4 weeks, and >4 weeks should have 3, 5 and 8-12 cm of feeding space per bird, respectively. The average watering space was 6.92±1.09 cm/bird. This was slightly above 1.3-5.0 cm/bird based on the age of the bird recommended by Prabakaran (2003). However, FAO (2004) and North and Bell (1990) suggested a drinking space of 2.5-3 cm/bird for poultry though their focus was on layer chickens. Therefore, the welfare of birds was taken care of in terms of providing adequate feeding and drinking spaces per bird.

Table 15: Feeding and drinking spaces (cm/bird)

Parameter	Kikuyu (n =42)	Kabete (n=78)	Mean±SD
Feeding space	9.76±1.77	11.62±1.94	10.69±1.86
Drinking space	7.22±1.10	6.62±1.10	6.92±1.10

4.5 Influence of housing on broiler welfare

4.5.1 Stocking density

Stocking density for broilers refers to the weight (kg) per unit space. It affects the ability of the birds to move and express normal behaviour. It also affects litter quality and indirectly impacts on temperature and humidity of the poultry house. Therefore, high stocking density compromises the welfare of broiler chickens (SCAHAW, 2000). However, in most cases, the economic interests of a farmer, rather than animal welfare considerations dictate ethical decisions on stocking density (Berg and Yngvesson, 2012). In the flocks studied, the mean stocking density was 14.8±9.57 kg/m^2 (Table 16). This was within the recommended 10-30 kg/m^2 for broiler chickens raised in deep litter floor systems (Adele and Federico, 2009; Meluzzi *et al.,* 2003, 2004; Grashorn and Kutritz, 1991; Shanawany, 1988). However, in some parts of Europe, a stocking density of 30-44 kg/m^2 was recommendable depending on the legislation of each country. For example, in the United Kingdom, a stocking density of 34 kg/m^2 was recommended based on the legislation of 2005, whereas in Denmark, a stocking density of 43 kg/m^2 was recommended in 2003, but was to be reduced to 40 kg/m^2 in 2006 (CIWFT, 2005; Danish Ministry of Justice, 2001). McLean *et al*. (2001) reported that a stocking density above 30 kg/m^2 results in reduced growth rate in broilers and heat stress, which compromises the welfare of the birds. In Kenya, Ministry of Livestock Development (1989) recommended 16.5-22.5 kg/m^2 as stocking density for broilers.

4.5.2 Relative Humidity

The mean relative humidity (RH) in houses among the flocks studied was 49.4±0.46% (Table 16). This was so close to the recommended humidity level for broiler chickens of 50-65% (Aviagen, 2014 and Yahav, 2000). A relative humidity below 50% negatively affects the growth of broiler chicks during brooding due to cold stress (Arbor, 2014).

Relative humidity of the poultry house affects the heat load borne by the birds within the house. High RH increases the heat load of the birds because of the reduced ability to lose heat through evaporation, whereas low RH causes nasal dryness and discomfort (Aviagen, 2014). However, a mean temperature of 26.7±0.58 ºC was recorded in the broiler houses (Table 16). It was above the thermo neutral zone of 18-24 ºC but within the recommended temperature range of 21.8-31.3 °C for broiler chickens (Olanrewaju *et al.,* 2010 and Zolnier *et al.,* 2013). The high temperatures recorded in broiler houses might have been due to the seasonal weather changes since the study was conducted in February, which is a hot season in Kenya.

4.5.3 Influence of open space on broiler welfare

Another parameter studied in the flocks was the open space (Table 16). Open space allows air exchange in a poultry house with fresh air from outside. It is usually considered to act as a control for heat and humidity in the poultry house (Anon, 2019). In Kenya, ventilation is provided through open spaces in poultry buildings. In broiler houses, the recommended open space is 30–80% of the house depending on prevailing weather conditions (Ministry of Livestock Development, 1989). In this study, a mean open space of 2.37±1.75 m^2 was recorded. This was much higher than the space recommended by Alchalabi (2015). He suggested that an open space of 0.3 m^2 was sufficient enough to achieve a natural air velocity of 3-5 m/s. In small scale intensive production systems, poultry houses should be designed in a way that air flows naturally through the house for ventilation (Daghir, 2001). Curtains or

flaps are often hanged on the side of the house to regulate air circulation by lowering or lifting them. However, the outside wind usually affects the exchange rate of air.

Table 16: Stocking density, humidity, temperature and open space in poultry houses

Parameter	Kikuyu (n=42)	Kabete (n=78)	Mean±SD
Stocking density (kg/m^2)	12.68±9.8	16.91±13.8	14.79±12.7
House Humidity (%)	49.1±0.58	49.6±0.57	49.4±0.57
House temperature (°C)	26.8±0.69	26.6±0.59	26.7±0.63
Open space (m^2)	2.53±2.7	2.24±1.9	2.38±2.27

4.5.4 Level of ammonia in poultry houses

The activity of microorganisms in the litter in broiler sheds result in particles that emit odours of different levels which affect the eyes of the broilers and even persons attending to them (Lacey *et al.,* 2004). The impact of ammonia smell can be determined by the intensity and offensiveness of the odour to olfactory sense of humans (Lacey *et al.*, 2004). In contrast, Miles *et al.* (2004) argued that farmers/stock persons who are in constant exposure to poultry sheds with high levels of ammonia might fail to detect ammonia that causes massive irritation to the eye, that is, 50 to 100 ppm (parts per million). However, in the broiler flocks studied, 46.6% of broiler houses did not have detectable ammonia smell or eye irritation while moderate odour and eye irritation were reported in 43.5% of broiler houses (Fig.12). Only 9.8% of houses had a strong ammonia smell and irritation to the eyes. In terms of the level of ammonia smell and irritation in the two sub-counties, Kabete had the highest number of flocks with no odour and irritation of ammonia to the eyes of the enumerators with 63.6%. At least 68.7% moderate smell and irritation of ammonia was reported in Kikuyu sub-county, while strong ammonia smell was reported mostly in Kabete sub-county at the rate of 18.1%. Where the levels were high, the welfare of the birds might have been compromised. This is in agreement with Miles *et al.* (2004) and David *et al.* (2015) who revealed that the human nose recognizes ammonia when it reaches 10-30 ppm and that it was advisable that the ammonia

level in poultry houses remained below 25 ppm. Therefore, this suggested that the level of ammonia in those flocks was lethal for the broilers. This may have resulted in reduced growth, discomfort, respiratory ailments, and other infections that compromise the welfare status in broilers (David *et al.*, 2015).

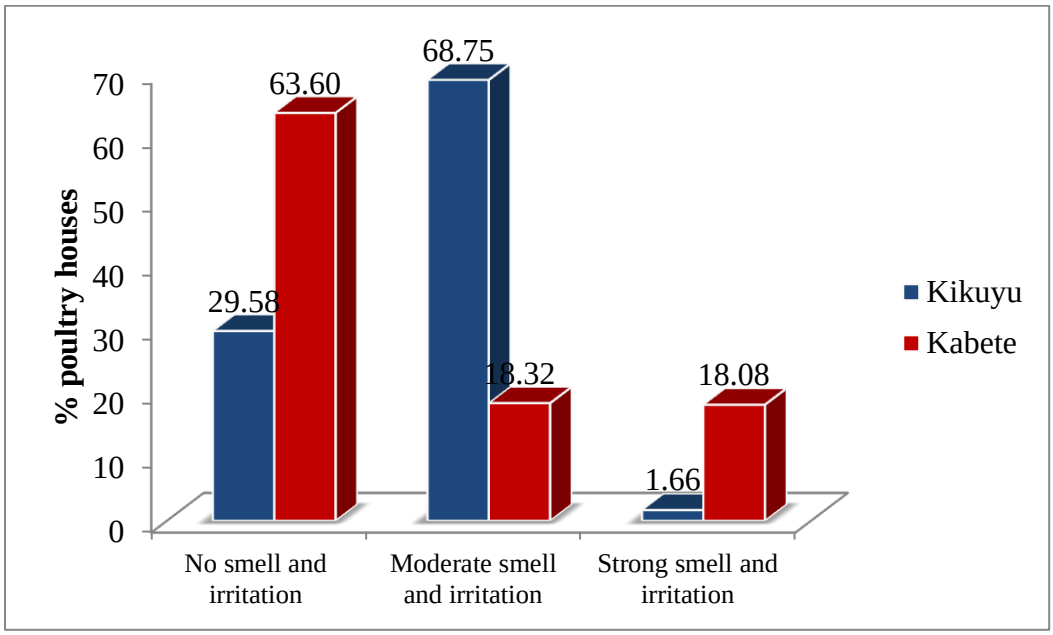

Figure 12: Poultry houses with the level of ammonia smell and irritation (%)

4.5.5 The depth and quality of litter

Litter depth and litter quality of the flocks studied are shown in Table 17. At least 88.7% of flocks studied had a litter depth of 5-10 cm, whereas, in about 5 and 4% of the houses, litter depth was below 5 and 11-15 cm, respectively. The depth of litter was above 15 cm in 2.1% of the broiler pens. Litter depth of 5 to 10 cm is recommendable; however adding more absorbent material would increase its depth when it becomes clapped to improve the ratio of litter to faecal matter (DEFRA, 1994). Dry litter was recorded in 85.6% of poultry houses. Dry litter controls the level of ammonia in poultry houses ensuring a safe environment for broilers and reducing the chances of carcass condemnation as a result of contact dermatitis (Tabler and Wells, 2018). This, in turn, was vital for the health and welfare of broilers as well as people working in the broiler sheds (Tabler and Wells, 2018; Meluzzi *et al.*, 2008;

Kristensen and Wathes, 2000). Too dry and flaky litter was recorded in about 7.4% of the broiler pens. Too dry and flaky litter conditions may cause severe dehydration and respiratory ailments in broilers, hence compromising their welfare (Casey, Brian and Fairchild, 2005). Too wet litter was reported at 6 and 8% in Kikuyu and Kabete sub-counties, respectively.

Table 17: Litter characteristics observed in broiler houses in the study area

Parameter	Kikuyu (n=42)	Kabete (n=78)	Mean
Depth of litter (cm)			
5-10	87.91	90.01	88.68
<5	7.27	2.22	4.74
11-15	4.82	3.54	4.18
>15	0.00	4.22	2.22
Quality of litter			
Dry	85.88	85.28	85.58
Too dry and flaky	8.12	6.71	7.41
Too wet	6.00	8.00	7.00

4.5.6 Effect of litter condition on feet status of broiler chickens

The effect of litter condition on feet of broiler flocks studied is shown in Fig. 13. Few injuries (2-3 wounds) were found in birds recorded in Kikuyu (6%) and Kabete (8.4%) sub-counties. This might have been due to wet litter condition reported in those flocks in Table 17 above. De Jong *et al.*, (2014) reported that wet litter results in footpad dermatitis in broilers, lowering their performance and compromising their welfare.

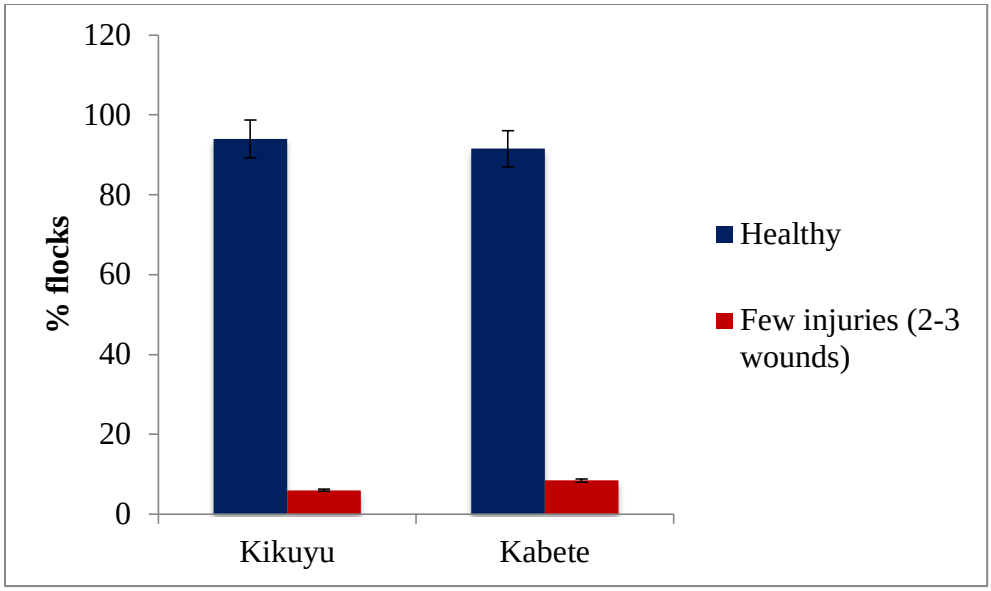

Figure 13: Feet health status of birds in the study area (%)

4.6 Health status of birds

4.6.1 Disease incidence and causes of mortality

Incidences of diseases were reported by 57% of farmers, and the mortality recorded a month before this study was 2% (Table 18). The proportion of farmers that reported *coccidiosis*, pneumonia, water belly and Gumboro as the leading causes of mortality was 82, 13, 3 and 1%, respectively. New Castle Disease (NCD) was reported by only 0.7% of farmers. During focus group discussions, the same diseases were reported by farmers as the most important in the area. Although farmers in Kikuyu sub-county managed their birds against pneumonia (Fig. 9), it was reported as the second cause of mortality by farmers in the two sub-counties (Table 19). Farmers also reported during focus group discussions that apart from vaccination of their birds, they undertook sanitation practices to manage against diseases. Conversely, farmers also reported that they provided treatment to sick birds and ensured that biosecurity measures were always in place to prevent the spread of diseases to their flocks. When asked how they managed their farm biosecurity, farmers responded that they always ensured disinfection and change of clothing/shoes before entering the poultry house, separation of age groups in the flock, proper housing, and control of human traffic. Therefore, biosecurity

improvement and sanitation practices can assist in the reduction of infections and mortality on the farm (Royal Society for Prevention of Cruelty to Animals, 2017).

Table 18: Proportion of farmers reporting mortality and causes of mortality (%)

Parameter	Kikuyu (n =42)	Kabete (n=78)	Mean
Diseases	59.06	54.79	56.92
Mortality from diseases	2.26	1.74	2.04
Causes of mortality			
Coccidiosis	71.0	92.7	81.85
Pneumonia	22.27	4.00	13.13
Water belly	4.97	1.08	3.02
Gumboro	0.00	2.22	1.11
New Castle Disease	1.33	0.00	0.67

4.6.2 Assessment of birds for breast blisters and hock burns

Assessment for breast blisters and hock burns was conducted in the flocks, and 95% of the birds observed had no evidence of breast blisters, (Table 19). Similarly, about 95% of the birds observed had no evidence of hock burn. Hock burns and sores on the foot of broilers are leg conditions that impair their ability to move as walking becomes painful (CIWFT, 2005; SCAHAW, 2000; Su, Sørensen and Kestin, 2000).

Table 19: Proportion of farmers reporting breast blisters and hock burns (%)

Parameter	Kikuyu (n =42)	Kabete (n=78)	Mean
No evidence of breast blisters	89.39	100.00	94.69
Evidence of breast blisters	10.60	0.00	5.31
No evidence of hock burn	91.06	98.00	94.53
Minimal evidence of hock burn	8.94	2.00	5.47

4.6.3. Management of broilers with sicknesses

Table 20 shows the action taken by farmers who identified sick birds in their flocks. At least 57% of farmers reported ill health symptoms of their birds to the nearest Agro-vet shops for advice, while about 45% of them contacted a veterinarian to examine sick birds who carried out diagnosis and advice farmers on the course of action to be taken. About 69.1% of broiler farmers in Kabete sub-county called a veterinarian for help. This was slightly lower than in a similar study on layers by Shukri (2018), who reported that 75% of poultry farmers in Kabete sub-county preferred calling a veterinarian to assess their sick birds at home. However, in this study, farmers reported during focus group discussions that calling a veterinarian to determine the condition of sick birds in their flocks was expensive as they had to cater for transport cost apart from the cost of diagnosis and treatment. Hence, they preferred reporting ill signs in their flocks to the nearest Agro-vet shop for advice. Only 17% of farmers slaughtered their birds for food before they died. This was however not an advisable practice as it exposes farmers to the risk of contracting highly infectious diseases such as avian influenza (Omiti and Okuthe, 2008).

Table 20: Proportion of farmers reporting management of sick birds (%)

Action taken	Kikuyu (n =42)	Kabete (n=78)	Mean
Report to Agro-vet shops	84.18	30.52	57.35
Call a veterinarian	20.30	69.09	44.69
Slaughter before it dies for food	31.82	2.00	16.91

4.7 Broiler welfare in terms of normal behaviour

4.7.1 Observation of birds and frequency of fear in broilers

Frequent observation of broilers is very vital in order to check on their health and for quick response in case of ill health identification. In this study, about 66% of farmers observed their birds at least four times a day, while 32% observed their birds twice daily and only 2% did not observe their birds at all (Fig. 14). Moreover, Colles *et al.* (2016) reported that observing birds frequently is necessary for identifying early signs of ill health and for prompt response in poultry flocks.

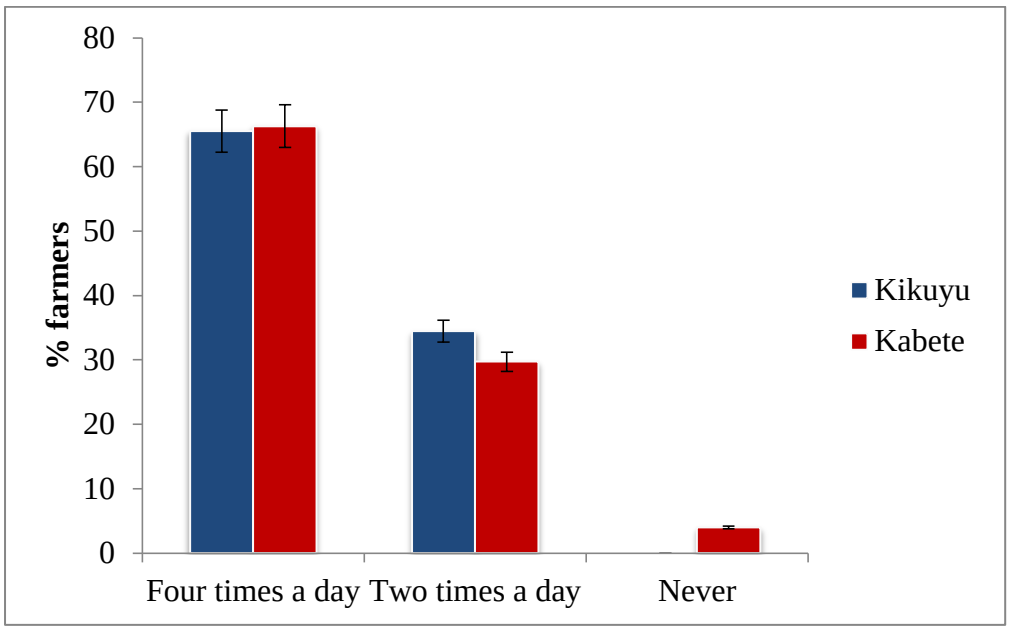

Figure 14: Frequency of farmers observing their broilers daily (%)

The frequency of expressing fear and their causes are shown in Table 21. About 70% of farmers reported that their birds expressed fear at least twice a week, while 23% of farmers stated that they noticed their broilers expressing fear four times weekly. Only 7% of farmers did not notice their birds expressing fear. Over 80% of farmers reported human noise as the cause of fear in their flocks, while 34% of them attributed the cause of fear in their flocks to pets (cats and dogs) and rats. Only 21 and 14% of farmers identified wild animals (mongoose and wild foxes) and motor traffic as causes of fear, respectively. Acute fear is responsible for

unnecessary suffering of the birds as a result of the injury caused when they seek to escape aimlessly after seeing a strange object (de Haas *et al.*, 2013, Jones, 1996). This, therefore, results in a high rate of mortality and compromises the welfare of the birds (Jones, 1996).

Table 21: Farmers reporting frequency of expressing fear and its causes in broilers (%)

Parameter	Kikuyu (n =42)	Kabete (n=78)	Mean
Observation of fear			
Twice a week	72.69	67.64	70.17
Four times a week	22.82	22.19	22.51
Not at all	4.48	10.16	7.32
Causes of fear			
Noise from people	94.70	71.60	83.15
Dogs, cats, and rats	21.60	46.57	34.08
Wild animals	5.15	35.92	20.53
Vehicles moving near the pen	15.91	12.58	14.24

4.8 The influence of broiler welfare on productivity

4.8.1 Farm characteristics of production

The mean flock size per household was 328±156 birds. This was within the range that was reported by Msami (2008) who reviewed the poultry sector in Kenya and found that most small scale broiler farmers kept between 300-2,000 birds. During the time of data collection, 93% of broiler farmers kept between 50-500 birds of market age, while at the same time 86% of them kept broilers aged below 3 weeks (Table 22). About 4.3% of farmers in the two Sub-counties kept between 501-1000 birds.

Table 22: Proportion of farmers keeping broilers (%)

Flock size	Kikuyu (n=42)	Kabete (n=78)	Mean
Finisher			
50-500	90.62	95.05	92.84
501-1000	3.66	4.94	4.30
1001-2000	2.86	0.00	1.43
>2000	2.86	0.00	1.43
Starters			
50-500	73.33	98.18	85.75
501-1000	6.66	1.82	4.24

About 67% of farmers reported that they had broilers of 1.1-1.5 kg live weight, while 26% of them kept broilers of 1.6-2.0 kg live weight during the time of the study (Table 23). Only 6.6% of farmers reported to had broilers of over 2 kg live weight. It was also reported that at least 53% of farmers were keeping broilers ranging from 3 to 6 weeks old and 33% of them were rearing birds of 1-3 weeks. Only a small fraction (8%) of farmers kept broilers of 6 to 8 weeks old. This was in agreement with Information Cradle Kenya (2019), who reported that broilers in Kenya were mostly sold when they attained 1.5-3.0 kg live weight but this was, however, dependent on the preferences of consumers and market demand. Consumers often base their decision to buy broilers on the basis of size, their appealing look, and valuation of the meaty parts such as the thighs and breasts.

Table 23: Productivity characteristics of the broiler flocks studied

Parameters	Kikuyu (n =42)	Kabete (n=78)	Mean
Live weight of birds during data collection (kg)			
1.1-1.5	68.63	65.20	66.92
1.6-2.0	21.36	30.37	25.87
>2.0	10.00	3.22	6.61
Age of birds during data collection (weeks)			
1-3	42.91	33.58	38.24
3-6	44.42	61.97	53.20
6-8	11.34	4.44	7.89
>8	1.33	0.00	0.67

4.8.2. The correlation coefficient between productivity and welfare indicators

The relationship between the live weight of broilers and the factors listed in Table 24 was determined by running the Pearson's correlation coefficient (r^2). There was a negative correlation between the broilers' live weight and feeding space. Hence, the relationship was insignificant ($p>0.05$). Conversely, broilers' live weight and litter quality were not significantly correlated ($p>0.05$). Also, there was a very weak positive correlation between the broilers' live weight and stocking density ($r=0.054$), where $p>0.05$. This implied that most of these factors were within the acceptable levels for broilers. However, there was a strong positive correlation ($r=0.821$) between the broilers' live weight and feet health, where the relationship was highly significant ($p=0.01$). This might have been due to the few wounds reported in the two sub-counties (Fig. 13), which may be attributed to the poor litter conditions recorded in Table 17. De Jong *et al.* (2014) linked poor litter conditions to footpad dermatitis in broilers. The correlation between broilers' live weight and watering space was not significant ($p>0.05$).

Table 24: Correlation between live weight of broilers and factors shown in the table

Factors	Correlation coefficient (r^2)	*p-value*
Feeding space	-0.002	0.983
Litter quality	-0.099	0.284
Stocking density	0.054	0.558
Breast blisters	0.137	0.138
Watering space	0.165	0.073
Feet health	0.821	0.05**

**. Correlation is significant at the 0.01 level (2-tailed).

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

1. Over 70% of farmers were informed about animal welfare. Good feeding, good health and suitable housing were perceived to be very important components of broiler welfare by over 80% of farmers, respectively. Most farmers vaccinated their birds against Gumboro and New Castle Disease, while *coccidiosis* was managed through farm hygiene practices and treatment of sick birds with coccidiostat. Farmers mainly measured the amount of feed provided to their birds by age and estimation, while others gave feed *ad libitum* to their birds.
2. Broiler welfare needs in terms of good feeding, stocking density, house temperature, house humidity, and litter depth were met. However, freedom of the birds from fear and distress was compromised as 70% of farmers reported that their birds expressed fear caused mainly by human disturbances.
3. There was no significant relationship between live weight of broilers and feeding and watering spaces, litter quality, stocking density and breast blisters. However, there was a significant correlation between the broilers' live weight and feet health.
4. The overall assessment of this study was that the welfare of the broilers was enhanced (good) though some of their needs were not met.

5.2 Recommendations

Based on the conclusions above, the following were recommended:-

1. The relevant authorities should step up nationwide sensitization of farmers on poultry welfare issues such as ways to improve their birds' expression of normal behaviour and how they can minimize fear and distress in their flocks.
2. Farmers should also be trained on management practices which ensure that they regularly remove old litter from their poultry sheds.
3. Farmers should frequently monitor, clean and replace broken feeders and drinkers to avoid feed and water spillage.
4. The county government should increase the number of extension workers in each sub-county and train them on animal welfare issues.

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APPENDIXES

Appendix I: Questionnaire

Survey questionnaire on the influence of management on welfare and performance of broiler chickens in small scale intensive production systems in Kiambu County, Kenya

I. GENERAL INFORMATION

1. Enumerator name _____ Gender _____
2. Questionnaire number _____
3. Date of survey _____
4. Sub-county _____ Ward _____
5. GPS co-ordinates; Longitudes _____ Latitudes _____
6. Start time _____ End time _____

Kindly fill the following questions by ticking or filling in appropriate spaces.

SECTION A: GENERAL RESPONDENT'S INFORMATION

1. Name of respondent _____ Age _____
2. Gender of the respondent i) Male [ ] ii) Female [ ]
3. Telephone number of respondent _____
4. Are you the owner of the farm i) Yes [ ] ii) No [ ]
5. Are you the owner of the broilers i) Yes [ ] ii) No [ ]
6. Please indicate your status in the house hold (tick appropriate)
    a) Husband [ ]
    b) Wife [ ]
    c) Daughter [ ]
    d) Son [ ]
    e) Employee [ ]
    f) Other (specify) [ ] _____

5. Please indicate your marital status (tick appropriate)
    a) Single [ ]
    b) Married [ ]
    c) Divorced [ ]
    d) Widow(er) [ ]
6. Please indicate the highest level of education you have attained. (tick appropriate)
    a) None [ ]
    b) Primary school [ ]
    c) Secondary school [ ]
    d) Post-secondary [ ]
7. Are you employed? (Tick appropriately)
    1. Yes [ ]
    2. No [ ]
8. Please indicate (write down)
    a. Number of birds in the flock [ ]
    b. Age of the bird [ ] weeks
9. Please indicate the land size of your farm (hectares) _____
10. **Section B: Evaluation of knowledge, attitudes and practices of farmers in relation to broiler welfare**

a) How important do you think the following practices are in broiler management: Rate from 1 to 5 where

1 = very important

2 = important

3 = slightly important

4 = somehow important

5 = Not important

Practices	**1**	**2**	**3**	**4**	**5**
Good feeding					
Suitable housing					
Good health					
Appropriate behaviour					
Provision of perches					

b) Are you informed about animal welfare i) Yes [ ] ii) No [ ]

c) On a scale of 1 to 3 where 1 = well informed 2 = informed and 3 = not informed

How do you rate your knowledge of animal welfare issues (tick one) (1). [ ] (2). [ ] (3). [ ]

If the answer to question b above is yes, where did you learn about animal welfare from? (Tick appropriately)

a. Radio/TV [ ]
b. Newspaper [ ]
c. Feed millers [ ]
d. Hatchery [ ]
e. Government extension agents [ ]
f. NGOs [ ]
g. Agro vets [ ]
h. Other (specify) [ ] _____

11. Section C: Criteria for evaluating performance of broilers in small scale production systems in Kiambu County

a) How many times do you feed your broilers in a day (Tick one)?

i) Once a day [ ] ii) Twice a day [ ] iii) Three times a day [ ] iv) Ad libitum [ ]

b) How do you know how much feed to give to broilers?

i) By weight [ ] ii) Estimation [ ] iii) Through manufacturers specifications [ ]

iv) Feed is always available to the birds [ ] iv) By age [ ] v) Other (specify) [ ] _____

II. CHARACTERISTICS OF PRODUCTION

12. For how long have you been keeping broiler chickens? (Years)

1.	<1 [ ]	2.	1-5 [ ]	3.	6-10 [ ]	4.	11-15 [ ]	5.	>15 [ ]

13. How many broilers chickens are you keeping (starters, finishers)? (Number)

	1.	<500	2.	500-1000	3.	1001-1500	4.	1501-2000	5.	>2000
Starter										
Finisher										

14. How many broiler chicken flocks are in this farm? (Number)

1.	1-3 [ ]	2.	4-5 [ ]	3.	>5 [ ]

15. How many flocks do you keep per year? (Tick appropriately)

a) One [ ]

b) Two [ ]

c) More than two [ ]

d) Other (specify) [ ] _____

16. What type of poultry do you keep? (Tick appropriately)

a. Indigenous [ ]

b. Exotic [ ]

c. Improved indigenous [ ]

d. Other (specify) [ ] _____

17. Please rank the following in terms of economic importance to you. Please rank only the ones in your farm. (Assign numbers 1-7 in order of importance)

    a. Dairy [ ]

    b. Bananas [ ]

    c. Vegetables [ ]

    d. Layer chicken [ ]

    e. Broiler chicken [ ]

    f. Maize [ ]

    g. Indigenous chicken [ ]

    h. Other (specify) [ ] _____

Choose ONE flock and collect data on it

18. When are the birds placed in the house? (Show month _____ and year _____)

19. How long do the birds take to reach market age?

    a) 35-42 days [ ]

    b) 43-49 days [ ]

    c) 50-56 days [ ]

    d) Other (specify) [ ] _____

20. What is the desired market weight of the birds in this area?

    a) 0.8-1.0 kg [ ]

    b) 1.1-1.5 kg [ ]

    c) 1.6- 2.0 kg [ ]

    d) >2.0 kg [ ]

    e) Other (specify) [ ] _____

21. Do you keep production records? (Tick appropriate)

a) Yes [ ]

b) No [ ]

22. If yes, check it and record what is important _____

23. What are the key challenges that affect your production? (Tick appropriately)

a) High cost of feeds [ ]

b) Diseases [ ]

c) Veterinary costs [ ]

d) Other (specify) [ ] _____

III. CRITERIA FOR WELFARE EVALUATION IN BROILER CHICKENS

A. Freedom from hunger and thirst

24. Do the birds have access to feed throughout the day?

a) Yes [ ]

b) No [ ]

25. If no, what are the reasons? (Tick appropriate)

a) Restrict feed for the birds deliberately [ ]

b) No money to buy feed [ ]

c) No one to feed the birds [ ]

d) Other (specify) [ ] _____

26. How many bags of broiler starter feed do you give to your chicken between 0-3 weeks of age? (Tick appropriately and indicate number of bags)

a. 50 kg [ ] __ bags __ days

b. 70 kg [ ] __ bags __ days

c. Other (specify) [ ] _____

27. How many bags of broiler finisher feed do you give to your chicken between 4-6 weeks of age? (Tick appropriately and indicate number of bags)
    a. 50 kg [ ] __ bags __ days
    b. 70 kg [ ] __ bags __ days
    c. Other (specify) [ ] _____
28. What type of feeding equipment do you use? (Tick appropriately)
    a) Feeding troughs only [ ]
    b) Pan feeders only [ ]
    c) Both troughs and pan feeders [ ]
    d) Other (specify) [ ] _____
29. How much feeding space is available to the birds? (Count and take measurements)
    a) Number of feed troughs [ ]
    b) Length of each feed trough (cm) [ ]
    c) Number of pan feeders [ ]
    d) Diameter of each pan feeder (cm) [ ]
30. What type of watering equipment do you use?
    a) Cylindrical drinkers only [ ]
    b) Trough drinkers only [ ]
    c) Both cylindrical and trough drinkers [ ]
    d) Other (specify) [ ] _____
31. How much watering space do you provide to the birds? (Count and take measurements)
    a) Number of cylindrical drinkers [ ]
    b) Diameter of each cylindrical drinkers (cm) [ ]
    c) Number of water troughs [ ]

d) Length of each water trough (cm) [ ] _____

32. Do you provide safe drinking water to the birds? (Measure by thumb)

a) Water is too cold [ ]

b) Water is too hot [ ]

c) Water is okay (at room temperature) [ ]

B. <u>Freedom from discomfort</u>

33. What is the size of the house occupied by this flock? (Take measurements)

a) Length (meters) _____

b) Width (meters) _____

34. What is the size of ventilation in the house? (Take measurements)

a. Back (meters) _____

b. House front (meters) _____

35. Please indicate if ammonia in the house is a problem. (Do assessment)

1. No smell of ammonia [ ]
2. Minimal smell of ammonia [ ]
3. Strong smell of ammonia [ ]

36. Assess the depth of litter (Tick appropriate)

a) Too shallow (<5 cm)

b) Normal depth (5-10 cm) [ ]

c) Deep (11-12 cm) [ ]

d) Too deep (>12 cm) [ ]

37. Assess the litter quality

a) Too dry and flaky [ ]

b) Dry [ ]

c) Too wet [ ]

38. Measure the temperature inside the house (see the thermometer reading)

a) <18 °C (very uncomfortable) [ ]

b) 18-24 °C (comfortable) [ ]

c) 25-30 °C (slightly uncomfortable) [ ]

d) >30 °C (very uncomfortable) [ ]

39. Measure the humidity inside the poultry house (see the hygrometer reading)

a. <40% [ ]

b. 41-50% [ ]

c. 51-60% [ ]

d. 61-70% [ ]

e. >70% [ ]

40. Calculate the stocking density (total house dimension divide by the number of birds)

1. House area (m^2) _____

2. Average bird weight (kg) _____

3. Number of birds in the house _____

C. <u>Freedom from pain, injury or disease</u>

41. Do your birds suffer from any disease?

1. Yes [ ]

2. No [ ]

42. How many birds died of disease in this flock? (indicate numbers)

1. Died of disease _____

43. Indicate the two most important causes of disease/death in your farm (list down)

a. _____

b. _____

44. What do you do if you see a sick bird?

    1. Call the vet [ ]
    2. Slaughter before it dies [ ]
    3. Other (specify) [ ] _____

45. Assess the feet of the birds (Tick appropriately)

    1. Healthy [ ]
    2. Few injuries [ ]
    3. Highly injured [ ]
    4. Other (specify) [ ] _____

46. Assess the breast of the birds (Tick appropriately)

    1. No evidence of breast blister [ ]
    2. Evidence of breast blister [ ]

47. Assess the birds for hock burn (Tick appropriately)

    1. No evidence of hock burn [ ]
    2. Minimal evidence of hock burn [ ]
    3. Evidence of hock burn [ ]

48. What are the management practices used to control/prevent diseases in your flock? (Tick the appropriate answers)

    1. Vaccination [ ]
    2. Isolating sick birds [ ]
    3. Other (specify) [ ] _____

49. Which diseases do you vaccinate/manage your birds against?

    1. Gumboro [ ]
    2. New castle disease [ ]
    3. Coccidiosis [ ]

4. Ascites [ ]

5. Other (specify) [ ] _____

50. Where do you get the vaccines and drugs from?

1. Government [ ]
2. Hatcheries [ ]
3. NGOs [ ]
4. Agro-vets [ ]
5. Other (specify) [ ] _____

51. Who helps you in controlling and preventing diseases? (Tick appropriately)

1. Government vets [ ]
2. Hatcheries [ ]
3. Private vets [ ]
4. Agro vets [ ]
5. Other (specify) [ ] _____

D. <u>Freedom to express normal behaviour</u>

52. Have you provided perches for the birds? (Ask and observe)

1. Yes [ ]
2. No [ ]

53. If yes, count and take measurements

1. Number of perches _____
2. Average length of a perch (cm) _____

54. How often do you observe birds to check on any disease problem?

1. Too often (4 times a day) [ ]
2. Less often (2 times a day) [ ]
3. Not at all [ ]

4. Other (specify) [ ] _____

55. How often do you notice your birds expressing fear? (Tick appropriately)

1. Never [ ]
2. Less often (twice a week) [ ]
3. Too often (four times a week) [ ]
4. Other (specify) [ ] _____

56. What causes this kind of fear? (Tick appropriately)

1. Noise from people [ ]
2. Dogs bark around the pen [ ]
3. Vehicles moving near the house [ ]
4. Wild animals [ ]
5. Other (specify) [ ] _____

57. Are there predators that attack chickens during day or night hours?

1. Yes [ ]
2. No [ ]

58. If yes, mention them _____

IV. EXTENSION SERVICES AND MARKETING

59. Do you get any training on poultry management from extension agents? (Tick appropriately)

1. Yes [ ]
2. No [ ]

60. If yes, how often do you receive extension services? (Tick appropriately)

1. Once a year [ ]
2. 2-3 times a year [ ]
3. 4-6 times a year [ ]

4. Other (specify) [ ] _____

61. If yes, who provides the training? (Mark appropriately)

    1. Government [ ]
    2. Hatcheries [ ]
    3. NGO (name it) [ ] _____
    4. Private vets [ ]
    5. Agro vets [ ]
    6. Other (specify) [ ] _____

62. Where do you sell your broiler chickens after attaining market weight? (Tick appropriately)

    1. Nairobi city market [ ]
    2. Local markets [ ]
    3. Restaurants and hotels [ ]
    4. Individuals [ ]
    5. Other (specify) [ ] _____

63. Is this enterprise of broiler keeping profitable? (mark appropriately)

    1. Yes [ ]
    2. No [ ]

64. What do you think are the benefits of broiler keeping? (Tick the appropriately)

    1. Income [ ]
    2. Employment [ ]
    3. Food security [ ]
    4. Manure [ ]
    5. Other (specify) [ ] _____

Appendix II: Focus group questions

Focus group discussion questions on influence of management on welfare and performance of broiler chickens for farmers in Kikuyu and Kabete sub-counties.

1. List the main crop and livestock enterprises kept on your farm
2. How would you rank the above in terms of profitability?
3. What are the three main by-products from your broilers operation? (list)
4. What do you do with the by-products?
5. What are the main benefits of broiler farming (list in order of importance)
6. What are the major challenges (list in order of importance)
7. How do you overcome the challenges?
8. What do you think is the importance of keeping broilers comfortable?
9. How important are the following practices in broiler management?

i) Correct stocking density (number of birds per unit area)

a) (Very important b) Somehow important c) Not important

ii) Ventilation in broiler houses

a) (Very important b) Somehow important c) Not important

iii) Proper feeding

a) (Very important b) Somehow important c) Not important

iv) Providing water ad libitum

a) (Very important b) Somehow important c) Not important

v) Removal of broiler manure

a) (Very important b) Somehow important c) Not important

vi) How often do you remove manure from broiler houses?

a) (Very important b) Somehow important c) Not important

vii) Provision of perches

a) (V. important b) Somehow important c) Not important

10. Where do you get your day old chicks and feeds from?

11. Where do you get information on broiler farming?

12. Are the following topics covered by the agro vet/extension agents?

    a) Good feeding Yes [ ] No [ ]

    b) Suitable housing Yes [ ] No [ ]

    c) Manure disposal Yes [ ] No [ ]

    d) Ventilation Yes [ ] No [ ]

    e) Vaccination program Yes [ ] No [ ]

    f) Other Health management Yes [ ] No [ ]

    g) Appropriate behaviour Yes [ ] No [ ]

13. What are the prevailing poultry diseases within your area (Gumboro, New Castle Disease, *coccidiosis*, water belly (ascites), pneumonia and others specify _____)?

14. How do you manage diseases

15. How do you manage farm biosecurity

[Thanks for your cooperation, time and participation in this discussion]