ANALYSIS OF WELFARE INDICATORS FOR CHICKENS IN LARGE SCALE CONTRACT AND NON-CONTRACT BROILER FARMS IN KENYA

A thesis submitted in partial fulfillment of requirements for Masters degree of University of Nairobi (Veterinary Epidemiology and Economics)

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DECLARATION

This thesis is my original work and has not been presented for the award of any degree in any other. Where other people's work has been cited, this has properly been acknowledged and referenced in accordance with the University of Nairobi requirement.

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DEDICATION

To

My daughter: Angel and my siblings: Caroline, Jane and Samuel.

To God is the glory.

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ABBREVIATIONS

BAUEC	-	Biosafety Animal use and Ethics Committee
CI	-	Confidence Interval
EU	-	European Union
FAWC	-	Farm Animal Welfare Council/ Farm Animal Welfare Committee
FPD	-	Foot Pad Dermatitis
FVM	-	Faculty of Veterinary Medicine
GIS	-	Geographical Information System
KMC	-	Kenya Meat Commission
KNBS	-	Kenya National Bureau of Statistics
MOLD	-	Ministry of Livestock Development
OIE	-	World Organisation for Animal Health
QMP	-	Quality Meat Packers
RSPCA	-	Royal Society for the Prevention of Cruelty to Animals
SCAHAW	-	Scientific Committee on Animal Health and Welfare
WAP	-	World Animal Protection
WTO	-	World Trade Organisation

ABSTRACT

World Organisation for Animal Health (OIE) defines animal welfare as the physical and mental wellbeing of an animal, its ability to perform innate or species-specific behaviour in relation to the conditions in which it lives and dies. This definition focuses on five freedoms that relate to welfare of animals under human control which include freedom from hunger, malnutrition and thirst; freedom from fear and distress; freedom from discomfort; freedom from pain, injury and disease; and freedom to express normal patterns of behaviour. These freedoms are provided through supply of the associated inputs at optimal levels. Hence lack of these inputs leads to outcomes that compromise animal welfare. The assessment of indicators associated with such outcomes helps in establishing the welfare status of animals, including chickens. Because of the multidisciplinary dimension of animal welfare, OIE has established a working group on animal welfare in which World Animal Protection (WAP) is a member. WAP consequently adopted OIE guidelines to develop broiler chicken welfare assessment criteria which include factors related to stocking density; growth; environment; catching and handling of the birds; as well as recording keeping on production activities and product quality. On the basis of this, a cross-sectional study design was used to establish the current status of broiler chicken welfare in large scale broiler chicken farms in Kenya. Data were collected from thirty (30) contract and thirty one (31) non-contract large scale broiler farms in 6 counties (Kajiado, Kiambu, Nakuru, Nairobi,Machakos and Murangὰa) using a pre-tested semi-structured questionnaire for various welfare indicators. Analysis of quantitative data was undertaken by means of descriptive and inferential statistics, while qualitative data were analysed with thematic analysis. The estimated stocking density for broiler chickens in contract farms was 21.80 kg/m^2 (95%CI: 18.2 - 25.6), while for the non-contract farms, this was 22.54 kg/m^2 (95%CI: 18.4 -26.8). The estimated growth rate of broiler chickens in contract farms was 51.2 g (95% CI: 50.3- 52), and 42.9 g (95% CI: 40- 45.6) for non-contract farms. The age at maturity for broiler chicken in contract farms was 34 days (95%CI: 33.8 ï 34.6), and was 38days (95%CI: 36.5 ï 39.9) in non-contract farms. Majority of these broiler farms reared Cobb 500 breed of chicken even though a few of the non-contract farms keeping Arbor Acres breed. In both types of farms, chicken were raised on deep litter system, with litter material spread throughout the shed, and there were no cages in broiler chicken houses. The litter quality in these broiler houses was always dry, but this would be affected by the prevailing weather conditions, besides moist litter occurring around drinkers. However, the broiler farms did not practice environmental enrichment including perches or other materials that birds would peck. In the contract farms, chickens were fed on pelleted and crumbled feed, whereas in non-contract farms they were fed on mash, pellet as well as crumble from time to time. For the contract farms, a three phase feeding regime was practised: 0.42 kg for starter, 1.26 kg for grower and 1.6 kg for finisher per broiler per cycle. The non- contract farms were feeding 1 kg for starter and 3 kg for finisher broiler chicken. At point of slaughter, ascites was the main cause of product condemnation reported in contract farms, but for the non-contract farms, ascites, dead on arrival and state of feather cleanliness were the causes of product rejection at the abattoir. Furthermore, the mortality rate of 6.4% and 3.1 %, and culling rate of 1% and 0.3% for broiler chicken in the contract and non-contract farms, in that order were statistically different ($P < 0.05$). In conclusion, large-scale broiler chicken farms were implementing the welfare practices, although most farms did not have environmental enrichment for perching, pecking and dust bathing by broiler chickens. The commercial broiler chicken farmers should therefore be trained on appropriate ways to improve on welfare of these broiler chickens especially through reduction of the conditions that predispose them to ascites by restricting feed or nutrient intake during the early stages of growth, restriction of lighting to reduce feed intake; and manipulation of diet formulation. This study recommends further studies on the influence of natural light on quality and productivity of broiler chicken in Kenya.

CHAPTER ONE: INTRODUCTION

The World Animal Health Organisation (OIE) defines animal welfare as the physical and mental wellbeing of an animal, its ability to perform innate or species-specific behaviour in relation to conditions in which it lives and dies (Tractor, 2012). This definition focuses on the five freedoms that relate to welfare of animals under human control. These include freedom from hunger, malnutrition and thirst; freedom from fear and distress; freedom from discomfort; freedom from pain, injury and disease; and freedom to express normal patterns of behaviour (OIE, 2019a). Specific inputs are associated with ensuring the satisfaction of these freedoms which include optimal supply of good quality food and water necessary for ideal growth rate; enriched and safe environment that is free from distress and permits expression of natural behaviour; housing; disease prevention and proper veterinary care; humane handling as well as and humane slaughter (OIE,2019a; RSPCA, 2009). It is when these inputs are not supplied in optimal levels that there are consequences in form of outcomes that are as a result of compromised welfare. The welfare of such animals can be assessed based on a set of given measurable indicators (OIE, 2019b)

Factors such as the growing global population, urbanization and increasing incomes have resulted to an increase in demand for animal source foods. Consequently, farmers have to explore ways of increasing production to satisfy the rising food demand. Intensification in animal systems can compromise welfare and result in other negative effects (Koknaroglu and Akunal, 2013). Well-being of animals has recently turned out to be a public concern and policy makers are now being forced to formulate policies that protect animal welfare (Korte *et al.*, 2007; Koknaroglu and Akunal, 2013; StÃ¸ier *et al.*, 2016). In broiler systems, welfare of broiler chicken entails provision of environmental conditions that are conducive for them to exhibit their natural behaviours (Koknaroglu and Akunal, 2013). In this regard, enhancing the welfare of broilers and observing good management practices is important for growth of the poultry industry. Consumers are ready to incur additional costs for products obtained from farms observing good animal welfare practices (Marion, 2004; Koknaroglu and Akunal, 2013; StÃ¸ier *et al.*, 2016) For example, raising broiler chickens under free range systems as opposed to caged production systems is preferred.

Broiler chicken produced under legal minimum standards have been found to have relatively lower production costs while ensuring attributes that contribute to reasonable improvement of animal welfare such as genetic makeup of the birds, stocking density and environment safeguards i.e. length of the dark periods are optimized (Jones *et al*., 2005; Gocsik *et al*., 2016). Therefore, upgrading of the environmental conditions where animals live has been found to result in increased profit, because products from these systems would meet the set market requirements and consequently providing more selling prospects (StÃ¸ier *et al.*, 2016). These authors argued that wellbeing of birds played a fundamental role in the sustainability of the broiler chicken enterprise through high yields which translated to higher returns. In addition to enhancing animal welfare, some authors have argued that the growing broiler chicken value chain should be evaluated to identify the prevailing challenges that hamper competitiveness (Abdurofi *et al*., 2017). It is worth noting that despite animal welfare standards being highly correlated to output, producers are still not keen to maximize the animal welfare (Lusk and Norwood, 2011) .

Bowles *et al.*, (2005) conducted a study on trade prospects in high-welfare commodities from developing countries. It was observed that in Thailand, the broiler industry had experienced annual growth over a period of 15 years and developed value-added products in order to create markets to counter competition from other countries. According to Bowles *et al.* (2005), the development and implementation of standards for organic products over the past decade had also resulted in growth in the export markets of these products. The authors concluded that there was growth potential for the broiler industry which could have been assisted by the development of OIE baseline standards. Considering employment is a challenge in some of the developing countries, raising welfare standards provides opportunities for skilled labour for enhanced inspection and handling practices (Nicol and Davies, n.d.) The authors argued that welfare concerns were likely be overlooked when intensification took place without increasing labour.

The commercial broiler production is a highly specialized farm enterprise (Kenchic, 2012) that supports nutritional requirements and economic development for the farming communities as well as generation of national revenue in Kenya (GOK, 2008). However, there is a paucity of studies in the continent reporting on broiler chicken welfare. Furthermore, in Kenya there is limited knowledge on the types of challenges that face large-scale broiler chicken farms and the welfare of the chickens they produce under intensive production systems. Similarly, there is limited training, extension and supervision in animal welfare issues as well as capacity to monitor and mitigate cruelty to animals (GOK, 2008), hence necessitating this study. This study therefore focused on establishing animal welfare practices in large scale contract and non-contract broiler systems; determining the mortality and culling rates in the large scale contract and non-contract broiler systems; and determining factors associated with occurrence of ascites in large scale contract and non-contract broiler systems.

1.1 General objective of the study

To establish the current status of broiler chicken welfare in the large scale broiler chicken farms in Kenya.

1.2 Specific objectives

1. To establish animal welfare practices in large scale contract and non-contract broiler systems in Kenya
2. To determine the mortality and culling rates in the large scale contract and non-contract broiler systems in Kenya
3. To determine factors associated with occurrence of ascites in large scale contract and non-contract broiler systems in Kenya.

1.3 Justification of the study

The findings of the current study will contribute to the knowledge on broiler chicken production; inform policy makers on the formulation of policy and setting guidelines on broiler chicken welfare practices for the country. It will also assist government in establishing the economics of broiler chicken production for planning and policy purposes. This is because the existing policies in Kenya do not sufficiently specify the roles of the relevant institutions involved in animal welfare (GOK, 2008). The organisations advocating for animal welfare will be interested in the study findings. Similarly the veterinary practitioners will benefit from information related to poultry diseases under large scale production and impact of intensification of broiler production on welfare of broiler chickens. In addition, the findings will be beneficial to investors in broiler production enterprises, particularly the large scale broiler chicken producers, feed manufacturers, researchers, extension personnel and other key players to understand nodes along the broiler value chains where targeted interventions can be directed to enhance the broiler chicken welfare in addition to maximising returns to the investors.

CHAPTER TWO: LITERATURE REVIEW

2.1 Animal Welfare and the 5 freedoms

According to Brambell Report of 1965 it was suggested that animals ought to have the freedom to rise up, rest, turn, clean themselves and stretch their extremities (McCulloch, 2013). Consequently, the Farm Animal Welfare Council (FAWC) developed the proposals into the Five Freedoms that are the framework for examining of animal welfare. The Farm Animal Welfare Council (FAWC) is an independent advisory body established by the Government of Great Britain in 1979 in order to appraise the welfare of farm animals on agricultural land, at marketplace, in transportation and at the abattoir; as well as inform the Government of laws or other amendments required (Farm Animal Welfare Council, 1992). In 2011 the council was replaced by Farm Animal Welfare Committee with similar terms of reference as the predecessor (Farm Animal Welfare Committee, 2013). The application of the five Freedoms is mainly in farming, policy making and academic circles hence forming the foundation of many animal welfare legislations, codes of recommendations and farm animal welfare certification schemes, and are the basis of the Welfare Quality® assessment scheme. Additionally, they are widely in use in teaching veterinary and animal welfare science learners (McCulloch, 2013)

These five freedoms define the ideal state for acceptable welfare whereby freedom from hunger and thirst is met through access to fresh water and diet to maintain full health and vigour while the freedom from discomfort is achieved by provision of an appropriate environment including shelter and comfortable resting area. Freedom from pain, injury or disease entails prevention or rapid diagnosis and treatment; freedom to express normal behaviour is attained by providing sufficient space (RSPCA, 2009; OIE, 2019a), proper facilities and the company of the animal's own kind whereas freedom from fear and distress is accomplished by ensuring conditions and care which avoid mental suffering (Spoolder, 2007; RSPCA, 2009; OIE, 2019a).

The context in which broiler chicken farmers operate has been found to be competitive and driven by cost-price. Furthermore, most recently there has been growing need to improve animal welfare in broiler production systems (Gocsik *et al.*, 2016). This is because animal welfare has turned out to have scientific basis against which significant political decisions are made (Broom, 2011). Globally, several studies on animal welfare research within the temperate regions have been undertaken. A study was undertaken to examine the willingness of Dutch broiler and pig farmers to convert to production systems with improved animal welfare and the barriers to adoption of high welfare practices (É Gocsik et al., 2015). It was reported that for farmers to change to a system that necessitated irreversible changes, between 62% and 87% of the respondents required 30% rise in their household incomes, whereas to change to one with reversible changes, only 20% of the respondents needed a comparable rise in their family incomes. Based on this study, only 40% of the respondents were agreeable to change to definite systems that permitted reversible changes if they were guaranteed of earning the equal returns as they did in their present system.

A review on the factors that affect welfare of farm animals noted that respect for animals in the food chain was regarded to be satisfactory based on an ethical matrix that afforded respect in accordance to the principles of safety, independence and fairness to consumers, farm animals, farmers and the living surroundings (Webster, 2001). According to Webster (2001), it was the farmerὂs responsibility to make provision for high-welfare conditions through good husbandry since the farmer could not guarantee high welfare conditions. From an economic perspective, Webster (2001) argued that the legislation to impose higher animal welfare standards cost farmers than the consumers. Hence it should have been the responsibility of the consumers to change need for higher standards of welfare into an effective demand. The author concluded that the strategy to encourage and fulfil this demand was through welfare-based quality assurance schemes with quality control ensured by independent audit which guarantees good animal welfare (Webster, 2001).

A study was conducted on good agricultural practices in broiler chicken production in Brazil with reference to animal welfare (Souza and Molento, 2015). It was found that indicators associated with accessibility and the quality of food and water were adapted by the respondents, although it was necessary for them to be enhanced. With regard indicators relating to the environment, there were concerns about air and litter quality as well as implementation of emergency systems on broiler houses that were completely enclosed Souza and Molento (2015) observed that natural light had been replaced by low intensity artificial lighting; footpad dermatitis was the largely mentioned disease as a sanitary indicator (93.3%) and environmental enrichment was not used in poultry houses.

2.2 Broiler production and factors that contribute to denying the 5 freedoms

The World Animal Health Organisation classifies broiler production systems into 3 categories: completely housed system; partially housed system; and completely outdoors system (OIE,2019b). In the completely housed system, broiler chickens are enclosed in a poultry house with or without environmental control while in partially housed system, birds are reared with access to a restricted outdoor area. However, in the completely outdoors system, broilers are not confined inside a poultry house at any time during the production period but are confined in a designated outdoor area.

Broiler chicken is a key animal-derived protein for human beings whereby in late 1990s, the worldwide poultry productivity grew steadily by 32.5 million tons of chicken meat (Santana *et al*., 2008). According to Santana *et al*. (2008), chicken was the most consumed protein with a consumption rate of over 90 pounds per capita in America. Furthermore, in 2015 the United States of America had the largest broiler chicken industry worldwide, and they had approximately 19 percent of their broiler products being exported to other countries around the world including destinations like Mexico, Canada and Hong Kong (National Chicken Council, 2016).

According to Nicol and Davies (n.d.) key welfare concerns for commercially reared broilers are leg health problems and lameness, metabolic disorders, and hunger in restricted-fed broiler chicken breeding flocks.Considering that accomplishment in rearing of broiler chicken depends primarily on productivity, breeding firms have been compelled to raise highly efficient breeds that meet consumer preferences (Kralik *et al.*, 2014). Therefore, rigorous breeding for productivity has been linked to elevated nutritional demand and consequently increased feed intake in broiler chicken breeding stock as well as feather pecking in hens. Because of the high feed intake, breeding stocks are likely to become obese and develop health problems if they feed to their satisfaction (Grandin and Deesing,2014). It has been recommended that in order to prevent health problems during rearing, rigorous feed controls should be applied, but this could also result in adverse consequences on broiler wellbeing if they were starved. Based on recent studies, the use of high- roughage feed together with an appetite suppressant are some of the interventions that have been applied to ease the adverse consequences of feed controls to ensure freedom from hunger, malnutrition and thirst (De Jong and Guémené ,2011; Grandin and Deesing, 2014).

Factors related to the handling systems in place at the time of harvest and transporting the broiler chickens for slaughter also play a critical role in ensuring freedom from fear and distress (Santana *et al*., 2008). According to Spurio *et al*. (2016) , one of the most important sources of stress to broiler chicken is heat stress during the transportation process from farm to the commercial slaughter house. It was therefore found important to develop inexpensive interventions that can be instituted during transportation time for enhanced comfort and freedom from fear and distress of broiler chicken as well as enhanced quality of meat (Spurio *et al.*, 2016). In a study to investigate the impact of dark house system on growth, performance and meat quality of broiler chicken, it was demonstrated that lighting system had an impact on growth rate and feed conversion ratio of the broiler chicken (Carvalho *et al.*, 2015). Assessment of birdsô welfare based on stress levels in the different lighting systems established that broiler chicken produced under relatively darker lighting systems were likely to have superior performance when compared to those raised in conventional systems even though the birds faced higher stress during pre-slaughter handling (Carvalho *et al.*, 2015). According to Riber *et al.* (2017) environmental enrichment is enhancement of the surroundings of confined animals, that allows the animals to express natural behaviour resulting in upgrading in biological function. Based on results of a study on effects of environmental complexity on fearfulness and learning ability in fast growing broiler chickens; it was reported that exaggerated fear responses of the flock affects broiler chicken welfare through smothering and increased mortality (Tahamtani *et al.*, 2018). The authors concluded that increasing environmental complexity by use of enrichments had positive impact on reducing fearfulness and supporting learning ability in broiler chickens consequently their welfare was improved.

To ensure freedom from discomfort, the key management factors such as the nature of ventilation, litter, watering points as well as size of the labour force within the chicken house should be considered. In addition, maintaining optimal temperature, humidity, and quality of air and litter is critical to the welfare of broiler chicken (Jones *et al*., 2005). According to Jones *et al.* (2005) by applying different stocking densities, the relative humidity within the first seven days after hatching was reported to be predominantly significant in shaping the outcomes of the birds.

Deterioration of litter condition within the poultry house has been shown to predispose broiler chickens to pain, injury and disease which affect the welfare standards for the birds. Furthermore, these injuries lead to increased frequency of lower scores for walking ability i.e. gait score, hock burns and foot pad lesions which have also been related to increased stocking density in poultry housing (Ġkrbiĺ *et al*., 2009). Ġkrbiĺ *et al.* (2009) demonstrated the significance of restrictive stocking densities as a factor impairing broiler welfare and hence lowering the economic efficiency of production. Higher stocking densities above 19 birds/ m^2 in poultry housing impact negatively on the rate at which the birds grow (Petek *et al*., 2010; Buijs *et al*., 2011). Wet and sticky litter was found to cause footpad dermatitis (FPD) which in addition affects broiler welfare and the quality of the products from these birds. De Jong and van Harn (2012) have therefore argued that broiler producers can reduce losses and improve bird welfare by maintaining a good litter quality.

Additionally, increasing vulnerability of broiler chickens to ascites was blamed on continuous breeding and dietary upgrading for enhanced utilisation of feeds and faster growth rates. The presence of ascites in broilers was thought to be as a result of an imbalance between oxygen supplied for sustenance of rapid growth rates and high feed conversion efficiency (Milsavljevic, 2014). In addition, the build up of ammonia gas emissions in the housing units was postulated to result in welfare problems and therefore a possible cause of ascites in broiler chicken. In farms where there is high stocking densities and poor ventilation, there is an invariably increased concentration of ammonia gas in the housing environment (Harper *et al*., 2010; Milsavljevic, 2014). This consequently results in lung damage with subsequent hypoxia that is considered to be the main cause of ascites in broilers (Harper *et al*., 2010; Milsavljevic, 2014). In another study that examined the physiological and nutritional aspects of ascites in broiler chicken, the interplay between nutrition, environment and genetic was reported to have a critical role in the occurrence of ascites (Baghbanzadeh and Decuypere, 2008). Due to the relationship with oxygen demand, ascites is precipitated by factors such as growth rate, hypoxia and temperature of the environment. In addition, Baghbanzadeh and Decuypere (2008) reported that the high metabolic rate can also be a major factor contributing to the susceptibility of broilers to ascites. An early-age feed restriction either qualitatively or quantitatively or light restriction has been recommended in farms to help slow down the growth rate of birds(Baghbanzadeh and Decuypere, 2008; Bessei, 2011)

Grandin and Deesing (2014), in their study on genetics and behaviour of domestic animals established that over-selection for production traits leads to behavioural problems such as feather pecking in hens and overly aggressive animals. In order to ensure freedom to express normal patterns of behaviour, the utilisation of new genetic breeding tools have been suggested to select against harmful behaviours while retaining the productive traits in animals. Zhao *et al.*(2006) investigated broiler chicken raised in confinement and reported that at lower stocking densities with limited lighting, the breeding stock would express their natural behaviour. Furthermore, Zhao *et al.*(2006) reported that the number of birds raised per square metre had greater influence on the wellbeing of laying birds than the effect of exposure to lighting. On the other hand, shadowing was observed to diminish the congestion outcome for those birds raised in cages thus alleviating the manifestation of poor welfare standards for caged broiler chicken breeding stock (Zhao *et al*., 2006). Enriched housing design was an essential component of broiler welfare since it led to significant improvement in the quality of the meat at slaughter (Simsek *et al*., 2009). Therefore, housing designs that have provisions for perching and dust bathing would enable the birds to express their normal behavioural patterns as well as ensuring high quality poultry products that meet customersô expectations(Simsek *et al.*, 2009).

According to Ruff (1999), parasites were a concern regardless of the scale of poultry production and economic losses could be considerable. In a study conducted to examine village poultry production systems in the central highlands of Ethiopia (Dessie and Ogle, 2001), disease was reported to be the most important problem, followed by predation, inadequate quantities of feed, poor housing, limited availability of water and parasites. Disease outbreaks regularly destroyed chickens across the flocks, and as a result, half of the eggs produced were incubated so as to replace the birds that had died (Dessie and Ogle, 2001). In addition, the authors established that the main source of loss in the system was the high mortality of chicks (61%) which took place between hatching and the end of brooding at 8 weeks of age.

2.3 Assessment of broiler welfare

According to Dawkins (2003), assessment of animal welfare should be objective and scientific. Manning *et al.*(2007) examined key health and welfare indicators for broiler chicken production with the aim of identifying measurable indicators as well as determining which were acting as "lead" as opposed to "lag" indicators. The authors argued that broiler welfare was previously assessed using lag indicators for instance final mortality, stocking density, levels of contact dermatitis, reject levels and leg health which only provided information necessary for improvement of subsequent production cycles and not the welfare of the concerned birds. On the other hand, lead indicators were intra-cycle indicators that provide details on broiler chicken welfare for remedial actions to be taken during the growing cycle (Manning *et al.*, 2007). The lead indicators identified included feed and water consumption, air and litter quality and daily weight gain. The authors found that water was an essential nutrient that needed to be regularly analysed to make sure that it complied with accepted quality standards in order that health and welfare of the birds was optimized given that it was consumed both daily as well as in every cycle.

Considering skeletal disorders were key causes of poor broiler welfare, a study was conducted to examine broiler welfare in different feed restriction schedules (Guria *et al.*, 2010). It was observed that maximum number of lame birds were found in the group fed ad libitum while those reared on alternating 6 hours phases of feeding and off-feed were least affected.

Ġkrbiĺ *et al.*(2014) also assessed broiler welfare by examining the effects of production system and body weight of Redbro broiler chicken on the occurrence and severity of footpad dermatitis. The effect of body weight on the incidence and severity of footpad dermatitis was not statistically confirmed, although severe forms of footpad dermatitis were absent in broiler groups that had the lowest body weight. According to Ġkrbiĺ *et al.*(2014), raising broiler chickens in free range system demonstrated a positive results in relation to improved occurrence of broilers devoid of lesions and less occurrence of moderate and severe lesions with regard to production system. In addition, the authors concluded that the impact of production system on the occurrence of the majority severe forms of dermatitis in Redbro broiler chicken was statistically confirmed.

In a pilot study using the Welfare Quality® assessment protocol, Gocsik *et al.*(2016) examined the cost-efficiency of animal welfare in broiler production systems. The authors established that the production system that had slow growing breed and stocking density ranging from 25 to 31 kg/m^2 was preferred by farmers due to high cost-efficiency and the flexibility to relapse to the conventional systems that required implementation of the legal minimum standards.

According to OIE (2019b), broiler chicken welfare should be examined using outcome-based criteria as useful indicators of animal welfare (Table 2.1). These indicators should to be adapted in the various contexts in which the broiler chicken are raised while considering the strain of the animals concerned (OIE, 2019b). Furthermore, on the farm some criteria measured include gait, mortality and morbidity rates, while bruising, contact dermatitis and breast blisters are best assessed at the abattoir, including the aging of the lesions (OIE, 2019b). The multidisciplinary dimension of animal welfare necessitated OIE to establish a permanent Working Group on Animal Welfare in 2002 (OIE,2015). The World Animal Protection (WAP) is a member of the working group. Consequently WAP developed an assessment criteria for welfare indicators based on the OIE guidelines (OIE,2015) which included: access to appropriate diet, keeping slower growing breeds, slow growth rates in birds of 50g per day, absence of cages in poultry housing, provision of enrichments for the chicken in the housing, good quality litter materials, adequate lighting system, proper catching and handling, a maximum of 12 hour fasting period before broiler chicken are taken for slaughter, maintaining a stocking density of 30 kg/m^2 and an established feedback mechanism on quality of products to farmers and other stakeholders based on welfare indicators: ascites, dead on arrival, pododermatitis, hock burns, breast blisters and state of cleanliness of feathers cleanliness (World Animal Protection, 2016). The current study investigated welfare indicators using World Animal Protection (2016) welfare assessment tool for broiler chicken to establish the current status of broiler chicken welfare in the large scale contract and non-contract broiler chicken farms in Kenya.

Table 2.1: Summary of welfare indicators based on the OIE outcome-based criteria and measurable framework for evaluating animal welfare practices in farms OIE (2019b)

Broiler production factors	Outcome-based criteria and measurable framework
1. Stocking density	Injury rate, contact dermatitis, mortality, behaviour, gait, disease incidence, metabolic disorders and parasitic infestations, performance, feather cleanliness.
2. Nutrition	Consumption of feed and water, performance, behaviour, gait, disease incidence, metabolic disorders and parasitic infestations, mortality, injury rate.
3. Selection of broiler strain	Welfare and health considerations, as well as productivity and growth rate, ought to be taken into consideration when selecting a strain for a specific place or production system
4. Performance	Growth rate; feed conversion and liveability
5. Outdoor areas	Behaviour, incidence of disease, metabolic disorders and parasitic infestations, performance, contact dermatitis, feather condition, injury rate, mortality, morbidity.
6. Prevention of feather pecking and cannibalism	Fear behaviour; spatial distribution; panting and wing spreading; dust bathing; feeding, drinking and foraging; feather pecking and cannibalism.
7. Type of floor, bedding, resting surfaces and litter quality	Litter must be maintained in order that it is dry and friable and not dusty, caked or wet.
8. Protection from predators	Fear behaviour, mortality, injury rate.
9. Handling and inspection	Behaviour, performance, injury rate, mortality, vocalisation, morbidity.
10. Staff training	Behaviour, performance, injury rate, mortality, vocalisation, morbidity, dust bathing; feeding, drinking and foraging; feather pecking and cannibalism.
11. On-farm harvesting	Injury rate, mortality rate during harvesting as well as upon arrival at the abattoir.
12. Painful interventions	Mortality, culling and morbidity, behaviour.

2.4 Role of guidelines and standards in broiler chicken welfare

Despite animal welfare guidelines not being addressed in the World Trade Organisation (WTO) agreements, animal welfare is gaining prominence globally hence the need to entrench the World Organisation for Animal Health (OIE) guidelines in global trade of animals and animal products (Thiermann and Babcock, 2005; OIE, 2015).Several countries have reviewed what constitutes animal welfare and how it was entrenched in their respective legal frameworks and regulations for housing and care of animals (Korte *et al.*, 2007). The American broiler chicken industry made deliberate efforts in the development of policies and provisions for broiler chicken welfare which yielded positive impacts (Marion, 2004).

In addition, Vanhonacker *et al*. (2016) in their study noted that it was a requirement by the new European Union (EU) regulations to have in place country-of-origin labelling as broiler meat imports from non-EU countries increased. The authors studied the opinions of consumers and producers on broiler production in addition to broiler meat originating from Belgium versus Brazil. The results demonstrated significant differences between the 2 countries for almost every characteristic associated with rearing of the chicken and the final product. Hence Vanhonacker *et al*. (2016) argued that the source of broiler meat greatly impacted on the consumersôopinion about welfare standards that the birds were subjected to.

In reaction to external market demand and the need to improve animal welfare, Brazil commissioned a study to advise its farming interventions in order to enhance animal welfare as well as maintain its position as a global exporter of chicken (de Moura *et al.*, 2010). Brazil was keen on alternative resources for upgrading, with no additional costs of production, including litter quality, requirements of animal welfare and environment affairs, for example recycling broiler litter. Consequently, the same authors examined animal welfare; environment; animal behaviour as well utilisation of modern climatisation technology to enhance the quality of the environment including physical and thermal comfort created to raise broilers. The authors proposed strategies on reduction of greenhouse gas emissions as well as global warming in the environment, for sustainable production system.

2.5 Contract broiler farming

Contract broiler farming is a model where farmers are willing to rear broiler chickens for a given period, at a price based on the ratio of feed to chicken weight at slaughter (Miller, 2018). Miller (2018) conducted a study on two broiler farms contracted by a large firm in United States of America. It was found that the broiler farms invested in the built infrastructure and produced the broiler chicken while the company that had contracted them was responsible for the supply and processing chains.

Areerat (2012) examined the contract broiler farming in Thailand where broiler production was the main economic activity in the countryổs livestock sector as a result of increased number of commercial farms or contract farming. It was established that contract farming was desired by farmers as well as for private companies even though most farmers complained of delayed delivery of the next cycle of chicks.

Simmons *et al*. (2005) examined the emergence and benefits of contract farming in three regions in Indonesia. After examining three contracts: for seed corn in East Java, seed rice in Bali, and broilers in Lombok the researcher established that the contracts were diverse depending on technical specifications of production in addition to the related costs. In addition, (Simmons et al., 2005) noted that involvement in contracts was influenced by farm size and other factors such as farmerổs age, education, and membership in farm groups. The authors concluded that contracts improved income to investment for the seed corn and broiler contracts except for seed rice contracts. Furthermore, the three contracts influenced the kind of labour used; but neither of them influenced total farm employment.

Another study on contract broiler production in Lombok, Indonesia evaluated the performance of integrated poultry production by way of contract farming system (Indarsih, *et al.*, 2010). The authors established that contract broiler production was preferred because of risk sharing (28%), financial credits (26%), and the guarantee of marketing (23%). It was however noted that there was displeasure in relation to incentive allocaated, the quota, and margins given that the ratios of margins between farmers and integrated poultry companies were 30%: 70%; 40%: 60% or 50%: 50% without clear reasons. According to Indarsih *et al.*(2010) performance parameter was satisfactory, indicating that quality of feed and management aspects were implemented as satisfactorily. It was concluded that capital was not the most important reason to work with the integrated poultry companies but government participation was found necessary in promoting poultry industry growth as well as looking for the new markets and legislation on maintaining the environment in order to prevail over price instability.

Considering contract broiler farming was one of the systems utilised to boost poultry production in Malaysia, a case study on performance of broiler contract farmers was conducted in Perak, Malaysia (Majid and Hassan, 2014). The researchers established that price per bird, feed conversion rate, average body weight, average age at slaughter, mortality rate, and rearing housing system except the size of farm, significantly influenced the performance of broiler contract farmers at ($P< 0.05$).

Kalamkar, (2012) analyzed production-related aspects of broiler farming under contract and independent management, and examined inputs and services provision arrangements. It was noted that about 67% of the contracts were of three years period while the rest had durations of eleven months or two years. It was observed that all the contract farmers analyzed did not possess a copy of the contract with the independent management. In addition the average net return per kg of live weight and per bird was found to higher in non-contract than contract farmers (Kalamkar, 2012). It was found that the average net returns per bird increased with increase in the size of the farm for both the groups. Some of the challenges facing contract farmers were such as delayed input supply, high prices of feed, delayed payment, low price, and sometime even rejection of products, low growing charges, delayed provision of chicks, delayed provision of veterinary services, expensive visiting charges and deduction of tax at source in spite of having a contract for input supplies and sale of outputs in place.

In the Kenyan context, there are no previous studies published on contract broiler farming. Therefore the current study reviewed the large scale integrated Poultry Company and the requirements necessary for broiler farmers to join the contract scheme and the working relationship between these entities.

CHAPTER THREE: MATERIALS AND METHODS

3.1 Study area

The study was undertaken in Kajiado, Kiambu, Machakos, Murangĝa, Nairobi and Nakuru Counties (Figure 3.1). The areas were purposively selected based on their popularity in large-scale broiler production. Kajiado County is bordered by 7 counties which include Nairobi, Narok, Nakuru, Kiambu, Taita Taveta, Machakos and Makueni Counties. It is also situated adjacent to Tanzania in the South West. The county has an estimated surface area of 21,900.9 square kilometres. Considering its immediacy to Nairobi, the major urban centres such as Ngong, Kitengela and Ongata Rongai are inhabited by people who work in Nairobi. The main economic activities in Kajiado County include pastoralism, wholesale and retail trade, mining particularly soda ash in Magadi and marble in Kajiado Central and agriculture which include horticulture and small scale farming. The County has one of the most visited National park i.e. Amboseli National park where visitors enjoy the beautiful scenic Mt. Kilimanjaro and the wildlife (KNBS, 2015a).

Kiambu County is situated adjacent to the northern border of Nairobi County (KNBS, 2009). It has a population of 1,603,400 and a total area of 2,543 square kilometres (KNBS, 2016) with agriculture predominantly providing employment to approximately 75% of the population. Agriculture, which is the main economic activity in the County, includes crop and livestock production activities (Okello *et al*., 2010).

Machakos County is situated in Kenyaĝs eastern region and borders Embu, Kitui, Makueni, Kajiado, Murangĝa, Kirinyaga, Nairobi and Kiambu counties. Based on the Kenya 2009 Census it had a population of 1,098,584 people, 264,500 households, and a total surface area of 6,208 square kilometres. The County is largely semi-arid with a hilly topography extending to nearly all parts. Maize and drought-tolerant crops including fruits, sorghum and millet constitute the subsistence farming carried out. Sand harvesting and industrial production particularly in Mavoko Sub-County form the main economic activities in the county. Masinga dam which produces electricity for the country, the proposed techno-city (Konza) and Kenya

Meat Commission (KMC) are some of the industries hosted within this county (KNBS, 2015b).

Murangôa County is located in the Central Kenya region and borders Nyeri, Nyandarua, Kiambu, Machakos and Kirinyaga counties. The County lies between latitudes 0^o 34ô South and 10 7ô South and Longitudes 36^o East and 37^o 27ô East. It has a total surface area of 2,558.8 square kilometres and had a population of 942,581 persons based on the Kenya 2009 census. Agriculture is the main economic activity for the county with tea and coffee being produced for commercial purposes whereas maize and beans are the subsistence crops. The dairy industry is also another economic activity for Murangôa County (KNBS, 2015c).

Nairobi County came into existence in 2013 but retained the same boundaries of the former Nairobi Province and the former Nairobi City Council. It covers a total area of 696.3 square kilometres with annual rainfall amounts averaging 55.4 mm whereas annual temperature averages 25.30^0C. The County has 9 sub-counties which include Starehe, Kamkunji, Kasarani, Makadara, Embakasi, Njiru, Dagoretti, Langata and Westlands. In 2014, it had a projected human population of 4,004,400 whereas the broiler population was 450,984 in 2013. Nairobi is the second largest city in the Great Lakes region after Dar-es-Salaam of Tanzania and the 14th largest city in Africa (KNBS, 2015d).

Nakuru County is situated in the Rift valley and shares boundaries with Kiambu, Baringo, Kericho, Laikipia and Nyandarua Counties. It lies at an average altitude of 1,850 metres above sea level within agro-ecological zones II, III and IV with an annual rainfall of 650 - 1200mm and nearly all the soils in the county are volcanic. The daily minimum temperatures vary between 11^0C to 14^0C while maximum temperatures vary between 23^0C and 29^0C. The County has a population of 1,603,325 out of which 45.8% live in urban areas and is cosmopolitan in nature. The county has an area of 7,509.5 square kilometres with 11 administrative sub-counties (KNBS, 2009). It is an agriculturally endowed county with diverse tourist attractions for example Menengai Crater and several lakes which include Lake Nakuru, Lake Naivasha and Lake Elementeita (KNBS, 2015e).

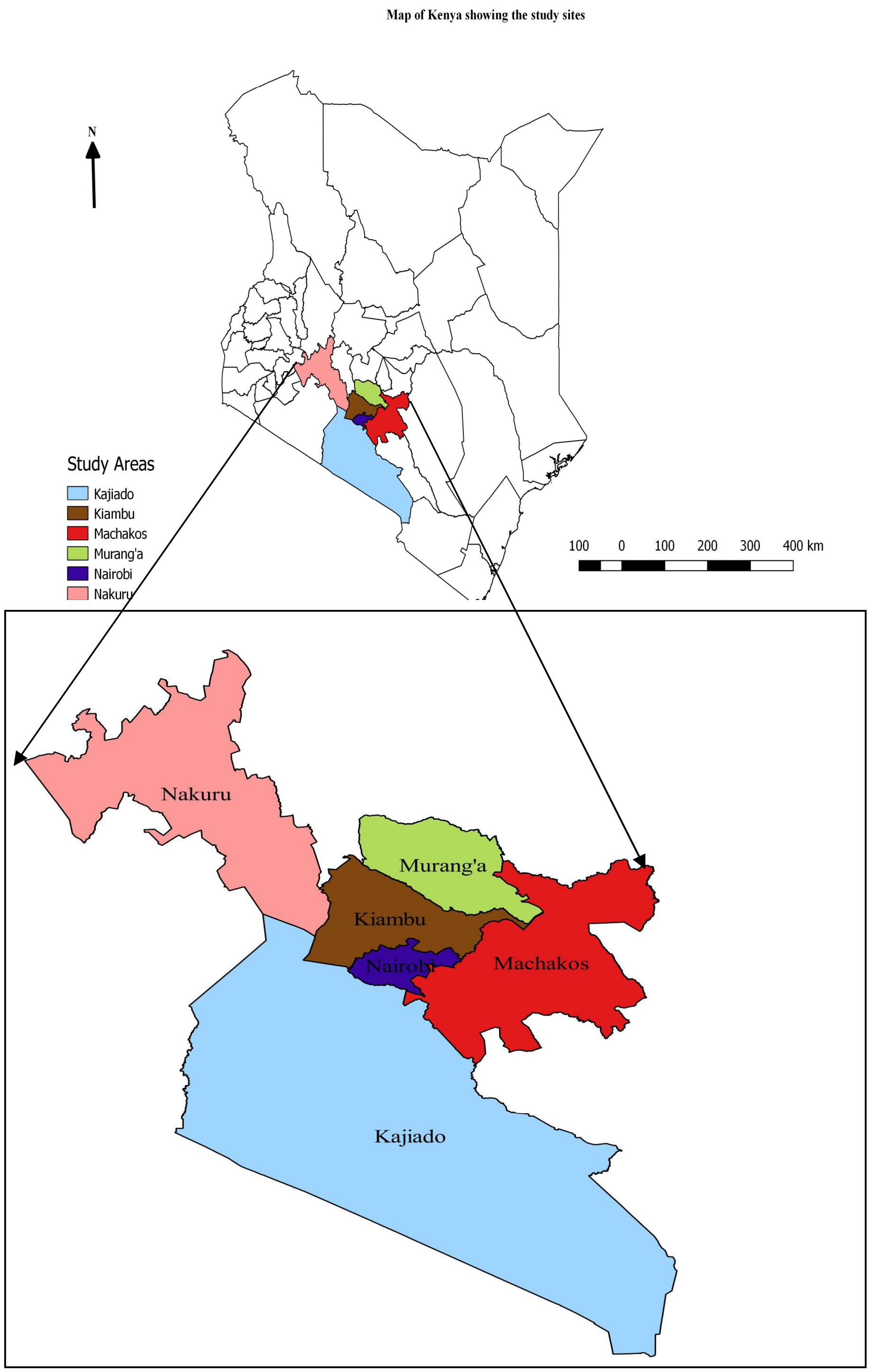

Figure 3.1: **Map of Kenya showing the Counties which were included in the study**

3.2 Study design

A cross-sectional study design was adopted. Cross-sectional study designs are often used when there is limited information on a phenomena and a quick survey likely to be considered necessary to obtain data that would provide an understanding of the situation, as well as advise on the design of future detailed studies (Kothari and Garg, 2014).

3.3 Study Population

The target population was large scale broiler farms in Kenya whereas the study population were those large scale broiler farms located in Kajiado, Kiambu, Machakos, Murangóa, Nairobi and Nakuru Counties.

3.3.1 Selection of study units

The large scale broiler farms, both contract and non-contract, participated in the study and they were identified with the assistance of field veterinarians from the large scale integrated Poultry Company who often provided extension services to these farms. Based on information obtained from the field representatives, there were 70 large-scale broiler chicken farms that were contracted by large scale integrated Poultry Company for broiler production in all counties. An equal number of non-contract large scale broiler farms were used for comparison with the contract large scale broiler farms. This constituted the sampling frame for each group of broiler chicken production farms.

3.3.2 Minimum requirement for recruitment of contract farmers by an integrated large scale broiler chicken company

The minimum requirements included the distance from the slaughter facility was about 100 km; at least 5 acres of land, accessible all weather road, and a permanent source of water. In the first instance, the contract manager visited the farm/site. Upon satisfactory inspection of the farm, the operations manager made a second visit so as to authorize the farmer to build. The farmer built and equipped the poultry houses according to the specifications of the large scale integrated Poultry Company. As part of the requirements, the farmer had to start with a minimum of 12,000 birds. Once the poultry house was complete, a security deposit of ksh 95 per chick placed was paid to the large scale integrated Poultry Company. This amount was refundable upon termination of the contract. In return, the farmer got day-old chicks, feed, vaccines, disinfectants and other related consumables for the birds on credit. When the birds matured for slaughter by day 32-35 as per the programme, the farmer was invoiced Ksh. 57 per day old chick delivered at placement. In addition, all the input supplies provided to the farmer on credit at the beginning of the full contract were invoiced for together at the end of the crop. However, technical support was provided for free. The buy-back price was at Ksh. 170 per kg of live weight bird for prime weight of between 1.60 kg and 1.80kg. In the event that the weight was higher than 1.80 kg, this then is paid at Ksh. 155 per kg live weight. Similarly, weight of less than 1.60 kilos was also paid for at Ksh. 155 per kg live weight. On the other hand second grade birds with scratches; broken wings and legs during catching and processing were paid at Ksh. 120/kg.

Acquisition of feeds for the contract farmers was from a designated feed milling company. Farmers were required to follow a three stage feeding regime with the allocation per bird, from day 1 to day 35 being 0.42kg/bird for starter crumbs, 1.26kg/bird for grower pellets and 1.60kg/bird for finisher pellets.

3.3.3 Sample size calculation

A sample size required for both groups of broiler farms was calculated using the standard formula for sample size determination when comparing means of continuous variables (Dohoo et al., 2010a). The parameters used for the sample size determination included weight in kilogram at the time of slaughter and age in days at the time of slaughter for the broiler chickens. The data on mean weights and standard deviations for the parameters which were used for the calculation of the sample size were obtained from secondary data. The sample size was determined using the formula below:

$n = 2\{(Z\text{Ŭ} - Z_{\text{ϐ}})^2 \text{ů}^2 / (\varepsilon_1 - \varepsilon_2)^2\}$ é é é é é é é é é é Formula 1(Dohoo *et al.*, 2010a)

where $Z\text{Ŭ}$ is $Z_{0.05} = 1.96$ referring to the level of significance, confidence= 95% ; $Z_{\text{ϐ}}$ is $Z_{0.80} = -0.84$ critical value a power of 80%; ů^2 is the variance; and ε_1 and ε_2 were the means for the contract and non- contract large scale broiler farms. The larger estimated sample size of

39 was adopted, and given the small sampling frame, finite population correction factor was applied. This required adjusting the sufficient size using finite population correction formula below, since this was a larger proportion (n > 10% of sampling population) of the contract farms.

$$n' = \frac{1}{1/n + 1/N}$$

é é é é é é é é é é Formula 2 (Dohoo *et al*., 2010 a)

Where n = the original estimate of the required sample size in an infinite population and N = the size of the population, and nô is the adjusted sample size.

Table 3.1: **Value of parameters used and the calculated sample sizes**

Parameter description	**Contract**	**Non contract**	**Standard deviation**	**Calculated sample size**	**Adjusted sample size**
Weight at slaughter (in kgs)	1.8	1.6	0.19	39	26
Age at slaughter (in days)	35	42	3.94	14	12

3.4 Data collection

Both primary and secondary data collection was undertaken. Secondary data were acquired from records kept at large scale integrated Poultry Company. These included the number of day old chicks purchased by each large-scale farm, number of deaths disaggregated by week or batches, the number of culled broiler chicken due to poor growth rates, small sizes and lameness. Primary data were obtained using a pre-tested semi- structured questionnaire which was administered to both the contract and non-contract broiler farmers located within the counties selected for the study. These farms were randomly identified among the broiler farmers who purchased day old chicks from the hatcheries of the large scale integrated Poultry Company. The questionnaires were administered to these farmers through face to face interviews. The questionnaire captured data on factors associated with poultry house environment including litter quality, ventilation and natural lighting. The dimension of poultry housing, the stocking densities per house, lag indicators of welfare (i.e. ascites, hock burns, breast blisters, state of feather cleanliness, dead on arrival) and routine management practices in broiler farms were also determined during the visits. For the broiler chicken housing conditions, rating score of between 1 and 10 were provided, where 1 meant the condition was less important or had lower impact, and 10 had high impact or more frequent in relation to downgrade or condemnation of the broilers at the time of slaughter for the broiler chicken in the contract and non-contract farms. The broiler farmer questionnaire is given in Appendix 7.

3.5 Data management and analysis

Data obtained from broiler chicken farmers was coded and entered into a database developed in Microsoft access package. These data were exported to Microsoft excel, cleaned and exported to Stata Version 10 statistical package for analyses. Continuous data were analysed by determining the arithmetic means, and their 95% confidence intervals. The means for continuous variables in contract and non-contract farms were compared using t-test to determine if they were statistically different. Categorical data were summarised, tabulated and compared using chi-square statistics. For the continuous variables at farm level and the lag indicators of broiler welfare including ascites, dead on arrival, breast blisters, hock burns, and state of feather cleanliness, statistical association was examined by computing pairwise correlation coefficients with corresponding levels of significance set at 5%. Other data that were collected in narrative forms were analysed using framework analytical approach (Gale *et al*.,2009; Gale *et al*., 2013). This involved identification of specific themes and the responses summarized based on the identified themes as were reported by respondents. Further analysis involved examining the statistical relationship between the different variables and the lag indicators of broiler chicken welfare. This analysis was undertaken by means of the general linear model with the ratings provided by various respondents with regard to occurrence of ascites as the dependent variable while other qualitative variables including ratings for litter quality, ventilation, natural lighting and other poultry house characteristics were the independent variables. The mortality and culling rates were estimated based on the true rate approach using the formula below (Dohoo et al., 2010b).

$$\text{True rate} = \frac{\text{Number experiencing event}}{\text{Average number in the period}}$$ é é é é é Formula 3 (Dohoo et al., 2010b)

Where the number of broiler chicken experiencing the event of interest were the number of recorded mortality in the last crop or the number of broiler chicken culled due to slow growth rates or lameness in each farm. The average numbers of broilers experiencing the events were derived by calculating the average number of broilers at the start of the crop and those that were sold at the time of depletion of the flock. Finally, growth rate was estimated per flock as a fraction between the average weight at time of slaughter in kilogram and the average age at slaughter in days.

3.6 Ethical Clearance

The research had set to observe high standard of ethics by ensuring that the welfare and the rights of respondents who participated in the study were protected. Before administration of questionnaires, the purpose of the study was explained to the respondents, and their rights to withdraw their responses even after data was collected were explained to them. In addition, the study acquired ethical clearance from the University of Nairobi Faculty of Veterinary Medicine Biosafety Animal Use and Ethics Committee reference number FVM/BAUEC/2018/138 of 26th January, 2018 (Appendix 7.3)

CHAPTER FOUR: RESULTS

4.1 State of welfare observed in the large-scale broiler chicken farms

4.1.1 Description of the study farms

A total of 61 questionnaires administered were filled and returned by respondents, of which 30 were from contract farms, while 31 were from non-contract farms as show. About 82% of the respondents were from Kiambu, Kajiado and Machakos while the rest were from Nairobi, Murangॐa and Nakuru. All the respondents accepted to take part in the study, and a few of them requested that they be provided with a feedback of the results of the study to help them improve their broiler chicken farming businesses.

4.1.2 Description of broiler farm practices in contract and non-contract farms

The various farm practices which were reported by the broiler chicken farmers are described under the various thematic areas (Table 4.1 and Appendix 7.2). These included: factors within the housing environment and their design, such as ventilation, quality of litter, and natural lighting; breeds kept in these farms; feeding and watering practices. The current study also documented challenges that these chicken farmers encountered; the types of training the farmers obtained from the extension agents; the buyers of broiler chickens and their products; and barriers to entry into large scale-broiler chicken farming.

The litter in the broiler chicken farms was always dry, but this was often affected by the prevailing weather conditions. For example, during rainy season, the litter in broiler houses would be moist or wet. Additionally, wet patches often occurred around drinkers and this made the litter to cake. In both farming systems, litter was often cleared from the housing after the cropping cycle was over, and the birds either sold to the processing plants or slaughtered and their meat sold to buyers. These litter materials were often used in the crop farms, or were sold to brokers, who in turn sold them to crop farmers who would use them on flower and other crop farms. In some contract farms litter materials from broiler chicken houses would be used as a protein source fed to dairy cattle. During dry seasons, farmers would often lack market for these litter materials, and in such cases some large scale farms would hire a lorry to transport the litter materials to neighbouring farms free of charge. The other challenges which were reported in non-contract farms included high costs of purchasing litter materials, increased incidences of respiratory infections in those people who work in broiler chicken houses, itchiness of hands, and lack of sufficient space for disposal of litter materials. The non-contract farmers also reported that when litter material was wet, then it would emit ammonia like smell, which was evident at the time of data collection, while sometimes litter materials would become quit dusty.

In both types of farming systems, ventilation and natural lighting were found to be adequate. However, the state of ventilation was reported to be affected by wind and the prevailing weather conditions. Most of the poultry houses had openings on at least two sides of the building wall for ventilation and natural lighting. The contract farms were on three stage feeding regime, which included starter (0.42 kg), grower (1.26 kg), finisher (1.6 kg) fed per chicken per cycle, while the non-contract farms were on a two stage feeding regime with starter (1 kg) and finishers (3 kg) per chicken per cycle. The contract farms only fed pelleted and crumbled feed, while for the non-contract farms they would feed mash, pelleted and sometime crumbled feed. In both farming systems, the breed of broiler chickens kept were Cobb 500, however, some few farmers kept Arbor Acres.

The challenges which were identified by the contract farmers which affected their businesses included high brooding costs, high mortality rate for broiler chicks, water shortages, poor growth rates for chicks, high costs of feed, high costs of heating, presence of diseases including ascites and navel ill, and staff management. For the non-contract farms, the main challenges included lack of market for mature broiler chickens, high mortality rates, and presence of diseases like ascites, frequent power blackouts, poor feed quality, and difficulty in sourcing of farm inputs (litter materials and charcoal), high transportation costs and predation of the broiler chickens by mongoose.

Both contract and non-contract large scale broiler farmers were adequately trained on management of broiler chickens. For example, both groups of farmers reported that they obtained extension services from field staff of large scale integrated Poultry Company on bio-security management, feeding, watering, disease control through vaccinations and medications, brooding and importance of keeping records. The buyer of the mature broiler chickens for the contract farms was the large scale integrated Poultry Company processing plant, while for the non- contract farms, the buyers included Nairobi City Market, Quality Meat Packers (QMP), brokers, cafeterias, butcheries, and other fast food restaurants.

Table 4.1: Narrative summaries on the various themes associated with raising broilers by both contract and non-contract large-scale farms in Kenya

Indicator	**World Animal Protection criteria for assessment of broiler chicken welfare**	**Contract farms**	**Non contract farms**
Estimated average stocking density	30 kg per square meter (one broiler chicken per square foot)	21.9 kg [95%CI: 18.2 - 25.6] 1.04 bird [95%CI: 0.84 ï 1.25]	22.5 kg [95%CI: 18.4 -26.8] 1.09 birds [95%CI: 0.78 ï 1.41]
Breed	Keep slow growing breeds e.g Cobb, Sasso, Hubbard, Rowan (Aviagen)	Cobb 500	Cobb 500, Arbor Acres
Diet	Continuous access to wholesome and nutritionally adequate feed and water	Pellet and crumble feed. Starter (0.42 kg), grower (1.26 kg), finisher (1.6kg)	Mash, pellet and sometimes crumble feed. Starter (1 kg), finisher (3 kg)
Growth rate	Average over lifetime of bird 50 g/ day	51.2g [95%CI: 50.3 ï 52]	42.9g [95%CI: 40 ï 45.6]
Cages	No cages	0%	0%
Enrichments	Provide enrichments from day 10 onwards to permit pecking, perching, and screening	No perches and other enrichments in broiler houses	No perches and other enrichments in broiler houses
Litter	Deep litter throughout the shed friable and dry to allow dust bathing, foot health and scratching	100% on deep litter, mostly dry but gets moist during rainy seasons and caking around drinkers	100% on deep litter, mostly dry but gets moist during rainy seasons and caking around drinkers

Indicator	World Animal Protection criteria for assessment of broiler chicken welfare	Contract farms	Non contract farms
Lighting	Natural light plus 6 hours continuous darkness daily and minimum of 20 lux	8.86 rating for natural lighting scale [1-10]; electricity at night	8.65 rating for natural lighting scale [1- 10]; electricity at night
Handling	Trained and competent staff on handling and catching of chicken	Training on handling and catching, general chicken management, biosecurity, medication	General chicken management, biosecurity, medication
Mode of transport	Transport to minimise stress	Specialised trucks fitted with crates	Pick-ups, gunny bags, motorcycles, slaughtered at home, human labour
Fasting before slaughter	Maximum of 12 hr	38% [95%CI: 18 ï 61]	4%[95%CI: 0.1 - 21.9]
Record keeping	Mortality rate	6.4% [95%CI: 4.9 ï 7.9]	3.1% [95%CI: 1.9 ï 4.3]
	Culling rate	1% [95%CI: 0.6 ï 1.4]	0.3% [95%CI: 0.1 ï 0.6]
	Medication	100% [95%CI: 84- 100]	83% [95%CI: 63 - 95]

Indicator	World Animal Protection criteria for assessment of broiler chicken welfare	Contract farms	Non contract farms
	Climate (temperature/humidity)	5% [95%CI: 0.1 - 25]	29% [95%CI: 13 ï 51]
Product quality ratings	Dead on arrival [0-10]	2.71 [95%CI: 1.95-3.45]	6.45 [95%CI: 4.10 ï 8.81]
	Ascites [0-10]	6.10 [95%CI: 4.61-7.58]	6.79 [95%CI: 4.88 - 8.70]
	Pododermatitis [0-10]	1	1
	Breast blisters [0-10]	1.42 [95%CI: 1.09 ï 1.74]	2.22 [95%CI: -0.08 - 4.52]
	Hock burns [0-10]	1.50 [95%CI: 0.89 ï 2.11]	3.0 [95%CI: 0.76 ï 5.24]
	Feather cleanliness [0-10]	1	4.56 [95%CI: 2.29 ï 6.84]

4.2 Estimation of mortality and culling rates in large scale broiler chicken farms

From the study the estimated mortality rate for broilers per 1,000 birds in contract farms was 64 birds (95% CI: 49 ï 79) and 31 birds (95% CI:19 ï 43) in non-contract farms; estimated culling rate for broilers per 1,000 birds in contract farms was 10 birds (95% CI:6 ï 14) and 3 birds (95% CI:1-6) in non-contract farms at (P < 0.05)

4.3 Univariate analysis for factors affecting broiler welfare

The study focused on various continuous variables whose means were calculated and 95% confidence intervals constructed around these means. The means were compared between the contract and non-contract farms to demonstrate any significant differences (Table 4.2). Amongst the continuous variables several had significant differences between the 2 farming systems studied. While focusing on the freedom from hunger and thirst there was significant difference in the estimated growth rate of broiler chicken in contract farms at 51.2 g (95% CI: 50.3- 52 as compared to 42.9 g (95% CI: 40- 45.6) in non- contract farms (P< 0.05). The age at maturity for broiler chicken in contract farms was 34.3 days (95%CI: 33.8 ï 34.6), and 38.2 days (95%CI: 36.5 ï 39.9) for non-contract farms. The estimated weight at slaughter of the broilers chicken in contract farms was significantly higher at 1.75kg (95% CI: 1.73 ï 1.77) than that of non-contract farms 1.64kg (95% CI: 1.53 ï 1.74) (P< 0.05). The continuous variables aligned to the freedom from discomfort as well as freedom to express normal behaviour comprised the estimated number of broiler chicken per house which in contract farms was 8,098 birds (95% CI:6,986ï 10,820) whereas in non-contract farms 1,225 birds (95% CI:1.783.1 ï 1,666.9) were kept (P< 0.05). There were also significant differences in the number of broilers per farm with 22,595 (8,237-36,953) being raised in contract farms while 1,654.2 (901.35 ï 2,407) in non-contract farms (P< 0.05). Several continuous variables addressing the freedom from pain, injury and disease had significant differences between the 2 farming systems. The estimated expenditure on veterinary medicines in contract farms was significantly different (P< 0.05) at Ksh72, 067 (95% CI: -3587 ï 147,721) as compared to 3,567 (95% CI: 132.43 ï 7,000.9) in non-contract farms; while the continuous variable on feather cleanliness was significantly different (P< 0.05) with rating in contract farms being 1 (95% CI) and 4.56 (95% CI: 2.29-6.84); and dead on arrival in contract farms was 3 (95%

CI: 1.95 ï 3.45) and 6 (95% CI: 4.10 ï 8.81) in non-contract farms. In addition, the farm-gate prices per broiler were significantly different (P< 0.05) with contract farms selling at Ksh 327.27 (311.2 ï 344.22) compared to non-contract farms at Ksh 389.88 (371.24 ï 408.51). There were no significant differences in the univariate analysis for relationships between being contract and non-contract broiler farmers with categorical variables (Table 4.3).

Table 4.2: Univariate analysis for mean differences for continuous variables between contract and non-contract broiler farmers in Kenya

Variables	Contract farms (30)	Non-contract farms (31)	P (T<t)
Continuous variable	**Means (95%CI)**	**Means (95%CI)**	
Number of broilers per farm	22,595 (8,237-36,953)	1,654.2 (901.35 ï 2,407)	0.0002
Number of houses	2.62 (1.59-3.65)	2.21 (1.55 ï 2.87)	0.1767
Number of broilers per house	8,098 (6,986-10,820)	1,225 (783.1 ï 1,666.9)	0.0001
Age at maturity in days	34.28 (33.83-34.64)	38.21 (36.50 ï 39.93)	0.0001
Weight at slaughter in kg	1.75 (1.73 ï 1.77)	1.64 (1.53 ï 1.74)	0.0287
Rating for litter quality [1-10]	8.33 (7.73 ï 8.93)	7.5 (6.88 ï 8.12)	0.0275
Rating for ventilation [1-10]	8.52 (7.97 ï 9.07)	7.83 (6.98 ï 8.67)	0.1532
Rating for natural lighting [1-10]	8.86 (8.37 ï 9.34)	8.65 (7.91 ï 9.40)	0.4675
Mortality rate for broilers per 1000 birds	64 (49 ï 79)	31(19 ï 43)	0.0008
Culling rate for broilers per 1000 birds	10 (6 ï 14)	3 (1 ï 6)	0.0038
Farm-gate price per broiler (ksh)	327.27 (311.2 ï 344.22)	389.88 (371.24 ï 408.51)	0.0001
Area per housing (squared feet)	9,397.4 (4,089.5 ï 14,705)	2,076.2 (446.52 ï 3,705.9)	0.0058
Density of birds per squared feet	1.04 (0.84- 1.25)	1.09 (0.78 ï 1.41)	0.7796
Expenditure on veterinary medicines (ksh)	72, 067 (-3587 ï 147,721)	3,567 (132.43 ï 7,000.9)	0.0123

Variables	**Contract farms (30)**	**Non-contract farms (31)**	**P (T<t)**
Continuous variable	**Means (95%CI)**	**Means (95%CI)**	
Retention fees for veterinarians (ksh)	0	11.11 (-12.33- 34.55)	0.3537
Number of broilers sold in the last crop	20,959 (6,245.6 ï 35,673)	1,482.2 (756.13 ï 2,208.3)	0.0025
Dead on arrivals [1-10]	2.71 (1.95 ï 3.45)	6.45 (4.10 ï 8.81)	0.0012
Ascites [1-10]	6.10 (4.61 ï 7.58)	6.79 (4.88 ï 8.70)	0.5466
Pododermatitis [1-10]	1	1	-
Hock burns [1-10]	1.50(0.89 - 2.11)	3 (0.76 ï 5.24)	0.1373
Breast blisters [1-10]	1.42 (1.09 -1.74)	2.22 (-0.08- 4.52)	0.3677
Feather cleanliness [1-10]	1	4.56 (2.29 ï 6.84)	0.0123
Number of broilers per feeder	96.06 (47.15 ï 144.96)	106.86 (65.10- 148.65)	0.7298
Number of broilers per drinker	108.45 (60.60 ï 156.30)	142.58 (78.39- 206.77)	0.4247
Growth rate in kg per day	0.0512 (0.0503 ï 0.0520)	0.0429 (0.040 ï 0.0456)	0.0360

Table 4.3: Univariate analysis for relationships between being contract and non-contract broiler farmers with categorical variables in Kenya

Variables	Contract farms (30)	Non-contract farms (31)	$\chi2$	P-value
Categorical variable	**Proportion (0.95CI)**	**Proportion (0.95CI)**		
Type of floor (deep litter/slatted floor)	1(0.69-1)	0.96 (0.79-0.99)	0.065	0.798
Walking spaces (yes/no)	0.95(0.76-0.99)	0.88(0.68-0.97)	0.060	0.807
Privacy curtains (yes/no)	0.95(0.76-0.99)	0.54(0.33-0.74)	1.486	0.223
Cages (no/yes)	1(0.84- 1)	1(0.87-1)		-
Access to water (yes/no)	1 (0.84- 1)	1(0.88-1)		-
Types of drinkers (bell drinkers/automatic plastics/nipples)	0.64(0.35-0.87)	0.33(0.16-0.53)	1.557	0.212
Sources of water (Tap water/borehole)	0.18(0.04-0.43)	0.25(0.1-0.47)	0.089	0.765
Litter materials (wood shavings/others)	1(0.75-1)	1(0.86-1)		-
Training of chicken handlers (yes/no)	0.95(0.76-0.99)	0.79(0.59-0.93)	0.071	0.790
Feeding before slaughter (no/yes)	0.38(0.18-0.61)	0.04(0.001-0.219)	0.061	0.805
Watering before slaughter (yes/no)	0.95(0.76-0.99)	0.86(0.64-0.97)	0.045	0.832
Is veterinarian consulted (no/yes)	1(0.84-1)	0.83(0.61-0.95)		0.738
Leg problems (yes/no)	0.57(0.34-0.78)	0.54(0.34-0.74)	0.435	0.509
Are you a member of farmer association (yes/no)	0.1(0.01-0.30)	0.04(0.001-0.211)	0.023	0.879

Variables	**Contract farms (30)**	**Non-contract farms (31)**	$\chi 2$	**P-value**
Categorical variable	**Proportion (0.95CI)**	**Proportion (0.95CI)**		
Record on medication (yes/no)	1(0.84-1)	0.83(0.63-0.95)	0.056	0.813
Records on climate (no/yes)	0.05(0.001-0.24)	0.29(0.13-0.51)	0.088	0.767
Interaction with government veterinarians (yes/no)	0.4(0.19-0.64)	0.43(0.22-0.66)	1.116	0.291
Encounter outbreaks in farms (yes/no)	0.3(0.12-0.54)	0.55(0.32-0.76)	0.124	0.725

Figure 4.1: Housing showing different types of drinkers and their arrangement alongside available walking spaces for broiler chicken

4.4 Factors associated with ascites in large scale broiler chicken farms

This study focused on various variables of broiler chicken production to determine their association with occurrence of ascites in broilers from large scale farms (Table 4.4). These included age at slaughter, stocking density, number of birds per drinker, birds per feeder, rating for litter quality, rating for natural lighting, culling rate, mortality rate and number of broilers per housing. Only natural lighting was found to be significantly associated with ascites at ($P < 0.05$).

Table 4.4: Factors associated with occurrence of ascites in broilers from large scale farms in Kenya

Variables	**Sum of squares**	**Mean squares**	**Variance ratio**	**P< 0.05**
Age at slaughter	8.7	8.68	0.72	0.409
Stocking density per squared feet	6.4	6.37	0.54	0.474
No. of birds per drinker	3.0	2.96	0.26	0.619
No. of birds per feeder	0.1	0.05	0.00	0.945
Rating for litter quality	7.3	7.28	0.69	0.416
Rating for natural lighting	68.5	68.50	6.59	**0.018**
Rating for ventilation	1.6	1.65	0.13	0.726
Weight at slaughter kg	21.1	21.13	1.68	0.207
Growth rate kg/day	10.9	10.9	0.80	0.384
Culling rate	0.4	0.43	0.03	0.857
Mortality rate	0.2	0.24	0.02	0.890
No. of broilers per housing	2.5	2.48	0.21	0.652

Figure 4.2: Presentation of brooders with broiler chicks and a modified source for heat and mature broilers in different types of housing

Figure 4.3: Broiler chicken housing showing different types of materials used for construction of walls and roofs and litter

CHAPTER FIVE: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Discussion

The current study aimed at establishing animal welfare practices; determining the mortality and culling rates in the large scale contract and non-contract broiler systems; and determining factors associated with occurrence of ascites in large scale contract and non-contract broiler systems. The study compared various broiler chicken welfare indicators between two farming systems: contract and non-contract broiler farms. The indicators were investigated based on the OIE (2019b) welfare criteria for broiler chicken and those that have been published elsewhere (Manning *et al.*, 2007; Guria *et al.*, 2010; Ġkrbiĺ *et al.*, 2014; Gocsik *et al.*, 2016; World Animal Protection, 2016).They included information on poultry housing environment such as litter quality; state of ventilation; natural lighting; feeding regimens; types of breeds kept; stocking densities; growth rates; and access to feed and water.

The stocking densities were not statistically different in both farming systems. When compared with the stocking density of 30 kg per square meter /one broiler chicken per square foot (World Animal Protection, 2016) there was compliance for this indicator in both farming systems. This finding was thought to have in part been as a result of the extension services provided by the field staff from the large scale integrated company. OIE (2019b) recommends that broiler chicken ought to be housed at a stocking density that permits them to access feed and water as well as walk and adjust their posture normally. Based on a report by the European Union on the welfare of chickens kept for meat production, the harmful effects of stocking density on broiler chicken welfare were evidenced in relation to poor litter quality, poor walking ability, foot pad dermatitis and behavioural restriction (SCAHAW, 2000). Abudabos *et al.*(2013) investigated the effect of various stocking densities on the performance, thermo-physiological measurements in addition to blood parameters between 0 days and 30 days of age female Ross broiler in three stocking densities classified as low (28.0 kg/m^2), medium (37.0 kg/m^2) and high (40.0 kg/m^2). It was concluded that increasing the stocking density rate from 28 to 40 kg /m^2 had apparent adverse effects on the performance of broiler chicken and were likely to put at risk their welfare.

Ġkrbiĺ *et al*. (2009) also argued that restrictive stocking densities were a significant factor impairing broiler welfare and hence lowering the economic efficiency of production. Furthermore, higher stocking densities above 19 birds/ m^2 in poultry housing impacted negatively on the rate at which the birds grew (Petek *et al*., 2010; Buijs *et al*., 2011). Bessei, (2011) argued that the effect of stocking density evident on growth rate and leg problems was due to its impact on litter and air quality. Furthermore, higher stocking densities impeded thermal energy transfer from the surface of the litter to the aerated room thus restricting the efficiency of conventional ventilation systems in reducing heat stress for broiler chicken(Bessei, 2011).

The birds in the current study had continuous access to water and feed but the feeding regime was different between the 2 farming systems. The contract farms were on three stage feeding regime, which included starter (0.42 kg), grower (1.26 kg), finisher (1.6 kg) fed per chicken per cycle, while the non-contract farms were on a two stage feeding regime with starter (1 kg) and finishers (3 kg) per chicken per cycle. In addition the contract farms only fed pelleted and crumbled feed, while non-contract farms would feed mash, pelleted and sometimes crumbled feed. According to Dixon *et al.*(2016), there were several aspects, including feeding and nutrition, environmental conditions, farming practices, housing system, social environment, infectious environment, and maternal health status, which could influence both the physical wellbeing, performance, behaviour and cognition of the offspring. The authors argued that inclusion of specific additives to feed or minute adjustments in incubation temperatures could realise positive benefits whereas other environmental aspects such as erratic feeding and lighting regimens ought to be avoided to reduce unfavourable effects. Following examination of the issues and constraints of matching poultry production with available feed resources, Farrell (2005) argued that the capacity of finishing broiler chicken to perform well on very low-energy diets permitted the addition of substitute feeds as well as by-products into formulations. It was however noted that the theory of matching production with accessible feed resources could negatively affect the growth of broiler chicken although in several countries it could have been largely an cost-effective alternative (Farrell, 2005). According to OIE (2019b) broiler chicken should at all times be nourished with a diet suitable for their age and genetics, that consists of sufficient nutrients to achieve their needs for sound physical condition and wellbeing.

Most of the farms kept Cobb 500 genotype which is known to be one of the birds with slower growth rates, but a few non-contract farms also kept Arbor Acres, which is a fast-growing breed. According to OIE (2019b), it is important to take cognisance of welfare and health requirements of the birds as well as productivity and growth rate during selection of a strain for a particular place or production system. The slow growing breeds recommended by organizations such as World Animal Protection (2016) include Hubbard JA757/JA957, Hubbard JA787/JA987, Rowan Ranger (Aviagen), Cobb Sasso. Wilhelmsson *et al.*, (2019) demonstrated that welfare for fast-growing broilers worsened when kept for more than 6 weeks. In addition there was a rise in mortality rate and occurrence of lameness and contact dermatitis while litter quality, thermal comfort and plumage cleanliness declined (Wilhelmsson *et al.*, 2019). These authors reported that signs of poor welfare were noted as well in the slower-growing hybrid, but to a minor degree and later during rearing. In addition, kind of feed only had negligible influence on the broiler chicken, even though Ross 308 birds matured faster on the mussel-meal diet. Therefore the slower-growing Rowan Ranger broiler type was recommended rather than the fast-growing Ross 308 broiler type in production systems with a long rearing period. However, Wilhelmsson et al., (2019) argued that the Rowan Ranger growth rate was viewed as moderate and, to avoid health challenges associated with fast growth rate, hybrids that grew at a much slower rate were recommended for organic broiler production systems with a long production time.

Because rearing of broiler chicken depends mainly on productivity, breeding firms have been constrained to raise highly efficient breeds that meet consumer preferences (Kralik *et al.*, 2014). Hence, rigorous breeding for productivity has been associated with elevated nutritional requirements and consequently increased feed intake in broiler chicken breeding stock as well as feather pecking in hens. According to Grandin and Deesing, (2014) breeding stocks were likely to become obese and develop health problems, if they feed to their satisfaction as a result of high feed intake.

The average growth rates were significantly higher ($P < 0.05$) for broiler chicken in contract farms at (51.2g/day) than in non- contract farms (42.9g/day), when assessed against the recommended growth rate of 50g per day (World Animal Protection, 2016). According to Knowles *et al.* (2008) the growth rates of broiler chicken rose by over 300% (from 25 g per day to 100 g per day) in the past 50 years as a result of rigorous genetic selection by broiler chicken breeders. Consequently, these led to growing public concern that many broiler chicken had impaired locomotion or were even unable to walk. Knowles *et al.*(2008) reported that at a mean age of 40 days, more than 28% of broiler chicken displayed signs of poor locomotion while 3% were nearly unable to walk. The high prevalence of poor locomotion occurred despite culling policies designed to remove severely lame birds from flocks (Knowles *et al.*, 2008). The authors argued that factors that are significantly associated with high gait score included the age of the bird (older birds), visit (second visit to same flock), bird genotype, not feeding whole wheat, a shorter dark period during the day, elevated stocking densities at the time of assessment, no use of antibiotic, and the utilisation of pelleted feeds which led to welfare challenges.

According to Bessei (2011), despite growth rate being a key economic aspect of broiler chicken production, the use of slow growing breeds reduces incidences of metabolic disorders that lead to mortality arising from Sudden Death Syndrome and ascites. From the current study it was established that broiler chicken were fed on pelleted and crumbled feed as opposed to mash fed to non-contract broiler chicken. It is thought to be the reason for reduced growth rate in non-contract farms. Therefore broiler chickens in contract farms had higher growth rate than the recommended 50g per day (World Animal Protection, 2016) and attained weight at slaughter at a relatively shorter time compared to those in non-contract farms. Brickett *et al*. (2007) reported that feeding mash rather than pelleted feed could improve leg health and walking ability.

Both contract and non-contract broiler farms in the current study did not use cages in the raising of the broiler chicken. Zhao *et al.*(2006) established that broiler chicken breeding stock displayed natural behaviours regularly when reared in larger spaces and in shadowed cages However, Zhao *et al.*(2006) argued that stocking density had additional effect on behaviour and welfare for broiler layers than lit environment. The authors suggested that being shadowed could diminish overcrowding effect and lessen the poorer quality welfare for broiler chicken breeding stock raised in cages.

There exists a predicament of whether enhancing the wellbeing of the chickens or reducing public health threat since outdoor poultry production systems considered to welfare-friendly are coupled with possible higher public health hazards (van Asselt *et al.*, 2019). van Asselt *et al.* (2019) examined the perceptions of consumers and poultry farmers in order to determine the dilemma and their opinions from a practical perspective. It was established farmers were less expected than consumers to select a system that benefitted the wellbeing of the broiler chicken at the cost of public health. According to van Asselt *et al.*(2019) the opinions of consumers and farmers were dependent on the context which needed to be considered towards achieving flourishing innovations in poultry production that were promoted by the general public(van Asselt *et al.*, 2019).

Majority of farmers in the current study employed good broiler chicken management systems, and this was possibly due to involvement of the field extension officers, who often educated the farmers on good broiler management practices. However, in most farms provision of environmental enrichment for these birds which would allow pecking, perching and screening, was lacking. Providing environmental enrichment in broiler chicken production could encourage species-specific behaviours in addition to possibly improve animal welfare while meeting consumer needs in an affordable way (Bergmann *et al.*,2017). In addition, environmental enrichment such as raised resting places, cover panels and substrate-for broiler breeders housed in cage systems, have been found to prevent or alleviate hunger, frustration, aggression, and abnormal sexual behaviour in broiler chicken breeding stock (Riber *et al.*, 2017). However, Riber *et al.* (2017) argued that an enrichment strategy which had negative impact on the animalsô health for instance environmental hygiene, or one that had several economic or practical limitations would certainly not be utilised on commercial farms and as a result under no circumstances will be beneficial to the animals.

According to Tahamtani *et al.* (2018), provision of enrichment reduced fearfulness that caused smothering and mortality in broiler chicken. Ohara *et al.*(2015) argued that bales of hay and perches characterized valuable enrichment materials, which allowed broiler chicken to express normal behaviour, lessened stress in the younger and lighter birds of both sexes, and reducing footpad dermatitis in female birds using the bales of hay and perches more than males. Thus, ensuring freedom to express normal behaviour, freedom from discomfort and freedom from pain, injury or disease for the broiler chicken was attained.

Furthermore, provision of environmental enrichment and natural light stimulated activity and normal behaviours in broiler chicken as opposed to provision of enrichment only or none at all (De Jong and Gunnink, 2019). Vasdal *et al.*(2019) established that there was a tendency for a decreased lameness with the enriched treatment ($p = .077$) when compared with birds without enrichment. According to Vasdal *et al.*(2019), birds in enriched environment exhibited higher levels of activities such as more running , worm running, play fighting, dust bathing and ground pecking while standing ($p < 0.05$) at 16 days than at 30 days. At 16 days and 30days, birds provided with environmental enrichment displayed more wing flapping, wing stretching, body shaking, ground scratching, and ground pecking while standing and lying compared to control birds. Additionally, birds in enriched environment demonstrated higher levels of body shaking and ground pecking while standing and lying ($p < 0.05$) than birds in similar setting in control pens even in place where enrichments were absent (Vasdal *et al.*, 2019).

The quality of litter material is important with regard to ensuring that broiler chicken are able to express their normal behaviour through dusting, bathing and scratching within the housing (World Animal Protection, 2016). In the current study, litter materials were mostly dry, but during the rainy seasons, the farmers reported that it would get moist which was also observed at the time of data collection. These moist conditions would hamper the broiler chicken welfare, and it may also increase the emission of ammonia gas which would affect productivity. The study findings indicated similarity with those reported by Bessei (2011), which indicated that high moisture content of the litter materials in chicken housing enhanced microbial activity, with a resultant rise in temperature and ammonia gas levels within the broiler house. Subsequently there was high incidence of contact dermatitis which impeded the freedom from pain, injury and disease.

Natural lighting appeared to have an association with the occurrence of ascites based on the ratings which were obtained from the respondents in the current study. Indeed, several studies have linked levels of light intensity to reduction or worsening of various broiler chicken welfare indicators. These studies also examined the effects of light intensity on quality of broiler chickens and productivity (Petek et al., 2010; Carvalho et al., 2015). However, the influence of natural light on quality of broiler products has not been investigated within the Kenyan context. Most of the available studies have been done under controlled environmental conditions, and therefore, there is a need to investigate the effects of restriction of natural light on product quality.

Ascites and other lag indicators of broiler chicken welfare had statistically significant positive correlations, and therefore any intervention that was directed at reducing one factor would in essence reduce the effects of the other welfare indicators. The increased occurrence of ascites in broiler chicken has also been associated with faster growth rate of broiler chicken (Baghbanzadeh and Decuypere, 2008). However, in the current study, the ratings obtained did not appear to suggest any strong relationship between ascites and growth rate in broilers. Reduction of growth rate in these broiler chickens has the potential to reduce the incidences of ascites. Indeed, efforts towards reduction of ascites in broiler chicken have previously focused on adoption of a breed with lower growth rates (Bessei, 2011), or reduction of feed or nutrient intake and the restriction of lighting to the chicken housing (Baghbanzadeh and Decuypere, 2008). Feeding of mash feed preparation has been reported to have potential of reducing growth rate, as opposed to crumbled and pelleted feed that most farms used as feed for the broiler chicken (Brickett,*et al.,*2007). According to Baghbanzadeh and Decuypere (2008), the incidence of ascites can be reduced through proper management of broiler chicken housing temperature and ventilation during cold weather.

The personnel in both contract and non-contract broiler farms had been trained on chicken handling and catching; and general chicken management, biosecurity and medication. Contract broiler farms used specialised trucks fitted with crates to transport mature broiler chicken for slaughter. However, non- contract broiler farms used pick-ups, gunny bags, motorcycles for transportation. The non-contract farms had poor handling that denied the birds freedom from discomfort. According to World Animal Protection (2016) the indicator on handling required that handlers be well trained and competent, and be able to apply proper catching and transport techniques which minimise stress and avoid pain or injury. Furthermore, farms should apply the rule of a maximum of 12 hours fasting pre-slaughter. The results of the present study had similarity to the conclusion made by Santana *et al.*, (2008) that factors related to the handling systems in place at the time of harvest and transporting the broiler chickens for slaughter played a critical role in ensuring freedom from fear and distress. Spurio *et al*. (2016) mentioned that one of the most important sources of stress to broiler chicken is heat stress during the transportation process from farm to the commercial slaughter house. In the current study this was noted in the case of non- contract farms due to lack of the necessary infrastructure to transport their birds to the market. Spurio *et al*. (2016) argued that it was important to develop low-cost interventions for use during transportation thus enhancing freedom from fear and distress of the broiler chicken as well as improved meat quality.

There was no significant difference in the univariate analysis for relationships between being contract and non-contract broiler farmers with categorical variables. The study results suggest that the extension services provided by the field extension officers from the large scale integrated Poultry Company and particularly on general chicken management could have led to this finding.

The farms included in this study only had interactions with the government veterinarians when they went to obtain movement permits for the birds, however, any further interactions with the veterinarians was minimal. This was partly due to the fact that the field extension officers often offered adequate advice to these farmers. The limited government involvement in the broiler farming systems was equally observed in the study on contract broiler production in Lombok, Indonesia that evaluated the performance of integrated poultry production using contract farming system (Indarsih, *et al.*, 2010). Indarsih, *et al.* (2010) further argued that government participation was necessary in promoting poultry industry growth in addition to exploring new markets and legislation so as to prevail over price instability.

The current study established in both contract and non-contract farms records were kept for age at maturity in days; weight at slaughter in kgs; growth rates in grams per day; mortality and culling rates; and conditions such as pododermatitis, ascites, hock burns, breast blisters, feather cleanliness, dead on arrival that led to downgrade or condemnation of the birds at the time of slaughter. According to Manning *et al.*(2007) lag indicators such as final mortality, stocking density, levels of contact dermatitis, reject levels and leg health provided information necessary for upgrading of successive production cycles. Conversely, monitoring lead indicators such as feed and water consumption, air and litter quality and daily weight gain can offer details on broiler chicken welfare essential for implementation of remedial actions during the growing cycle. The rating of feather cleanliness was statistically less frequent ($P< 0.05$) in contract farms (1) as compared in non-contract farms (4.56). According to OIE (2019b) assessment of the feather status of broiler chicken presents valuable details about broiler chicken welfare since plumage dirtiness is correlated with contact dermatitis and lameness for individual birds or may be associated with the surroundings and production system.

In the current study, the mortality and culling rates for broilers per 1000 birds were significantly higher contract farms than in non-contract farms ($P< 0.05$).The culling rate for broilers per 1000 birds was 10 (6 ï 14) in contract farms and3 (1 ï 6) at ($P< 0.05$). On the other hand, contract farms had a statistically lower rating of birds as dead on arrival at point of slaughter compared to non-contract farms ($P< 0.05$).The losses incurred through mortality in farms and through condemnation and downgrades at the time of slaughter impacts entirely the farmerôs earnings. According to OIE (2015), daily, weekly and cumulative mortality, culling and morbidity rates are required to be within recommended ranges. Unexpected rise in these rates might be a sign of poor broiler welfare. Therefore, these are losses which can be minimised through adoption of animal welfare practices which in turn would result into reduction of the health challenges like ascites, which was indentified to be the main cause of condemnation at point of slaughter.

According to Vieira *et al.*(2011) , the key factors that predisposed broiler chicken to daily mortality rate were average dry bulb temperature and relative humidity; lairage time; daily periods; density of broiler chicken per crate; season of the year; stocking density per lorry; transport time; and distance between farms and slaughterhouse. Vieira *et al.*(2011) established that seasons had significant effects ($P < 0.05$) on average mortality rates with the highest incidence being observed in summer (0.42%), followed by spring (0.39%), winter (0.28%), and autumn (0.23%) (Vieira *et al.*, 2011). Therefore Vieira *et al.* (2011) observed that there was a reduction in pre-slaughter mortality of broiler chicken during summer ($P < 0.05$) when the lairage time was extended, generally following 1 hour of exposure to a controlled environment. The authors concluded that lairage time for 3 to 4 hours in a controlled lairage environment during summer and spring was essential to decrease the heat stress in birds (Vieira *et al.*, 2011).

In the Dutch poultry meat production chain, the first week mortality of the broiler chicks was an important measure to quality which was highly associated to the cost of the chicks that the broiler farm had to pay to the hatchery (Yassin *et al.*,2009). These authors observed that first week mortality was significantly related to breeder age, egg storage length at the hatchery, season, strain, feed company of the breeder farm, year, and hatchery. In addition, the first week mortality was significantly different between chicks originating from eggs of different breeder flocks and those kept for grow-out at different broiler farms(Yassin *et al.*, 2009).

De Jong *et al.*(2017) conducted a ômeta-analysisô of effects of post-hatch food and water deprivation on development, performance and welfare of chickens. It was concluded that 48 hours (36ï 60 hours) post-hatch food and water deprivation led to lower body weights and higher total mortality in chickens up to six weeks of age with the latter being indicative of poor broiler welfare. However, these authors argued that effects of post-hatch food and water deprivation on organ development and physiological status appear to be largely short-term.

McCarron *et al.*, (2015) noted that infectious diseases in poultry could spread rapidly and lead to huge economic losses within poultry trade network in Kenya. The authors noted that in the past decade, in different continents, the accelerated spread of highly pathogenic avian Influenza A

(H5N1) virus, was frequently through informal trade networks, which led to the death and culling of hundreds of millions of poultry. Endemic poultry diseases such as Newcastle disease and fowl typhoid could also be devastating in many parts of the world(McCarron *et al.*, 2015).

In the current study, there were significant differences in the number of broilers per farm with more being raised in contract farms compared to those in non-contract farms. This was attributed to the minimum requirements set by the large scale integrated Poultry Company whereby it was imperative for contract farms to keep at least 12,000 birds. In addition, the farm-gate prices per broiler in the present study were significantly different with contract farms selling at lower prices as compared to non-contract farms at Ksh 389.88 (371.24 ï 408.51) at ($P< 0.05$). The results of the current study are similar to those reported by Kalamkar(2012) in the analysis of production-related aspects of broiler farming under contract and independent management; and examination of inputs and services provision arrangements. The average net return per kg of live weight as well as per bird were reported to be higher in non-contract than contract farms (Kalamkar, 2012).

5.2 Conclusions

The study findings led to the following conclusions:

1. The welfare practices that were investigated between these two types of farms were adequately implemented by broiler farmers in both farming systems.

2. Significant differences were observed in welfare indicators for continuous variables with growth rates; mortality rates, culling rates, number of broiler chicken; weight at slaughter and rating on litter quality being higher in contract farms compared to non-contract farms.

3. The age at maturity in days and rating of birds as dead on arrival in contract farms were significantly lower as compared to non-contract farms whereas farm gate prices fetched by non-contract farms were significantly higher than those of contract farms.

4. The mean differences for stocking densities, number of broilers kept per feeder, number of broilers kept per drinker, rating for natural lighting and rating for ventilation were not significantly different between the two farming systems which were investigated.

5. Ascites was the most common lag indicator of broiler welfare in both farming systems, while other conditions including state of feather cleanliness and dead on arrival, and were also rated as of significance.

5.3 Recommendations

The following recommendations can be made from the study as intervention measures to enhance broiler chicken welfare in large-scale broiler chicken farms:

1. The farmers keeping broiler chicken need to be educated on the importance of upscaling broiler chicken welfare, especially through reduction of conditions that predispose broilers to ascites and mortality by practising the following:

i) Restriction of feed or nutrient intake during the early stages of growth, restriction of lighting to reduce feed intake;

ii) Manipulation of diet formulation, or feeding mash preparation to the broiler chickens;

iii) Provision of environmental enrichment for the birds to allow pecking and perching within poultry housing.

2. There is need to disseminate the research findings to all stakeholders, both at national and county level, for inclusion of welfare practices in the development of guidelines for broiler chicken production.

5.4 Areas for further research

There is need to carry out further research related to the current study. These studies should include:

1. Studies on farm level welfare indicators and economic drivers in small- scale broiler chicken farms.

2. Controlled studies to investigate broiler chicken carcass characteristics with different breeds under controlled conditions of natural lighting, ventilation, feeding regime and litter quality.

3. Descriptive studies on influence of natural light on quality and productivity of broiler chicken in Kenya.

4. Studies on the estimated economic cost of broiler chicken meat condemnation in abattoirs and their implications on profitability within these production systems.

CHAPTER SIX: REFERENCES

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CHAPTER SEVEN: APPENDICES

7.1 Broiler farmer questionnaire to evaluate welfare indicators for Large Scale contract and non-contract broiler farms in Kenya

Introduction

Iôm a student at the University of Nairobi pursuing Masters in Veterinary Epidemiology and Economics. I am conducting a case study on large scale broiler farms to collect data on the existing farm level conditions and their association with product downgrade or condemnation at slaughter. The findings of this study will be used to address welfare concerns in broiler production systems, inform the process of policy and welfare standardsô formulation for broiler in addition to providing necessary information to the broiler chicken value chain actors particularly the large scale producers, feed manufacturers, researchers, extension personnel.

The information generated from this study will contribute to the knowledge on broiler chicken production; inform policy makers in formulation of legislation and welfare standards for broiler chicken as well as beneficial to investors in broiler production enterprises, and other key players in the broiler chicken value chain.

The interview will take approximately 30 minutes to complete and it is completely voluntary with no payment for participation in this survey .If you choose to participate in the interview and anything makes you uncomfortable you are justified to end the interview at whichever moment. In addition you are entitled to refuse to respond to any question for any reason you might have. All information will be treated with utmost confidentiality and I am kindly requesting for your consent to take part in the study.

Broiler farmer consent obtained [Yes____] [No_____] Thank you.

Detail of Farm Location

County/Location	
Farm Id/Name	

A. **Farm Demographics and Poultry Housing**

1.	Are you a contract farmer for Large Scale Integrated Poultry Company ? (Tick appropriately)	**A. Yes____** **B. No_____**
2.	How many broiler chickens do you keep per crop?	
3.	How many broiler houses do you have in your farm?	
4.	What are the dimensions of poultry housing in metres squared? (Tick appropriately)	**A. _________** **B. _________** **C. _________** **D. _________**
5.	If you have more than one housing how many broilers are kept per unit?	

6.	Are their sufficient walking spaces for the broilers in the housing? (Tick appropriately)	**A. Yes ____** **B. No ____** **C. I do not know ____**
7.	If yes, briefly explain the nature of the walking spaces	
8.	Are there privacy curtains within the poultry housing? (Tick appropriately)	**A. Yes ____** **B. No ____** **C. I do not know ____**
9.	If yes, explain the types of curtains used?	
10.	Are there perches where the birds can rest in the poultry housing? (Tick appropriately)	**A. Yes ____** **B. No ____** **C. I do not know ____**
11.	If yes, explain the nature of these perches?	

12.	Do you have cages within your broiler chickens house? (Tick appropriately)	**A. Yes ____** **B. No ____** **C. I do not know ____**
13.	If yes, what is the number of cages within a broiler chicken house?	

B. <u>Broiler Chicken Management</u>

1.	What type of feed do you provide for your broilers? (Tick appropriately)	**A. Mash _______________________** **B. Pellets _______________________** **C. Crumps ______________________** **D. Any other (specify) _____________**
2.	What quantities of these feed (in kg) is fed per broiler (or whole crop) in a cycle?	**Starter/broiler mash/pellet/cramps______** **Growers mash/pellet/cramps _________** **Finishers mash/pellet/cramps _________**
3.	What is the current market price for these broiler feeds per unit?	**Starter/broiler mash/pellet/cramps ___ksh**

	Growers mash/pellet/cramps ________ksh **Finishers mash/pellet/cramps ________ksh**
4. What are your sources for these broiler feeds? (Name of the company manufacturing feeds?)	
5. How many feeders do you have in the poultry house?	
6. What is the source of the feeders you use in the farm?	
7. What is the market price per feeder/ feeding trough?	
8. Do the broiler chickens have continuous access to drinking water in the house?	**A. Yes ____** **B. No ____** **C. I don't know ____**
9. If yes, how many drinkers do you have in the poultry house?	
10. What is the source of drinkers you use in	

	the poultry house?	
11.	What is the market price per drinker you use in the poultry house?	**__________Ksh**
12.	Which broiler chicken breeds do you keep in your farm?	
13.	What is the estimated age at maturity for broiler chicken in your farm?	
14.	What is the average weight at slaughter for broiler chicken raised in your farm?	
15.	Do you provide enrichments to the broiler chicken in your farm? (Tick appropriately)	**A. Yes ____** **B. No ____** **C. I don't know ____**
16.	If yes, which of these types of enrichments do you provide for broiler chickens? (Tick appropriately)	**A. Perches_______** **B. Walking spaces _________** **C. Resting areas ____________** **D. Any other (specify) ______**
17.	Which challenges do you face in broiler	

	production?	
18.	What is the source of heating during brooding? (Tick appropriately)	**A. Electricity ________________** **B. Charcoal _________________** **C. Any other (specify) _________**
19.	How much money do you spend on sources of energy per crop?	

20. In your opinion what is the nature of litter in the chicken house? Using a scale of 1 to 10 and indicate the nature of litter in poultry housing where 1 is moist litter and 10 is dry litter (circle one through observations of litter conditions)

Nature of Litter	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**I do not know**

21.	General comment on litter conditions	
22.	How often is the litter cleared from the poultry house?	

23.	What is the nature of ventilation and natural lighting in the poultry house? Using a scale of 1 to 10, and indicate the state of ventilation and natural lighting where 1 is poor ventilation and lighting and 10 is adequate ventilation and lighting (circle one through observations of state of ventilation and lighting in poultry house)

Nature of ventilation	1	2	3	4	5	6	7	8	9	10	I do not know
Natural lighting status	1	2	3	4	5	6	7	8	9	10	I do not know

24. General comment on state of the ventilation?	
25. General comment on the natural lighting?	

C. <u>Personnel and Knowledge on Disease Management</u>

1. Who handles the broiler chicken on a day to day basis? (Tick appropriately)	**A. Daughter ______** **B. Son ______** **C. Woman ______** **D. Man ______** **E. Hired worker ______** **F. Any other (specify) __________**

2.	Are the broiler chicken handlers given any type of training? (Tick appropriately)	**1. Yes** ________ **2. No** _______ **3. I do not know** ______
3.	If yes, who offers this training to broiler chicken handlers?	
4.	What is the type of training offered to the chicken handlers?	
5.	How are broiler chicken transported to slaughterhouses?	
6.	Do you feed the broiler chicken before they are transported to slaughter? (Tick appropriately)	**A. Yes** ________ **B. No** _______ C. **I do not know** ______
7.	If yes, how much feed is provided (in Kgs)?	
8.	If no, why donά you feed them?	
9.	Do you water the broiler chicken before they are transported to slaughter? (Tick appropriately)	**A. Yes** ________ **B. No** ________

		C. I do not know _____
10.	If yes, how much water is provided?	
11.	If no, why donꞌt you water them?	
12.	Is there a veterinarian who is contracted to visit the farm? (Tick appropriately)	**A. Yes ______** **B. No _______** **C. I do not know _______**
13.	How often do the veterinarians visit the farm?	
14.	If there is a retainer fee, then how much is paid per month/visit?	**__________ ksh**
15.	How much do you spend on purchase of veterinary medicines per crop?	**__________ ksh**
16.	How many broiler chickens died in the farm in the last crop?	
17.	How many broiler chickens were culled in the farm in the last crop?	
18.	Which diseases affect your broiler chicken?	

19.	Do you encounter leg problems or leg health problems in the farm? (Tick appropriately)	**A. Yes** _____ **B. No** _____ **C. I do not know** _____
20.	If yes, mention any three leg problems that are frequently observed in your farm?	
21.	Do you keep records of medication in the farm? (Tick appropriately)	**A. Yes** ______ **B. No** ______ C. **I do not know** ______
22.	If yes, which type of medicines is frequently used in broiler chicken farms?	
23.	Do you keep records on climate variable of poultry housing? (Tick appropriately)	**A. Yes** ______ **B. No** _______ C. **I do not know** _______
24.	If yes, which climatic data do you record within the poultry housing?	

25. Based on your opinion, which of the following conditions results in downgrade or condemnation of broilers at time of slaughter for chicken from your farm? Using a scale of 1 to 10 rate the frequency of these conditions where 1 is less frequent and 10 most frequent conditions (circle one number per health condition)

Podo-dermatitis	1	2	3	4	5	6	7	8	9	10	I do not know
Ascites	1	2	3	4	5	6	7	8	9	10	I do not know
Hock burns	1	2	3	4	5	6	7	8	9	10	I do not know
Breast blisters	1	2	3	4	5	6	7	8	9	10	I do not know
Feather cleanliness	1	2	3	4	5	6	7	8	9	10	I do not know
Dead on arrival	1	2	3	4	5	6	7	8	9	10	I do not know
Others (Indicate)	1	2	3	4	5	6	7	8	9	10	I do not know

26. General comment on health conditions affecting downgrades?	

D. Governance and Extension Services and Farm Outputs

1. What are the products you get from broiler chicken farming?	

2.	What was the number of broiler chicken sold in the last crop?	
3.	Who are the buyers of these broiler chicken products?	
4.	What is the market price per broiler chicken sold?	__________**ksh**
5.	Why do you prefer your current sources of broiler feeds?	
6.	Why do you prefer your current day old chick supplier?	
7.	What is your source of water used by the broiler chickens?	
8.	Do you belong to any farmer association? (Tick appropriately)	**A. Yes _____** **B. No ______**
9.	If yes, what other businesses does the group engage in?	
10.	Do you interact with government veterinary and extension officers? (Tick appropriately)	**A. Yes _____** **B. No _____** **C. I do not know _____**
11.	If yes, for what purpose do you interact with them?	

12.	Have you ever encountered a disease outbreak in your farm?	**A. Yes** _____ **B. No** _____ **C. I do not know**_____
13.	Which disease was involved in this outbreak?	
14.	How did you manage the outbreak?	
15.	How did you handle the dead birds?	
16.	How do you handle litter from your poultry housing?	
17.	What challenges do you encounter in selling your broiler chicken?	
18.	What challenges do you encounter in handling litter from poultry?	
19.	What would a new entrant to the business require for broiler production?	

7.2 Detailed narrative summaries on the various themes associated with raising broilers by both contract and non-contract large-scale farms in Kenya

Thematic areas	Contract farms	Non-contract farms
Litter quality	Source of wood shavings may have affected litter quality; litter is mostly dry but it was affected by ventilation; litter conditions varied with the prevailing weather conditions i.e. dry in hot, during cold weather the litter was mostly moist and also caked; it was always dry in the first days but caked afterwards; sometimes the litter had a lot of dust; wood shavings also absorbed moisture in addition to trying to keep the litter dry by ventilating the broiler houses; patches of cake around drinkers during brooding were noticed; it also took long for the litter to dry in cold weather. Litter is always cleared from the housing once per cycle. After the cropping, litter was disposed to crop farms e.g. those planting flowers, while some were also sold to other farmers. The challenges with handling of litter were on disposal especially during dry season due to lack of buyers; when there were not enough buyers for litter, farmers would hire a lorry to collect litter and	Litter was mostly dry though some parts had wet patches. The wet points occurred at drinking points. Wet litter mostly occurred during rainy seasons, and hence weather conditions contributed to the litter conditions. Poor quality of litter materials also promoted wetness, farmers usually did not turn litter until day 28, but they added wood shavings daily to keep litter dry and clean. Litter was mainly disposed to crop farms or it was sold to brokers. Poultry manure was a source of protein which was used on dairy animals. The main challenge with handling litter included wetness; smell of ammonia; it got dusty and shortages of labour for turning litter. The cost of purchasing litter materials was often high. The other challenges include respiratory infections and itchiness of hands for the workers; lack of space for disposal; lack of buyers of manure. Most of the farmers reported

Thematic areas	Contract farms	Non-contract farms
	dispose them freely to large scale farmers.	clearing the litter after slaughtering the birds, but others reported litter clearance: thrice, weekly, after four days, and fairly timely within the same crop.
Ventilation	When it was very cold, there were challenges in maintenance of ventilation, hence farmers closed the ventilations to the housing, while sometimes it was too windy. The poultry housing was open sided walls for ventilation and lighting, but there was a tendency to close up open walls during brooding stage. The wall curtains were opened when necessary. During brooding period ventilation was restricted. However, thereafter it was maintained according to the prevailing weather.	Ventilation is always good and was affected by weather conditions and depending on size of openings on the walls, but the walls were always open on two sides.
Natural lighting	Lighting usually had no challenges unless when there was blackout. Allowing light by lifting up the curtains, but at night they used artificial lighting. However, sometimes natural light is too bright especially at midday. The natural light was generally too bright for broilers, but this was controlled only using electricity during brooding. After brooding, natural light took over except at night.	Lighting is generally adequate, but it was impacted by weather conditions. It also reduced the cost incurred on electricity. During the day they used natural light but at night electricity was used. One respondent reported the need for light improvement to promote feeding.

Thematic areas	Contract farms	Non-contract farms
	Light was very good at day time, dim at night after 26 days of age, sometimes bright especially midday, night time required use of artificial lighting.	
Feeding practices	Fed mainly pellets and crumbles; feeding regimes included: 0.42 kg for starter, 1.26 kg for grower and 1.6 kg for finisher per broiler bird	Fed mash, pellets and sometimes crumbles; feeding regimes included 1kg for starter and 3kg for both grower and finisher stages for broiler birds.
Breed of birds	Cobb 500	Cobb 500 and some few farms kept Arbor acres
Challenges of broiler farming	Birds not feeding well sometimes; brooding costs; changing of weather patterns; returns were very little; water shortages, high mortality, poor growth rates, lameness; lack of experienced labourers and high staff turnover; non-achievement of uniform growth rate; high prices of feeds, briquettes and wood shavings; respiratory distress, ascites, navel ill.	High cost of feed; lack of market for mature broilers or non-availability of ready market fluctuating prices; high mortality rate of chicks and premature deaths; poor quality of chicks; transport costs; frequent power blackouts, fluctuations of feed prices, feed quality; sudden deaths during the last week in farms; high mortality in the first week; inconsistent feed quality and supply; frequent predation by mongoose; occurrence of diseases, shortages of chicks; high cost of the chicks; high turnover of workers; difficulty in sourcing for production materials e.g. litter and charcoal.

Thematic areas	**Contract farms**	**Non-contract farms**
Training offered to broiler farmers	Technical training on brooding, catching; bio-security i.e. vaccination, cleaning and disinfection, disposal of dead birds; broiler economics; general farm management i.e. ventilation, temperature, litter management, feeding routines/procedures and handlers general hygiene	General poultry management; biosecurity and hygiene; feeding management; disease management; medication and vaccination of the birds; watering; chicken management, weighing; litter management, feeding, record keeping; and brooding techniques.
Buyers of broiler birds	Large scale integrated Poultry Company, hotels and other distributors	City market, QMP, Hotels, individual buyers, institutions, butcheries, brokers, cafeterias, shops, event planners, fast food restaurants, bars, large scale integrated Poultry Company
Barriers to entry to broiler farming	Capital, good knowledge of poultry keeping, ample land space for construction of shed and litter disposal; good accessibility, and assured chicken market; able to construct standard structure to hold minimum of 12,000 birds; reliable source of water; good flock source, good feed quality source; 5 acre land, adequate reliable source of water, capacity to start a venture of 12,000 birds minimum; reliable water source, bio-security, adequate numbers of experienced handlers; good housing; preparedness with all required equipmentôs, standardized	Enough capital for the investment in broiler chicken; availability of land/housing, labour force, water and electricity; technical knowledge and skilled manpower; market for the mature birds and market information; management skills and entrepreneurial skills.

Thematic areas	Contract farms	Non-contract farms
	poultry units; basic management skills; poultry management skills; source of water and feed, medicines and market for the mature birds.	
Diseases of broiler chickens	Newcastle disease, gumboro, ascites, respiratory problems/distress, coli-septicaemia, reovirus infection, Chronic respiratory disease, *E.coli,* Navel ill, lameness, mono eyed, weaklings and deformities	Chronic respiratory disease, gumboro, deformities, water belly, coccidiosis, heart attack, snoring, respiratory infections, ascites/ flip overs, Newcastle disease, *E.coli*
Mode of transport	Large scale integrated Poultry Companyôs fabricated trucks crates with birds packed 13-14 birds per crate	Big hand cart, motorcycle, pickups, gunny bags, lorries, human labour, birds slaughtered at home

7.3 Ethical clearance by the Bio safety; Animal use and Ethics committee

UNIVERSITY OF NAIROBI
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Dr Joshua Orungo Onono
Dept. PHP&T

REF:FVM BAUEC/2018/138
26/01/2018

Dear Dr Onono,

RE: Approval of Proposal by Biosafety, Animal use and Ethics committee

Environmental impact on productivity and product quality case study

By Joshua Orungo Onono

We refer to the above proposal that you submitted to our committee for review and approval. . We have now reviewed the proposal and have noted the following: That your study involves use of questionnaires for collection of data on poultry husbandry and production. Furthermore, it is noted that even in the abattoirs, you will be collecting retrospective data. We note that your study does not involve actual use of live birds or animals for the research.

We hereby approve your work as detailed in your proposal.

Rodi O. Ojoo BVM M.Sc Ph.D
Chairman, Biosafety, Animal Use and Ethics Committee,
Faculty of Veterinary Medicine
University of Nairobi

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