WELFARE AND PRODUCTION OF LAYERS IN SMALLHOLDER POULTRY FARMERS IN KABETE SUB-COUNTY, KENYA

BY

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A Thesis Submitted in Partial Fulfillment of Requirements for Master's Degree of Science

in Livestock Production Systems of University of Nairobi

2018

DECLARATION AND APPROVAL

I hereby declare that this thesis is my original work and has not been presented for any degree in any other university.

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APPROVAL

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

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DEDICATION

I am happy to dedicate this work to my husband Abdikani Omar, my daughter Mariam Abdikani, my father Jama Gelle, my mother Asha Ahmed as well as my brother and sisters.

ACKNOWLEGEMENT

I thank to Almighty God Who enabled me to complete this thesis successfully.

My deepest gratitude is to my supervisors Prof. Paul N. Mbugua and Dr. Joyce Maina, Department of Animal Production, University of Nairobi for their endless guidance, advice and support in carrying out the research and preparation of thesis.

I express my deepest sense of thankfulness and profound regards to Inter-Governmental Authority on Development (IGAD) for the sponsorship during my studies and financial support to complete this work. Your willingness to take me on as a graduate student is something that I appreciate beyond words.

I extend my heartfelt gratitude to University of Nairobi, Department of Animal Production staff and students for their advice and encouragement during my study.

Finally, I feel to express my sincere gratefulness to my family and my husband's family for their moral support.

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LIST OF ABBREVIATIONS AND ACRONYMS

CIA	Central Intelligence Agency
GDP	Growth Domestic Product
GoK	Government of Kenya
ASALs	Arid and Semi-arid Lands
FAO	Food and Agriculture Organization
USAID	United States Agency for International Development
UK	United Kingdom
CM	Centimeter
^{o}C	Degree celcius
M	Metre
US	United States
PPM	Parts per Million
CO_2	Carbon dioxide
NH_3	Ammonia
N	Population size
n	Sample size
e^2	error term
FGD	Focus Group Discussion
SPSS	Statistical Package for Social Science
%	Percentage

>	More than/above
Fig.	Figure
SD	Standard deviation
no	Number
L	Litres
FPD	Foot Pad *Dermatitis*
FCR	Feed Conversion Ratio
NCD	New Castle Disease
GoKC	Government of Kiambu County
RSPCA	Royal Society for the Prevention of Cruelty to Animals
AMVA	American Medical Veterinary Association
MOLD	Ministry of Livestock Development
ICPALD	IGAD Centre for Pastoral Areas and Livestock Development
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
ha	Hectare
NGO	Non-Governmental Organization
g	gram
CRC	Cooperative Research Centre
OIE	the Office International des Epizooties

DEFINITIONS OF OPERATIONAL TERMS

- Agro vets - is a business outfit dealing with agricultural and veterinary drugs
- Animal welfare - is an indication of how an animal is fairing in a given situation
- Private vets - are veterinarians delivering veterinary service to farmers to prevent and control diseases
- Small holder - is the production of crop or livestock in a small plot of land and completely depends on family labour

ABSTRACT

Poultry production is receiving a lot of attention because of increased demand for food, reduced land size and need for employment creation. To increase production of poultry products there is a need to intensify production systems. Such intensification may compromise the welfare of the layers.

This study had three objectives namely: to assess the knowledge and practices of small scale farmers towards welfare of layers; to determine the welfare status of layers in smallholder farms; and to assess the influence of poultry welfare on production. Data was collected from three wards of Kabete Sub-county involving of 135 randomly selected farmers keeping laying hens. A semi-structured questionnaire was used to collect information on knowledge and practices of farmers on welfare of layers, feeding, housing, health, behaviour and farm production characteristics. Measurements were taken to determine stocking densities, feeding, watering, perching and nesting spaces, house temperatures and litter depth. Observations were made to assess house ammonia level, foot pad dermatitis and litter quality. In each of the wards a focus group discussion of farmers were held. Focus group discussion was also held in extension agents. About 60% of the farmers were aware of animal welfare. Those with knowledge on poultry welfare were 59.3, 63.6% and 53.9 in Muguga, Nyathuna and Kabete, respectively. Feed millers (28.5±2.8%), the media (25.8±9.9%) and state extension agents (15±9.7%) were the main sources of information on animal welfare. More farmers with formal education (92.8%) knew about poultry welfare than those without (6.2%). All farmers vaccinated their birds against New Castle disease and Gumboro, however only 35 and 38% of them vaccinated against fowl pox and fowl typhoid. To prevent spread of diseases in the house 60% of the farmers isolated sick birds

from the rest of the flock and to control cannibalism 69% of the farmers had debeaked the birds. One flock per household was studied so as to collect data on welfare issues.

Water and feed were provided throughout the day by 100 and 80% of the farmers, respectively. The average feed consumption was 115.2±15.7 g/bird/day. No significance difference in feed consumption was noted between the three wards ($p>0.05$). The average feeding space was 10.4±3.0 cm/bird while the linear watering space was 2.5±0.7 cm/bird. The stocking density was 10±3, 10±3 and 11±3 birds per m^2 for Muguga, Nyathuna and Kabete, respectively. The average poultry house temperature at the time of study was 24.6±2.3, 24.4±2.2 and 22.9±2.9^oC in Muguga, Nyathuna and Kabete, respectively. In half of the poultry houses, ammonia level was not irritating the eyes of enumerators. In majority (67%) of the poultry houses, the litter depth was 11 to 15 cm and in most of them (70%) the litter was dry. The proportion of farmers providing perches in Muguga, Nyathuna and Kabete was 14.8, 23.6 and 34.6%, with the perching space being 7.1±5.8, 12±11, 12±8.7 cm/bird, respectively. About 37% of the farmers reported occurrence of diseases. All farmers provided laying nests. However none of them provided sand bathing facilities. In most of the farms (98%) the birds were noted to express fear due to presence of cats/dogs. It was found that there was no correlation between hen-day production and stocking density, level of ammonia in the poultry house, provision of perches and litter quality.

In conclusion, it was found that 60% of the farmers had knowledge on animal welfare and most of them learnt it through feed millers, the other sources were media and state extension service. Most of the farmers debeaked and vaccinated the birds against diseases. Welfare needs in terms of good feeding, house temperature, and litter quality were met. However the stocking density was high and there was minimum attempt to provide facilities for normal behaviour (perches and

sand bathing boxes). There was no association between stocking density, house ammonia level, and litter quality and hen-day production. The overall assessment was that the welfare of the birds was compromised because some of their requirements were not met. The recommendations from this study are state extension programmes should be promoted to train the farmers on layers' welfare needs. Welfare standards should be formulated and the existing livestock acts should be enforced by the relevant national authority. Through the extension agents farmers should promote facilities for normal behaviour and use the recommended stocking density of layers for better performance.

Key wards: poultry welfare, feeding, housing, ammonia, health, appropriate behaviour, Kabete sub-county.

CHAPTER 1: INTRODUCTION

1.1 Background

Kenya is located in eastern Africa and borders Tanzania to the south, Uganda to the west, Sudan to the north and Somalia and the Indian Ocean to the east. The country has a human population of 46 million people (Central Intelligence Agency World Factbook, 2018). The country's economy mainly depends on agriculture, which contributes 26% of the GDP (Government of Kenya, 2010). Agriculture provides more than 18 and 70% of formal and informal employment, respectively. Agriculture generates 65% of the country's export (Government of Kenya, 2010).

The livestock sub-sector contributes 17% of the agricultural GDP and 7% of exports (Government of Kenya, 2010). Most of livestock especially cattle, goats, sheep and camel are concentrated in the arid and semi-arid lands (ASALs). The ASALs cover about 80% of the country where most of the animals referred to above are farmed. In ASALs, 90% of employment and 95% of family income directly depends on livestock production (Food and Agriculture Organization, 2005).

Poultry production is found mainly in the high potential areas of Kenya, which are suitable for arable farming. Poultry production is receiving a lot of attention because of such factors as decrease in land size, need for employment creation, increasing demand for animal protein and availability of infrastructure that can support this type of agricultural production.

Food and Agriculture Organization, (2006) classified poultry production systems into four sectors namely Sector 1 Sector 2 Sector 3 and Sector 4. Sector 1 represents the industrial and integrated production system while both Sector 2 and Sector 3 cover the commercial poultry production systems. Sector 4 is the backyard poultry production system, which is common in many rural households in Kenya and other developing countries. The parameters considered in

arriving at this classification include level of bio-security, marketing system and level of integration in the production system. Thus Sector 2 is deemed to have higher bio-security than Sector 3. Chickens raised for table egg production (layers) in Kenya are found in Sector 2 and Sector 3, where the birds are either housed under the deep litter system or under the battery cage system. How well the birds are managed, which is manifested by their welfare, influences their productivity.

Animal welfare is an indication of how it is fairing in a given situation Serpell, (2008) and includes its physical state and how the it is surviving with the situations in which it lives. Animal welfare is expressed or based on terms that were formulated by the Brambell Committee in 1965. These in turn were based on the four human freedoms advanced by the American president, Franklin Roosevelt, in 1941, which were freedom of speech, freedom of worship, freedom from want and freedom from fear (Webster, 2016).

An animal is in a good state of welfare if it experiences five freedoms namely: (i) Freedom from hunger and thirst, (ii) Freedom from discomfort, (iii) Freedom from pain, injury and disease, (iv) Freedom to express normal behavior and (v) Freedom from fear and distress (OIE, 2018).

The animal's health, productivity, behavior and physiology are parameters that can be used to assess its welfare. Also environmental factors like air quality and light intensity can influence welfare of animals. The knowledge and practices of the person who takes care of the animals have an important bearing on the welfare the animals are likely to experience.

Lake Research Partners, (2018) reported that 77% of consumers were concerned about animal welfare and how animals for human food are raised. They also pay much attention on food labels

that show how animal were raised. Consumers are concerned about the welfare status of farm animals and this has led to formulation of certification scheme by traders which includes animal welfare (Botreau *et al.*, 2007). Consumers were interesting the origin of poultry product and how the chickens were raised before they purchase it. The perception of consumers on animal welfare can affect the type and brand of poultry product to purchase (Nicol and Davies, 2013).

1.2 Statement of the problem

An animal that enjoys the five freedoms listed above is expected to experience good welfare. The Animal's welfare can be compromised through the type of production system it is put through. Thus, raising laying hens in stress free environment is crucial in order to get high egg production. Increase in human population, rising levels of income, and urbanization are factors that contribute to increased demand for animal protein and consequently the desire for increased productivity of the layers. Therefore, small scale egg producers are using more intensive production systems such as the deep litter and the battery cages. Such intensive production systems are likely to compromise the birds' welfare in pursuit of increased productivity.

There is therefore need to determine whether the welfare is met, how to assess such welfare in the current small holder poultry production systems in Kenya. Such information can be used to formulate welfare standards for poultry production in Kenya.

1.3 Objectives

1.3.1 Broad objective

To assess the welfare of laying hens in smallholder farms in Kiambu County, Kenya

1.3.2 Specific objectives

- To assess the knowledge and practices of small scale farmers towards welfare of layers
- To determine the welfare status of layers in smallholder farms in Kabete sub-county, Kenya
- To assess the influence of poultry welfare on production

1.4 Research questions

1. What are the knowledge and practices of small scale farmers that influence poultry welfare?
2. What are the resources needed to ensure welfare of layers in small holder farms in Kabete sub-county, Kenya?
3. What is the effect of poultry welfare on production of layers?

1.5 Significance of the study

This study will provide information on the relationship between good bird welfare practices and productivity. From this study, information generated can be used in the other forms of poultry production in Kenya.

CHAPTER 2: LITERATURE REVIEW

2.1 Poultry industry in Kenya

The poultry refers to domestic birds raised mainly for eggs and meat and these include chickens, ducks, geese, turkeys, guinea fowls, quails and ostriches. A review of current FAOSTAT did not show any data for waterfowls and turkeys, but gave a chicken population of 44 million birds in 2016. This means that the chicken is the most important type of poultry in Kenya (Nyaga, 2007). According to (Omiti and Okuthe, 2008) there were 37.3 million birds, 84% of which were indigenous birds, while 8.4%, 5.7% and 1.8% were layers, broilers and other species, respectively. The other species included ducks, turkeys, pigeons, ostriches, guinea fowls and quails (Omiti and Okuthe, 2008). In 2008, the Ministry of Livestock Development (MOLD) gave the poultry population to be 29,615,000 birds. The returns from the National Census of 2009 showed that there were 25.7 million indigenous chickens and 6 million commercial ones (Roy and Muthami, 2011). Commercial layer farmers are concentrated near the urban centers and peri-urban areas where they can easily access to the market of Nairobi city. These areas include Thika, Kiambu, Maragua, Nakuru, Nairobi and Kilifi (Nyaga, 2007). Chicken population in Kenya from 2012 to 2016 is shown in Table 1.

Table 1: Chicken population in Kenya 2012 to 2016

Year	Chicken population (Millions)
2012	35
2013	40
2014	42
2015	41
2016	44

Source: (FAOSTAT, 2017)

Poultry production is carried out in the high potential areas and is concentrated near the major Peri-urban centers. The estimated gross value of poultry products in 2009 was Ksh. 10.3 billion for eggs and 4.6 billion for chicken meat (Roy and Muthami, 2011). Poultry contributes 6.1% to livestock GDP, 2.3% to agriculture GDP and 0.7% to GDP (Omiti, 2007). Besides contributing to the GDP, the poultry sector provides employment for two to three million people (USAID, 2010). Poultry is important in providing nutritionally rich food in the small holder farms in Kenya. Poultry also indirectly increases food security, such as improving nutrient utilization, contributing to mixed farming and allowing access to education and healthcare facilities (Wong *et al.,* 2017).

2.2 Animal welfare

The origin of the concept of animal welfare goes back to the publication of the book *Animal Machine* in 1964 by Harrison, which was critical of the intensive form of animal production practiced in Britain at that time (Craig and Swanson, 1994). As a result of this publication, a committee was set-up by the British Government to enquire into the welfare of animals raised intensively (Conklin, 2014) that culminated in the Brambell Report of 1965. This report stated that animals should have freedom to stand up, lie down, turn round, groom themselves and stretch their limbs. By 1993, five freedoms shown below were published by the Farm Animal Welfare Council of UK (Webster, 2016). The five freedoms are: (i) Freedom from hunger and thirst, (ii) Freedom from discomfort, (iii) Freedom from pain, injury and disease, (iv) Freedom to express normal behavior and (v) Freedom from fear and distress.

2.3 Farmer understanding of layers welfare

In most cases, the farmer aims at maximizing egg production for increased profitability of the operation. Consequently the farmer will provide adequate housing; feeding and disease control

as well as ensure adequate lighting and ventilation. If the farmer does this most of the welfare issues will be met. However, this does not mean that the farmer understands the five welfare freedoms. Farmers' understanding of layer welfare has been studied. For example (Stadig *et al.* 2015) reported that farmers using deep litter system were putting more consideration into hen welfare while choosing the housing system than those using cage systems. This is probably due to the fact that cages are designed to meet the various welfare needs.

The farmers are unlikely to provide conditions that will promote well-being or good welfare for the birds unless they have knowledge about animal welfare. Such knowledge can be acquired through formal training, extension programs or reading (Craig and Swanson, 1994). In most cases, farmers see animals as a resource that can be exploited for maximum production therefore do not place a lot of emphasis on welfare.

2.4 Methods of assessing poultry welfare

To assess the welfare of poultry one needs to take into account the five freedoms, from which the welfare principles can be derived. The principles are good feeding, good housing, good health and appropriate behaviour. The criteria for assessing welfare are then formulated based on these principles as shown in Table 2.

Table 2: The principles and criteria used to develop welfare assessment methods

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

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

Having identified the principles and the criteria, the next thing is to identify ways of measuring the welfare status of the animals of concern. The assessment can be resource based, animal based or management based (Nicol and Davies, 2013). In resource based assessment one would consider issues such as the feeding equipment, the watering equipment and perching facilities. The animal based one would consider health of animal, level production and animal behaviour, while management based would take into account issues like dust bathing boxes, bird mortality and laying nests (Nicol and Davies, 2013).

2.4.1 Good feeding

Laying hens adjust their feed intake in order to meet their energy requirements. When the environmental temperature is high, feed intake decreases and when it is cold the birds consume more feed. This is because in cold weather birds require more energy to regulate body temperature. Laying hens take about 120 grams of feed per day (Jacob, 2015). The feeding and watering space provided to laying hens usually depends on the type of equipment in use. The recommended feeding and watering spaces per adult laying hen in America are 10-12 cm and 2.5-3.0 cm, respectively (North and Bell, 1990). Since the laying hen can only eat about 118-120 grams of feed per day, it is essential to provide a ration which contains sufficient amounts of all the nutrients required by the bird. This is to avoid nutritional deficiencies and hence enhance welfare and productivity of the birds (Leeson and Summers, 1997).

In poultry production, water is needed for various metabolic processes, reducing air temperature and facility sanitation. Water is the most critical nutrient in all animals. It is necessary for the processes of digestion, carrying materials from one part of the animal body to another, lubrication of organs and temperature regulation (Fairchild and Ritz, 2015). Water consumption is influenced by the ambient temperature, level of production, water quality and water

temperature. As an example, a laying hen at 90% production at 21^{o}C will consume about 200 ml of water per day(Gutierrez *et al.*, 2009, Fairchild and Ritz, 2015). Water intake and feed intake are interdependent, so reduced water intake can also lead to reduced food intake and hence production (Ezieshi *et al.*, 2003). Availability of water ensures freedom from thirst. Hence water is critical at high ambient temperature. To minimize stress, provision of adequate watering facilities is necessary.

2.4.2 Good housing

Providing layers complex environment with enough space enables them to express specific behaviour which has positive effects on welfare. The effect of housing system on welfare depends on its management. This means that even a housing system which is considered to be good in terms of hen welfare when poorly managed negatively affects the welfare of birds (Lay *et al.*, 2011).

Stocking density is another important aspect of management related to housing. Stocking density defines the space provided per bird, which influences the association or interaction of the birds in the house. Stocking density influences mortality, bird health and behavior such as feather pecking and cannibalism (Carmichael, Walker and Hughes, 2010). At high stocking density (12 birds per m^2) in UK the welfare of the birds was compromised compared to a density of 9 or 7 birds per m^2 (Zimmerman *et al*., 2006). The recommended stocking density in Europe is variable. Some authors recommended stocking densities of less than 4 birds/m^2 while others recommended 5-6 birds/m^2 (Gordon and Jordan, 1982, Mrema *et.al.*, 2011) , Others in America were giving 8 birds/m^2 (North and Bell, 1990). The space requirement for laying hens in Kenya is 3 birds/m^2 (Rangoma, 2018). The factors that influence stocking density are the size of the bird and environmental temperature.

Ventilation is important in poultry production because it regulates house temperature, replenishes the house with fresh air and removes moisture from the house. Proper ventilation reduces heat stress, which negatively affect poultry production and can lead to death. In the tropics air flow into poultry houses can be improved by having the sides of the house open and ensuring that the building is not more than 8 metres wide (Food and Agriculture Organization, 2004). The thermo-neutral zone for laying hens is between 15 and 27^{o}C. Above 27^{o}C the production of the birds is compromised (Talukder *et al*., 2010, North and Bell, 1990). When the temperature of the poultry house is above 30^{o}C, chicken develop severe heat stress (Thiele, Pottgüter and Gmbh, 2008).

Light is another important environmental factor, which influences physiology, growth and development of poultry. In this regard, the length of the photoperiod (hours of light per day) and the light intensity are considered. A well-lit house is essential for chickens to be able to feed. Light is also important for sexual maturity of growing pullets (Food and Agriculture Organization, 2004). Stimulatory lighting (over 8 hours of light per day) is necessary for the laying hens. Increasing the length of photoperiod to 16 hours of light per day was shown to increases egg production (Food and Agriculture Organization, 2004). The average light duration for laying hens should be 14-16 hours (Thiele, Pottgüter and Gmbh, 2008). Light intensity influences growth rate, feed intake and feed conversion of broilers, as well as egg production in laying hens (Hartini *et.al.*, 2002). Light intensity below 5 lux, usually results in decreased egg production while that of above 25 lux results stress and feather pecking. Thus the laying hen requires light intensity of 10-15 lux (Thiele, Pottgüter and Gmbh, 2008, Food and Agriculture Organization, 2004).

Ammonia is one of the air pollutants produced in poultry houses. High concentrations of ammonia have adverse effects on the health of birds hence decreases production. It also

predisposes birds to respiratory diseases and secondary infections due to stress (David *et al.*, 2015). The accepted ammonia levels for laying hens should be less than 25 ppm and should not exceed 50 ppm (Webster, 2005). Ammonia concentration above 50 ppm cause human eyes to burn and tear which makes it uncomfortable for workers in the poultry house. Even at a low level (25 ppm) ammonia causes depression in feed intake and reduces feed conversion efficiency in broiler chicken. It increases incidences of respiratory tract lesions, viral infections and keratoconjunctivitis (Casey, Brian and Fairchild, 2005). Ventilation in a poultry house should be such that it removes ammonia and ensures that it does not accumulate above 5 ppm (Humane Farm Animal Care, 2013). Relative humidity on the other hand has less effect on egg production and feed consumption than high temperature.

Litter is combination of bedding materials, excreta, feathers and wasted feed and water. The function of litter includes absorption of excess moisture from the droppings and drinkers, insulation of birds from the cooling effects of the ground and diluting fecal materials (Casey, Brian and Fairchild, 2005). The litter material should be highly absorbent, inexpensive and free from chemicals, toxins, mold and readily available (Thiele, Pottgüter and Gmbh, 2008). Excess litter moisture increases the incidence of blisters on breast and feet and skin burns. The litter should neither be too dry nor to too wet. Too dry and dusty litter can cause respiratory diseases. The ideal litter moisture should be between 20-25%. Litter moisture content can be estimated by squeezing a hand full of litter. If it adheres tightly and forms a ball, the litter is too wet. If it adheres slightly, it has the proper moisture content. If it does not adhere at all, it is too dry (Casey, Brian and Fairchild, 2005). Factors used to manage build up litter include correct litter temperature and litter moisture, decreasing level of ammonia and disease occurrence (Malone, 2004). Overstocking, poor ventilation of the house, insufficient litter depth and poor

management of drinkers are farm related factors which result in poor litter quality (Malone, 2004). Managing all the above factors well will be an essential tool to reduce litter build up, litter moisture, temperature, diseases and ammonia (Malone, 2004).

2.4.3 Good health

Poorly managed houses can predispose to poultry diseases which has negative effects on their welfare and production. It is important to manage the environment in which birds are reared in a way which is corresponding to the climate of the area (Nijhuis and Lister, 2012). Foot pad lesions are mainly found where the litter is wet due to poor management of drinkers. A study by Ekstrand, Algers and Svedberg, (1997) showed that there was a relationship between watering equipment and prevalence of foot pad *dermatitis,* where birds reared in houses equipped with open water containers had higher prevalence of food pad *dermatitis* than those with water nipples. Beak trimming is practiced to minimize cannibalism and feed wastage. It is desirable to carry it out at an early age of about 6 weeks (Andrade and Carson, 1975). This involves cutting about a quarter to one third of the upper beak or both upper and lower peak of the bird. There is pain induced by debeaking but this is reduced if the procedure is carried out when the birds are young (American Veterinary Medical Association, 2010).

Cannibalism is an abnormal behaviour from the birds' welfare point of view. It is important to minimize factors that can promote cannibalism such as high stocking density and provision of too much light in the house.

Pain, fear and distress are grouped together as states of suffering (Duncan, 2004). Welfare is compromised when animals experience suffering. The major states of suffering investigated in animals include pain and discomfort, fear, deprivation, frustration and conflict.

Pain, is the most important state of suffering that indirectly reduces welfare (Duncan, 2004). It can result from injury due to poorly designed housing and equipment and surgical interventions such as debeaking. Procedures that are performed in order to increase the long-term welfare of the animals involved by removing parts of the anatomy that cause injury (beak) which result in pain for the animal in terms of both acute and chronic pain. For example, in the case of de-peaking there is strong evidence of chronic pain many weeks after the surgery (Duncan, 2004). On the other hand, fear is regarded as an undesirable state of suffering by the scientific community, welfare and policy groups, and farmers (Jones, 1996). Fear responses such as violent escape or panic can cause severe injury to the birds raised in intensive farming system hence can negatively affect the welfare and production of poultry. If the fear is high and constant, it results reduced feed conversion efficiency, growth rate, egg production and egg shell quality. It also decreases the ability of birds to adapt to a new environment, interact with other birds and with the stock person. Therefore in order to improve poultry welfare and productivity it is necessary to reduce such kind of fear (Jones, 1996).

2.4.4 Appropriate behaviour

Animal behaviour in general is defined by the way animals interact with each other, with other living organisms and with the environment. It includes how to avoid predators, defend resource, reproduce and care for the young (Wikibooks, 2018). The common facilities that would support normal behavior of layers are perches, laying nests and sand bathing boxes. To improve bird's welfare, provision of facilities that would allow normal behavior is essential.

It is important to provide perches. The recommended length of perch space per adult laying hen varies from 15 to 25 cm/bird (Clauer, 2010, Food and Agriculture Organization, 2004). Provision of nesting boxes minimizes the chance of egg laid on the floor. It is crucial to provide adequate

nesting space so as to allow the birds express normal laying behaviour. The recommended nesting space per every 3-5 hens in the flock is 30 cm^3 and the nest boxes should be 60 cm above the floor and far from the perches (Clauer, 2010, Food and Agriculture Organization, 2004, Gordon and Jordan, 1982). Dust bathing is a natural behaviour which helps birds to remove damaged feathers and to keep them in good condition (Olsson and Keeling, 2005, Fulton *et al.* 2010). It is therefore important to provide dusting boxes or facilities.

Freedom from fear and distress is one of the five animal freedoms in the animal welfare code. Attainment of such freedom in the birds will result in realization of good performance. Fear is a protective mechanism that causes the birds to respond to harmful stimuli through escape, defensive behaviour, avoidance behaviour, immobility and vocalization (Poultry Cooperative Research Center, 2018). In a poultry production setup fear can be caused by wild animals, domestic pets such as dogs and cats, noise from people, machinery and introduction of strangers to the poultry house. Beaumont *et al*. (2010) stated that fear is a normal behaviour that enables birds to properly react to a danger but when it is too high it can cause panic and reduced man-animal interaction. Fear is associated with freezing behaviour, tonic immobility, escape attempts, aggression, increased adrenal cortex activity and heart-rate elevation (Costa e*t al*., 2012). Fear stimuli results in release of corticosterone which increases the concentration of glucose in the blood to provide energy for the bird to escape. A prolonged elevation of corticosterone can decrease immunity, health and productivity of the bird since the energy that would be used for production have been used for self-defense and escape (Poultry Cooperative Research Centre, 2018a). Poorly handling of the bird induces chronic stress response which was found to increase fear and decrease productivity and resistance to infection. Several methods can be used to reduce fear in poultry. (a) Enriching the birds' environment. (b) Allowing them to become used to

humans. (c) genetic selection toward less fearful stains of birds (Poultry Cooperative Research Centre, 2018a). Stress is one of the most important indicators of animal welfare. Stress is known to have a significant impact on physiological, psychological and behavioral variables. Stress responses help an organism to cope with the environment in which it lives. However, if response to stress is activated for a long period of time it may have harmful effects on various physiological processes such as reproduction, immunity and growth of the organism (Toates, 2000).

2.5 Welfare of layers in small holder production

Laying hens may face different welfare problems such as pain from beak trimming, fearfulness due to overcrowding, competition of inadequate feeding and watering spaces which results in emaciation and dehydration, feather pecking and cannibalism. Some of these welfare problems are influenced by the environment under which the birds are raised (Janczak and Riber, 2015). Pullets should be raised in an environment which is similar to the one they will be housed in during production. This is done to minimize fear and injury due to pecking and related behaviour (Janczak and Riber, 2015). In the cages system, freedom from injury, pain and diseases as well as freedom from discomfort are well covered compared to the deep litter system (Shimmura *et al.*, 2011). In contrast, freedom to express natural behaviour and freedom from fear and distress is better in the deep litter system than the cage system (Shimmura *et al.*, 2011).

2.6 Effect of welfare on production

A bird in good welfare would be experiencing the five freedoms referred to earlier. It is expected that such a bird will perform better than the one lacking these freedoms. A bird receiving adequate nutrition such as enough energy, protein and micronutrients will perform well (Underwood and Suttle, 2000). If the birds are overcrowded in the house, it will affect

production and will increase propensity for respiratory diseases and *coccidiosis* and compromise productivity (Nicol and Davies, 2013).

Exposure of birds to high ambient temperature reduces their productivity. Talukder *et al,* (2010) have reported that temperature above 27^{o}C in poultry houses affects feed consumption, egg production and weight gain. One of the environmental stressors that challenge poultry production worldwide is heat stress. Its impact on broilers and layers include reduced growth, decreased egg production and decreased quality and safety of poultry products (Lara and Rostagno, 2013). When birds experience any form of environmental stressor, they use energy for production to cope with the situation and maintain their physiology hence decreased growth and egg production (Talukder *et al*., 2010).

When carbon dioxide (CO_2) concentration in the house is above 3000 ppm feed consumption and egg weight decreases. Ammonia concentration in the house above 37 ppm has similar effects to that of (CO_2) (Talukder *et al*., 2010). Poorly managed environment causes stress to the birds and lowers the immune system hence chickens become susceptible to infections, which impact negatively on productivity (Talukder *et al*., 2010). It is important to manage the environment in which birds are reared in a way which is corresponding to the climate of the area (Nijhuis and Lister, 2012).

2.7 Legal status on poultry welfare in Kenya

Animal welfare regulations are made to prevent animals from unnecessary suffering. In the United Kingdom, there are number of Acts which involve animal welfare such as Animal Protection Act (1911) and The Agriculture Act (1968) as well as the Animal Welfare Act (2006). These acts are generally aimed at preventing animals from all kinds of suffering.

The European Commission has laid down minimum standards for the protection of all farmed animals as spelt out in the Council Directive 98/58/EC (European Commission, 2018). In Canada there are animal welfare laws aimed at preventing animals from suffering. Examples of such acts are: Cruelty to Animals Act, which prohibits cruelty to animals that is wilful or without lawful excuse; Health of Animal Act, which protects animals from undue suffering during transportation; and Meat Inspection Act, which aims at protecting food animals during handling and slaughter (Wepruk, 2004).

In most African countries, there are no animal welfare laws and those that are there are hardly enforced. In Ethiopia, there are no practice and enforcements of animal welfare legislations. Neglecting animal welfare during farming, transportation and slaughter had led to poor productivity (Asebe and Gelayenew, 2016). In Kenya, there are no comparable legislations to those of UK and Canada. But there are livestock Acts which if sufficiently practised would have covered some aspect of animal welfare. Two examples are given to amplify this point. (i) Prevention of Cruelty to Animals Act Cap 360 of 1963. This act aims at preventing cruelty to animals. (ii) Animal Diseases Act Cap 364 of 1965. This act aims at preventing diseases in farm animals. In Kenya and other African countries there is need for legislation that specifically addresses welfare of farm animals since welfare aspects are not well covered in African countries compared to what is seen in Canada and UK (GoK, 2013).

CHAPTER 3: MATERIALS AND METHODS

3.1 Introduction

Although welfare of laying hens is of concern to the farmers, consumers, veterinarians and animal scientists, it has not received much attention in Kenya. There is therefore need to evaluate welfare issues for laying chickens in smallholder farms in Kenya. The specific objectives of the study were:

i. To assess the knowledge and practices of small scale farmers towards poultry welfare.
ii. To determine the welfare status of layers in smallholder farms in Kabete sub-county, Kenya.
iii. To assess the influence of poultry welfare on production.

3.2 Study area

Administratively Kenya is divided into 47 counties, which include Kiambu County. This county is located in the central highlands of Kenya and close to Nairobi, the capital city of the country. The county is further divided into 12 sub-counties namely Gatundu North, Gatundu South, Thika, Lari, Githunguri, Juja, Limuru, Kiambaa, Kiambu, Ruiru, Kikuyu, and Kabete. In 2009 Kenya National Bureau of Statistics (KNBS) reported that Kiambu County had 25.6% of the national commercial poultry flock (Kenya National Bureau of Statistics, 2009). Most of these birds were found in Kikuyu (6.4%) and Gatundu (5.9%). The choice of the study area was based on the poultry population.

The study was conducted in Kabete Sub-county, which has an area of 60.20 km^2 and it has human population of 140,427 people (County Government of Kiambu, 2009). Kabete was created by the IEBC in 2012 after Kikuyu was split into two: Kabete and Kikuyu (Independent Electoral and Boundaries Commission, 2012). This sub-county consists of five wards namely Gitaru, Muguga, Nyathuna, Kabete and Uthiru with human population as shown in Table 3.

Table 3: Wards forming Kabete sub-county of Kiambu county, Kenya

Ward	Area, km^2	Human population, number
Kabete	10.1	30,657
Gitaru,	13.5	29,177
Nyathuna,	17.8	28,771
Muguga	15.3	27,527
Uthiru	3.5	24,295

Source: (SoftKenya, 2011)

A field survey, to assess the welfare of laying hens, was carried out in Kabete sub-county, covering Muguga, Nyathuna and Kabete wards.

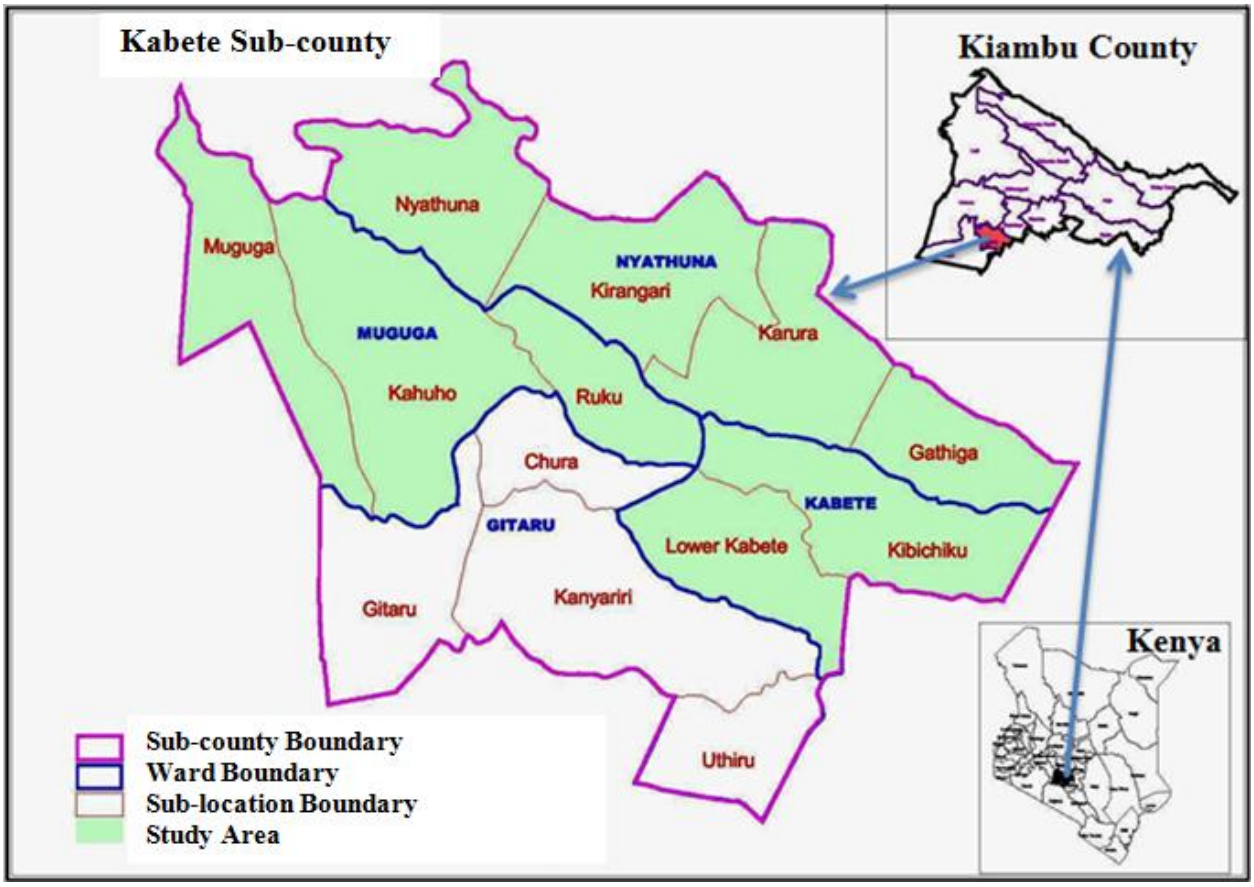

Figure 1: Map of Kabete sub-county showing Muguga, Nyathuna and Kabete wards

3.3 Sample size and its determination

A sample of 135 farmers keeping chickens for production of table eggs (layers) was used. The sample size was determined using Yamane (1967) formula with 95% confidence level (Israel, 2003). The number of poultry farmers in the study area was 205 (County Government of Kiambu, 2013). The Yamane formula was suitable for the study because the population of farmers keeping layers was known. The Yamane formula is as follows: $n = \frac{N}{1 + N(e^2)}$

Where n= Sample size, N= Population size and e=0.05; Precision level (error term).
By solving for n, a sample size of 135 farmers was obtained.

The sample size was divided into three wards depending on availability of farmers keeping laying hens in each ward. It was intended to interview 45 farmers in each ward to get equal sample sizes but due to Kabete ward being closer to the city, farmers shifted from poultry farming to building residential houses and only 26 farmers were interviewed in Kabete ward. The remaining 19 farmers were divided into Muguga and Nyathuna. Thus data collected from 54, 55 and 26 farmers in Muguga, Nyathuna and Kabete wards, respectively.

3.4 Data collection

Data was collected from primary sources, and methods employed under each specific objective were:

1. To assess the knowledge and practices of small scale farmers towards poultry welfare.

- Survey: A total of 135 commercial layer farmers were randomly selected and interviewed through semi-structured questionnaire to collect information on knowledge and practices of farmers on welfare of layers (Appendix I).

2. To determine the welfare status of layers in smallholder farmers in Kabete sub-county, Kenya.

- Survey: Semi-structured questionnaires were used to collect information on welfare status of layers in small holder farmers in Kabete sub-county.
- Measurements taken/assessment done
    - Floor area, nesting area, feeding and drinking spaces, perching space and litter depth.
    - House temperature using thermometer
    - Assessing litter consistency by use of the hand. To estimate litter moisture content, a handful of litter was squeezed. If it adhered tightly and made a ball, it was too

wet. If it adhered slightly, it had the proper moisture content (dry). If it did not adhere at all, it was too dry (Ritz, Fairchild and Lacy, 2009).

- There are more accurate methods of estimating ammonia level in the layer houses such as use of ammonia test papers but unfortunately I did not get it during data collection. Thus ammonia level in the layer houses was estimated based on the irritation it caused to the eyes of enumerators. If there was no irritation, the ammonia level was not a problem (ammonia level is <25 ppm) but if it slightly irritated the eyes, the ammonia level was high (25-50 ppm) and when it was very uncomfortable to work in layer house, ammonia level was too high or more than 50 ppm (Tahseen and Barnes, 2010).

3. To assess the influence of poultry welfare on production.

- Survey: Semi-structured questionnaire were used to collect information on production characteristics of studied layer flocks (Appendix I).

Focus Group Discussions (FGD): Four FGD were conducted, the first three covering farmers in each of the wards and the fourth one covering government officers working in the area. Focus group questions had been formulated in advance (Appendix II).

It has been shown in Chapter two that to assess welfare of layers there is need to consider the welfare principle and the criteria to be used. From the criteria measures taken in assessing that welfare were formulated as shown in Table 4.

Table 4: Welfare criteria and measures in assessing welfare of layers

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

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

3.5 Data analysis

Data obtained was first checked for completeness, entered into Excel data sheet and coded. Descriptive statistics showing mean, standard deviation, frequency, percentage and correlations were computed using the Statistical Package for Social Sciences (SPSS), version 21.0 (Techopedia, 2018). Microsoft Word and Excel were used in the preparation of summary tables and developing graphs.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Knowledge and practices of farmers on chicken welfare

4.1.1 Knowledge of farmers on chicken welfare

The proportions of farmers who were aware of animal welfare are presented in Fig. 2. The mean percent farmers who aware of animal welfare was 59.0±4.1. Those with knowledge on animal welfare were 59.3, 63.6% and 53.9 in Muguga, Nyathuna and Kabete, respectively.

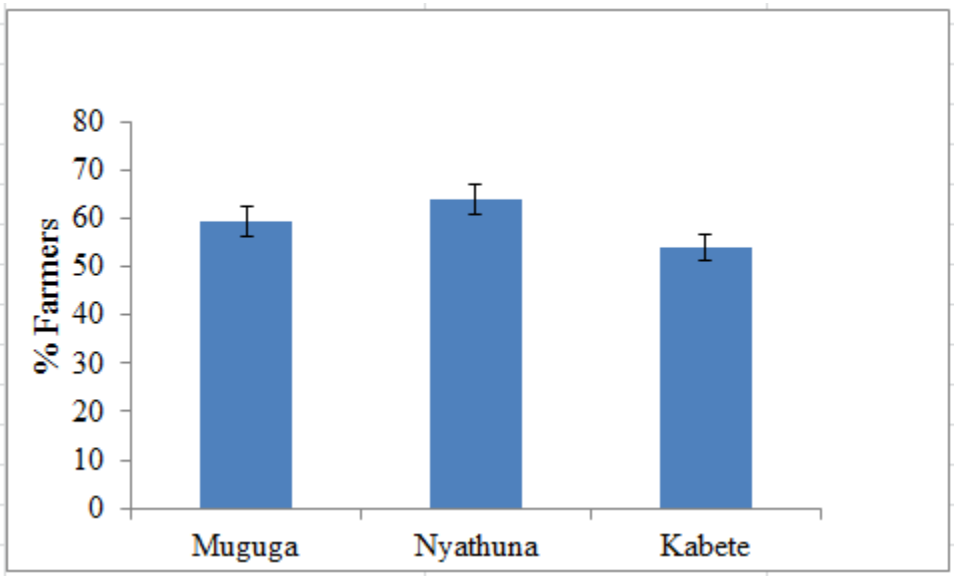

Figure 2: Proportion of farmers aware on animal welfare

The farmers obtained information on animal welfare from the media, feed millers, agro vets, and government extension services, other farmers, schools/colleges and NGOs (Table 5). Among these sources the feed miller was the most important followed by the media and government extension service as well as learning from other farmers. The feed millers had more interactions with the farmers as they promoted their feed brands. The farmers may also have access to print media as well as electronic media. This was in agreement with the study by (Craig and Swanson,

1994) who reported that knowledge on animal welfare can be acquired through training, extension programmes and through media.

Table 5: Proportion of farmers indicating sources of information on animal welfare (%)

Sources	Muguga (n=32)	Nyathuna (n=35)	Kabete (n=14)	Mean
Feed millers	31.3	25.7	28.6	28.5±0.8
Media[1]	18.8	37.1	21.4	25.8±9.9
Government extension service	25.0	5.7	14.3	15±9.7
Other farmers	12.5	11.4	21.4	15±5.5
Agro vets	6.3	14.3	7.1	9.2±4.4
School/college	3.1	5.7	7.1	5.3±2.0
NGOs	3.1	0.0	0.0	1.0±1.8

1: Media represents radio, TV and newspapers

The association between level of education of farmers and knowledge on animal welfare is shown in Fig. 3. Majority of farmers who had formal education were aware of animal welfare. About 55% of farmers with post-secondary level of education had knowledge on animal welfare, followed by 24% and 16% for secondary and primary levels, respectively. This shows that farmers with formal education have access to and read newspapers and books compared to those with no formal education.

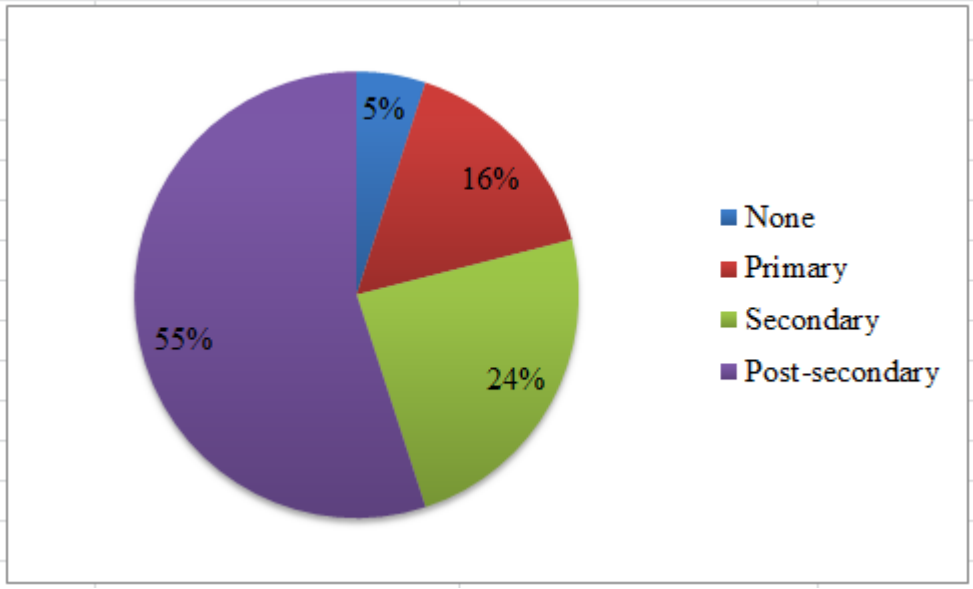

Figure 3: Proportion of farmers aware of poultry welfare according to level of education

4.1.2 Management practices to prevent and control diseases

Management practices to prevent diseases, diseases vaccinated against, sources of vaccine, and who helps farmers to prevent and control diseases are shown in Table 6. All the farmers in three wards vaccinated the birds against New Castle disease and Infectious bursal disease (Gumboro), however only 35 and 38% of the famers vaccinated against fowl pox and fowl typhoid. To prevent spread of diseases in the poultry houses 60% of the farmers isolated sick birds from the rest of the flock. About 69% of farmers beak trimmed birds so as to prevent cannibalism. These management practices are widely recommended by the state extension service as well as poultry breeders.

Most farmers (82%) obtained vaccines and drugs from the agro vet outlets and the others (18%) from the private veterinarians. The private veterinarians and agro vet employees provided advisory services on disease control. They also vaccinate against the diseases mentioned and

provided treatment. Above 76.5% of farmers in the three wards got support from agro vets to prevent and control diseases. This shows the important role of played by agro vets in disease prevention and control programs.

Table 6: Proportion of farmers undertaking various practices to prevent/control diseases in the flock (%)

Practices	Muguga (n=54)	Nyathuna(n=55)	Kabete(n=26)	mean
Management practices done to prevent diseases				
Vaccination	100	100	100	100
Debeaking	87	54.5	65	69
Isolation of sick birds	59	54.5	65	60
Diseases vaccinated against				
NCD	100	100	100	100
Gumboro	100	100	100	100
Fowl typhoid	33.3	41.8	38.5	38
Fowl pox	27.8	40	38.5	35
Sources of vaccine and drugs				
Agro vets	72.2	84	88.5	82
Private vets	28.7	12	11.5	17.5
Who helps to prevent and control diseases				
Agro vets	66.7	78.2	84.6	76.5
Private vets	33.3	21.8	15.4	23.5

4.2 Welfare status of layers

4.2.1 Welfare needs in terms of feeding

Access to feed and water is shown in Fig. 4. Above 80% of farmers in the three wards provided feed to chickens throughout the day while 100% of them provided water to the hens throughout the day.

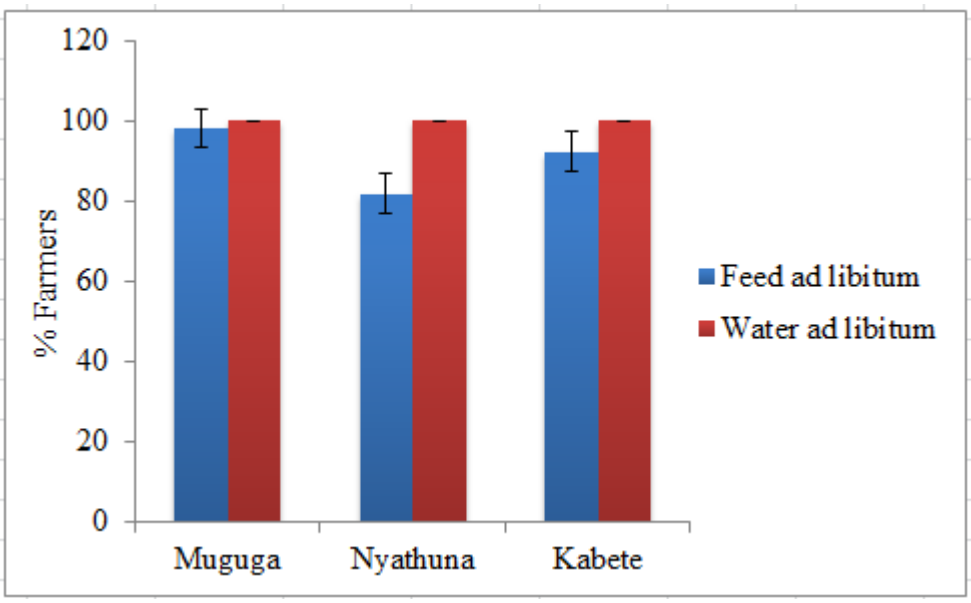

Figure 4: Proportion of farmers providing feed and water ad libitum

Table 7 shows feed consumption, feeding space and watering space for the flocks studied. The average daily feed consumption was 115.2±15.7 g/bird. No significance difference in feed consumption was noted between the three wards ($p>0.05$). This level of feed consumption was within the normal range of 118 to 120 g/bird/day (North and Bell, 1990, Leeson and Summers, 1997, Thiele, Pottgüter and Gmbh, 2008, Jacob, 2015). Closely related to feed consumption is feeding space available. From this study it was found that the mean feeding space was 10.4±3.0 cm/bird which was within the recommended feeding space of 10-12 cm/bird (Food and Agriculture Organization, 2004 and Food and Agriculture Organization, 2011). The average linear watering space was 2.5±0.7 cm/bird which again was within the recommended space of 2.5-3 cm/bird (Food and Agriculture Organization, 2004, North and Bell, 1990). No significance difference in feeding and drinking spaces were noted between the three wards ($p>0.05$). Data on feed consumption, feeding space, and watering space show that the layer flocks studied were free from hunger and thirst.

Table 7: Feed consumption, feeding and watering spaces

Item	Muguga (n=54)	Nyathuna (n=55)	Kabete (n=26)	Mean±SD
Feed consumption (g/bird/day)	114±18	116±14	118±12	115.2±15.7
Feeding space (cm/bird)	10.1±3.0	10.2±2.9	11.6±3.1	10.4±3.0
Drinking space (cm/bird)	2.3±0.4	2.6±0.8	2.4±0.6	2.5±0.7

4.2.2 Welfare needs in terms of housing

4.2.2.1 Stocking density and poultry house temperature

The factors which impact freedom from discomfort for poultry are stocking density of the birds, house temperature and litter quality as well as ammonia concentration in the house. The stocking density was 10±3, 10±3 and 11±3 birds/m^2 for Muguga, Nyathuna and Kabete, respectively (Table 8). No significance difference in stocking density was noted between the three wards ($p>0.05$). This was higher than the recommended three to nine birds/m^2 (Rangoma, 2018, European Commission, 1999, Food and Agriculture Organization, 2011, North and Bell, 1990).

A Study by Kang *et al.,* (2016) suggests that increasing stocking density up to 10 birds/m^2 causes reduced egg production per day, reduced feed intake and increased rate of broken eggs which have negative effects on production and welfare of laying hens.

The poultry houses temperature in the three wards was 24.6±2.3, 24.4±2.2 and 22.9±2.9^oC for Muguga, Nyathuna and Kabete, respectively, which was not significantly different ($p>0.05$). This was within the thermo-neutral zone of 15-27^oC for a laying hen (Talukder *et.al.,* 2010).

Beyond 27^{o}C the bird becomes heat stressed which affects production (Thiele, Pottgüter and Gmbh, 2008, Talukder *et al*., 2010).

Table 8: Stocking density of layers and house temperature

Parameter	Muguga	Nyathuna	Kabete	Mean
Stocking density (birds/m^2)	10±3	10±3	11±3	10±3
House temperature (^{o}C.)	24.6±2.3	24.4±2.2	22.9±2.9	24.2±2.5

4.2.2.2 Ammonia levels in poultry houses

Ammonia levels in the poultry houses were assessed based on irritation of the eyes of the enumerator. Ammonia problems in the house can arise due to overcrowding of the birds, water spillage, poor ventilation and inadequate amount of litter. Fig. 5 shows that in half of the poultry houses studied ammonia level was not a problem (no irritation to the eyes). However in 18, 36 and 31% of the houses in Muguga, Nyathuna and Kabete, respectively ammonia levels were high (slightly irritated the eyes of enumerator). Such levels of ammonia may lead to respiratory diseases and predispose birds to secondary infections, which may compromise their welfare (David *et al.,* 2015).

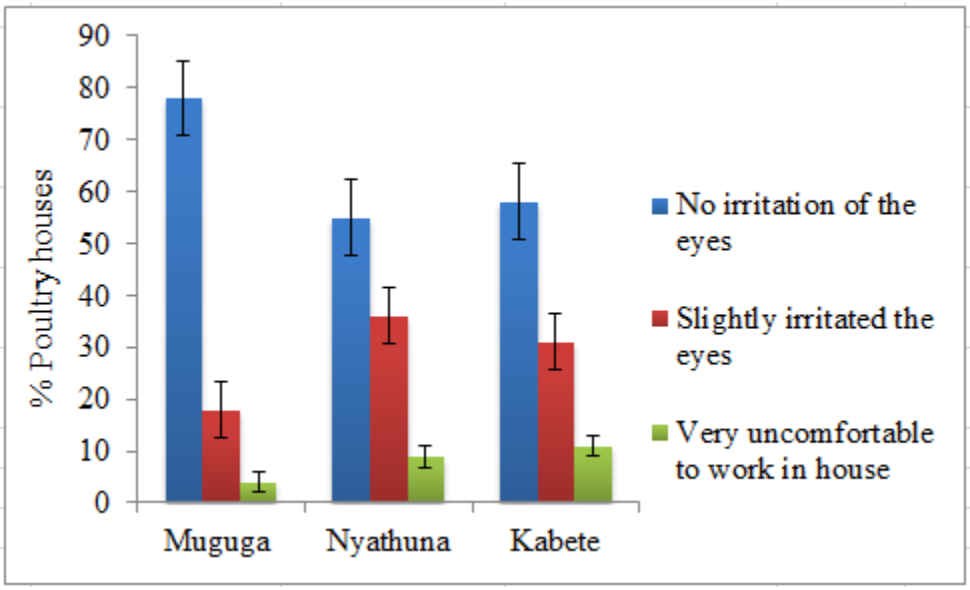

Figure 5: Proportion of poultry houses with ammonia irritating to the eyes (%)

4.2.2.3 Litter depth and litter quality

The depth of the litter, quality of litter and health of feet of hens are shown in Table 9. About 20% of the houses, the litter depth was 5 to 10 cm and in 67% of them the litter depth was 11 to 15 cm. Litter depth was more than 15 cm in 14% of the houses. About 70% of the poultry houses had dry litter, which is important as it decreases the chances of burnt hock problem and foot pad dermatitis. These conditions are mainly related to high moisture and ammonia contents in the litter (Ekstrand, Algers and Svedberg, 1997). Controlling environmental conditions such as litter quality has a positive influence on poultry welfare (Meluzzi, *et al,* 2008). Too dry litter was found in 22, 7 and 8% of the houses in Muguga, Nyathuna and Kabete, respectively. Litter which is too dry may lead to dehydration and respiratory diseases and hence compromise the welfare of laying hens (Casey, Brian and Fairchild, 2005). The highest percentage (16.4) of houses with too wet litter was in Nyathuna followed by Muguga (5.6%) and Kabete (3.8%). Increased litter

moisture content causes severe foot pad dermatitis (FPD) and lowers the performance of the birds and impact negatively on welfare of the birds (De Jong, Gunnink and Van Harn, 2014). In this study only 3.7% of birds in Muguga ward were found with this condition, which was absent in the other wards. This may be due to the management practices (feeding space, watering space and litter quality) which were within the acceptable norms.

Table 9: Proportion of farmers reporting various characteristics of the litter and health of birds' feet (%)

Parameters	Muguga *	Nyathuna *	Kabete *	Mean
Depth of litter (cm)				
11-15	50	61.8	88.5	66.8
5-10	24	27.3	7.7	19.7
>15	26	10.9	3.8	13.6
Quality of litter				
Dry	72.2	76.4	88.5	79
Too dry	22.2	7.3	7.7	12.4
Too wet	5.6	16.4	3.8	7.6
Health of feet of birds				
Healthy	96.3	100	100	98.8
Few wounds (2-3 wounds)	3.7	0	0	1.2

** Respondents in Muguga, Nyathuna and Kabete were 54, 55 and 26, respectively for all parameters*

Litter quality was not a problem in the farms studied and therefore foot pad lesion was not a problem as well (Fig. 6).

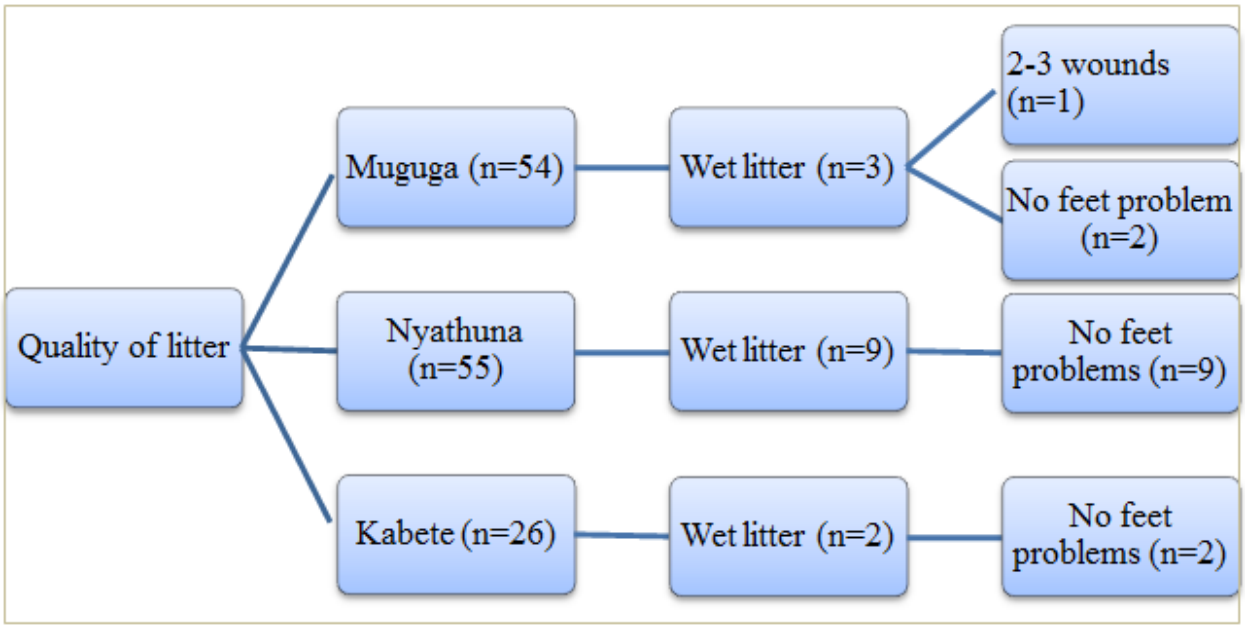

Figure 6: litter quality and feet problem (foot pad dermatitis)

4.2.3 Welfare needs in terms of health

4.2.3.1 Incidence of diseases and causes of mortality

The proportion of farmers who reported occurrence of diseases was 37% and the mortality recorded one month prior this study was 38% (Table 10). The proportion of farmers reporting New Castle disease, infectious bursal disease (Gumboro), cannibalism and coccidiosis as causes of mortalities were 33, 23, 16 and 1%, respectively. These were the same diseases that were reported to be important in the study area during focus group discussion. Even though most farmers had vaccinated their birds against Newcastle and Gumboro diseases as shown in Table 6, these were the highest causes of death. Since majority of farmers get vaccines from Agro vets (Table 6), it may be due to inappropriate timing of vaccinations or unskilled personal carrying

out the vaccinations. Since vaccines are delicate, it is necessary to handle them carefully in order to retain their potency. Poor handling procedures result in decrease of potency (Poultry Cooperative Research Centre, 2018). Improving biosecurity and health management practices on the farm can reduce transmission of infectious diseases and mortality (Royal Society for the Prevention of Cruelty to Animals, 2017). About 26% of the farmers reported that they lost their birds through predators such as mongoose, snakes and accidents such as falling objects. Predators may either eat or scare of the birds which may affect performance and welfare of laying hens. Poultry houses should be monitored and maintained to prevent entry of predators such as mongoose and snakes (Royal Society for the Prevention of Cruelty to Animals, 2017). About 27% of the farmers reported cannibalism in their flocks (Table 10). This study showed that 31% of the farmers did not trim beaks (Table 6). It is therefore likely that cannibalism was a problem in the farms where beak trimming was not practiced. About 33, 25 and 23% of the farmers in Muguga, Nyathuna and Kabete, respectively reported problem of cannibalism. Cannibalism may lead to severe distress, injury and death in the flock which compromises the welfare of laying hen (American Veterinary Medical Association, 2010).

Table 10: Proportion of farmers reporting diseases, mortality, cannibalism and causes of mortality (%)

Diseases, other conditions reported and cause of mortality	Muguga (n=46)	Nyathuna(n=37)	Kabete(n=19)	Mean
Moralities	42.6	32.7	38.5	38.0
Diseases	42.6	34.5	34.6	37.2
Cannibalism	33.3	25.5	23.1	27.3
Causes of mortality				
New Castle Disease	27.8	36.4	35.5	33.2
Wild animals and accidents	31.6	23.3	23.1	26
Gumboro	22.2	23.6	23.0	23
Cannibalism	15.8	16.7	15.4	16
Coccidiosis	2.6	0	0	0.9

In Muguga, 50% of farmers reported diseases affecting egg production while Nyathuna and Kabete reported 36.4% and 30.8%, respectively. This could partly explain the low production in Table (15).

4.2.3.2 Management of sick birds

It was important to find out what actions farmers took when they found sick birds in their flocks (Table 11). About 75% of farmers called a veterinarian to assess the situation and recommend the action to be taken. However a few of the farmers (6%) reported that no action was taken while some of them (19%) slaughtered the birds for home consumption.

Above 90% of farmers in Nyathuna and Kabete called veterinarians when birds were sick. Approximately 37.0% of farmers in Muguga called veterinarians when birds are sick and 56% of them slaughtered the birds before they died for home consumption. This may be the reason why mortalities in Nyathuna and Kabete were lower than that of Muguga (Table 10). This shows that effort was made to control diseases to ensure welfare of the birds and high production.

Table 11: Proportion of farmers reporting management of sick birds (%)

Characteristics	Muguga (n=54)	Nyathuna(n=55)	Kabete(n=26)	Mean
Management of sick birds				
Call a vet	37.0	92.7	96.2	75
Slaughter before it dies for food	55.6	0	0	19
None	7.4	7.3	3.8	6

The farmers used several methods to prevent cannibalism (Table 12). Majority of farmers in Muguga (58.0%) and Nyathuna (73.3%) managed cannibalism by beak trimming, while in Kabete equal proportion (50%) of farmers used beak trimming and calcium supplementation. Beak trimming although effective in controlling pecking and cannibalism, leads to trauma of the bird during the procedure and loss of sensory tool (Farm Animal Welfare Council, 2010). It has been reported that there is less ground pecking and less feather pecking in beak trimmed birds compared to non-trimmed ones (Hartcher *et al.*, 2015). Providing green leaves for pecking, which was practiced by 63% of the farmers (Table 13) was another way of preventing cannibalism. It allows the birds to practice pecking which is a normal behaviour, it also provides the aggressive birds with something that they can attack (Clauer, 2009). About 28% of the

farmers gave calcium supplementation in the form of limestone to control cannibalism. The efficacy of this procedure has not been validated.

Table 12: Proportion of farmers reporting preventive mechanisms of cannibalism (%)

Prevention of cannibalism	Muguga (n=19)	Nyathuna (n=15)	Kabete (n=6)	Mean
Beak trimming	58.0	73.3	50.0	45.4
Mineral supplement	21.0	13.3	50.0	28.1
Removal of injured birds from the flock	21.0	13.4	0	11.5

4.2.4 Welfare needs in terms of normal behaviour

4.2.4.1 Provision of facilities to express natural behaviour

Provision of perches, laying nests, sand bathing facilities and green leaves for pecking provides opportunities for birds to express normal behaviour (Table 13). The percentage of farmers providing perches in Muguga, Nyathuna and Kabete were 14.8, 23.6 and 34.6%, respectively. The perching spaces in Muguga, Nyathuna and Kabete were 7.1±5.8, 12±11 and 12±8.7 cm/bird, respectively. There was no significance difference in perching spaces between the three wards ($p>0.05$). Provision of perches in all three wards was below the recommended length of 15-25 cm/bird (Food and Agriculture Organization, 2004, Clauer, 2010). This shows that farmers may not have knowledge on the importance of perches. In focus group discussion it was reported that some of the farmers did not provide perches to the birds due to problems with bugs.

All farmers provided laying nests to the birds. This may be due to the fact that farmers were focused on production and attempted to minimize the number of eggs laid on the floor. The

thrust was to provide an appropriate place for egg laying rather than to meet the hen's behaviour requirement *per se*. Provision of nesting boxes minimizes egg laid on the floor and allows birds to express laying behaviour (Clauer, 2010). It is crucial to provide adequate nesting space so as to allow the birds to express normal laying behaviour. The nesting areas in Muguga, Nyathuna and Kabete were 25±3, 25±3 and 24±3 cm^3 for every five birds, respectively, which was below the acceptable nesting pace of $30cm^3$ for every 3-5 bird (Gordon and Jordan, 1982, Food and Agriculture Organization, 2004, Clauer, 2010). The nesting spaces in the three wards was the same ($p>0.05$). Inadequate nesting space is likely to lead to competition for nest boxes, egg breakage and egg lay on the floor.

None of the farmers provided sand bathing facilities. This could be due to lack knowledge of farmers on the importance of expressing natural behaviour on the welfare of laying hens. Sand bathing is a normal behaviour in poultry, which helps birds to keep their feathers clean, helps them stay free of mites and lice and removes damaged feathers (Olsson and Keeling, 2005, Lay *et al.,* 2010, Fresh egg daily, 2012). Although provision of green leaves was used for control of cannibalism, it is also important as a means of ensuring natural behaviour of pecking. About 63% of the farmers provided fresh green vegetables for this purpose, implying that some farmers knew the importance of pecking behaviour (Clauer, 2009).

Table 13: Proportion of farmers providing facilities to improve welfare of the birds (%)

Facilities	Muguga (n=54)	Nyathuna(n=55)	Kabete(n=26)	Mean
Provision of perches	14.8	23.6	34.6	24
Provision of laying nests	100	100	100	100
Dust bathing facilities	0	0	0	0
Green leaves for pecking	63.0	52.7	73.1	63
Perching space provided (cm/bird)	7.1±5.8	12±11	12±8.7	10±9
Area of laying nests (cm^3 / every 5 birds)	25±3	25±3	24±3	25±3

4.2.4.2 Observation of birds and frequency of fear

It is important to observe the birds frequently so as to identify any sick ones and take appropriate action. It was found that majority of the farmers in Muguga (81.5%), Nyathuna (94.5%) and Kabete (96.2%) observed the birds twice a day (Fig. 7). Frequent observation of the chicken is essential for early identification of diseases and taking appropriate actions (Colles *et al.*, 2016).

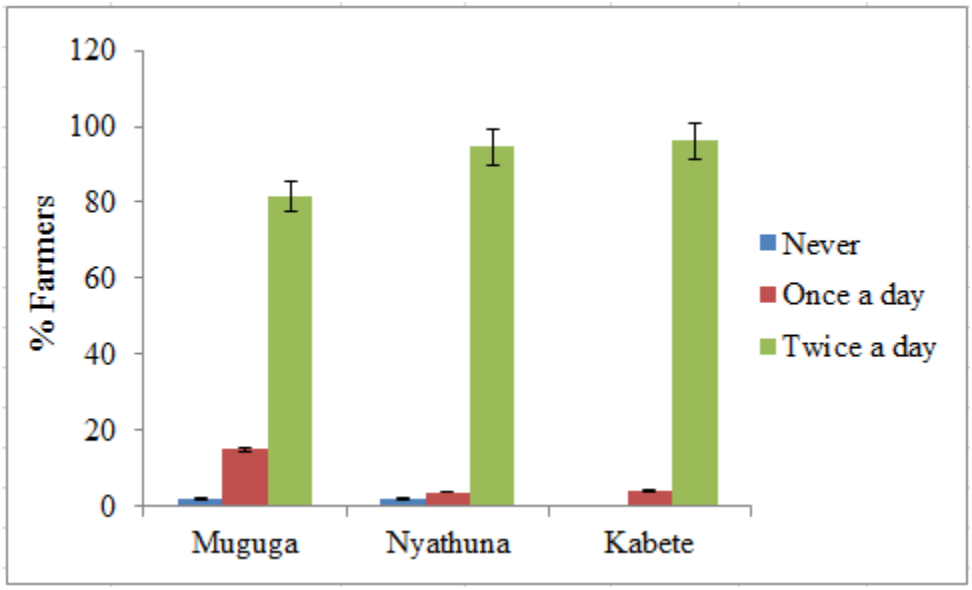

Figure 7: Proportion of farmers reporting frequency of bird observation

Table 14 shows frequency of expressing fear and its causes. Over 98% of the farmers stated that birds expressed fear twice a week. The main causes of fear were pets (cats and dogs) as well as rats as reported by 46% of the farmers. Other causes were human activity and vehicular traffic as well as wild animals which were reported by 33% and 21%, respectively. Constant fear is associated with low egg weight, low feed intake and high mortality which negatively affects bird welfare (de Haas *et.al.*, 2013). Therefore, it is important to minimize fear in poultry as much as possible.

Table 14: Proportion of farmers indicating frequency of fear and its causes (%)

Frequency of fear and its causes	Muguga (n=54)	Nyathuna (n=55)	Kabete (n=26)	Mean
Frequency of expressing fear e.g. by flying aimlessly				
Twice a week	96.3	98.2	100	98.2
Four times a week	3.7	1.8	0	1.8
Causes of fear				
Dogs, cats and rats	61.1	34.5	42.3	46
Noise from people and vehicles	20.4	49.1	30.8	33.4
Wild animals	18.5	16.4	26.9	20.6

4.3 The influence of layers welfare on production

4.3.1 Production characteristic of the farm

The average flock size per household was 410 ±256 birds. About 50% of the farmers kept between 201-400 layers (Fig. 8).

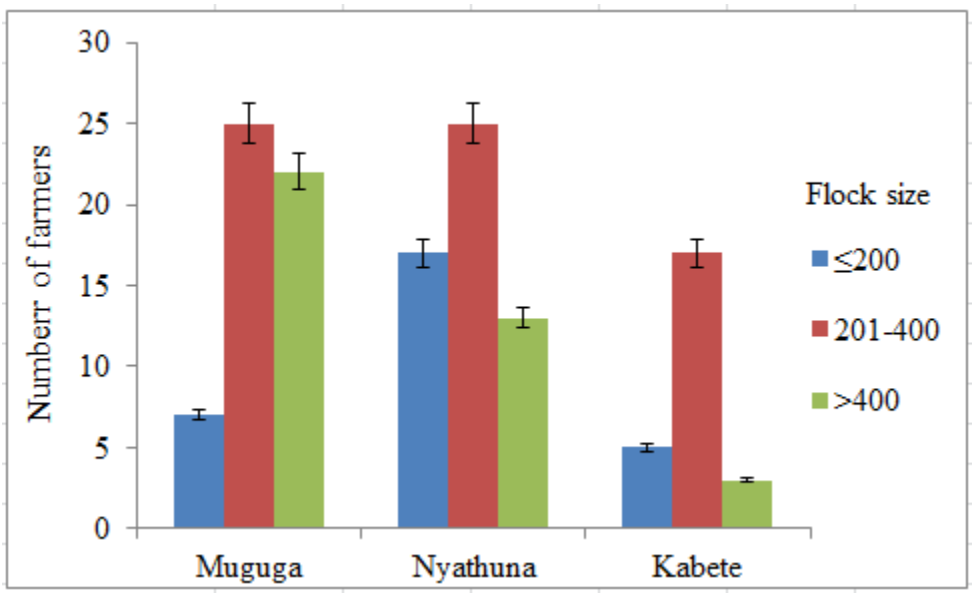

Figure 8: Number of farmers keeping layers

Factors influencing the numbers of layers kept by small scale farmers are as follows; availability of capital for putting up poultry houses, availability of capital for purchase of day old chicks, feeds, drugs and paying for labour, availability of market for the eggs and availability of space for putting up a poultry houses.

The age at point of lay of hens studied was 18.5±1.6, 19.6±2.3 and 20.0±2.3 weeks in Muguga, Nyathuna and Kabete, respectively (Table 15), which was within the normal time for chickens to start laying (North and Bell, 1990). There was no significance difference on age at point of lay between the three wards ($p>0.05$). it was reported that age of moving pullets to laying quarters was between 16 to 20 weeks and commercial flocks usually commence laying at less than 20 weeks of age (North and Bell, 1990) Length of lay of hens at the time of data collection was 32±15, 26±14 and 20±12 weeks in Muguga, Nyathuna and Kabete, respectively, which was the same ($p>0.05$).

The average hen-day egg production (%) was 80.0±12%. The layers in Kabete were younger than those in Muguga and Nyathuna and one would expect higher egg production in Kabete yet it was not the case. The average hen-day production of the three wards was the same ($p>0.05$). The overall egg production at 80.0±12% was lower than expected 95% (Hy-line, 2016). Egg production is influenced by the breed and nutrition of birds, disease control program and the stockman ship of the farmer.

Table 15: Production characteristics of the laying flocks studied

Parameter	Muguga[1]	Nyathuna[1]	Kabete[1]	Mean
Age at point of lay (weeks)[1]	19.4±1.9	19.5±1.8	20.0±2.3	19.6±2.0
Number of weeks hens in lay at time of data collection[1]	32±15	26±14	20±12	27.6±14.8
Percent hen-day production [2]	83.1±11.9	79.0±11.5	77.0±9.5	80.0±12

1 = Farmers in Muguga, Nyathuna and Kabete were 54, 55 and 26, respectively for the first two parameters. 2= Muguga (n=40), Nyathuna (n=44) and Kabete (n=19).

4.3.2 Effect of layers welfare on hen-day egg production

Correlation between hen-day production and factors like level of ammonia in the poultry house, litter quality, stocking density and provision of perches is shown in Table 16. It was found that there was no correlation between hen-day production and these factors as most of them were within the recommended levels for layers. There was no correlation between hen-day production and these factors within the wards except in Kabete ward, where a positive correlation ($r =0.575$) between provision of perches and hen-day production was found and it was significant ($p<0.01$). Since the hen-day production was lower than expected 95%, it may be due to the fact that some of the welfare issues such as facilities to express normal behaviour and disease prevention

programs were not fully met. High stocking density of 10 birds/m^2 also reduces hen-day production, feed intake and negatively affects the welfare of layers (Kang *et al.,* 2016).

Table 16: Correlation between hen-day production and factors shown in the table

Factors	Correlation co-efficient (r^2)	*p value*
Stocking density	-0.029	0.791
Ammonia levels in the poultry houses	-0.035	0.718
Litter quality	-0.163	0.090
Provision of perches	-0.119	0.220

4.4 Characteristics of the farmers

4.4.1 Age, gender, marital status and level of education

Ages of the farmers in the study area are presented in Fig. 9. Majority (47.4%) of farmers in Kabete sub-county were above 50 years of age. The distribution of the farmers into three age brackets namely 21-30, 31-50 and >50 years was varied between the three wards. Thus in Muguga only 3.7% of the farmers were between 21 and 30 of age, while 40.8% were between 31-50 years of age, in the same area 55.6% were above 50 years old. The corresponding figures in Nyathuna were 18.2, 45.4 and 36.4% for the same age groups, respectively. In Kabete ward 11.5% of the farmers were between 21-30 years of age, 34.6% were between 31-50 years of age and 53.3% were above 50 years of age. The average age groups of the three wards was the same ($P>0.05$). The age category above 50 years represents retired people who take up poultry farming to supplement their pension. The age group of 21-30 years represents the young people who usually have no capital to invest in poultry production and hence did not take part in poultry farming. This may result in reduced poultry production as old farmers tend to be resistant to

change their ideas and adapt exotic poultry farming methods, while young farmers tend to be more flexible in their decisions to adapt new farming technology rapidly (Yami *et al*., 2006).

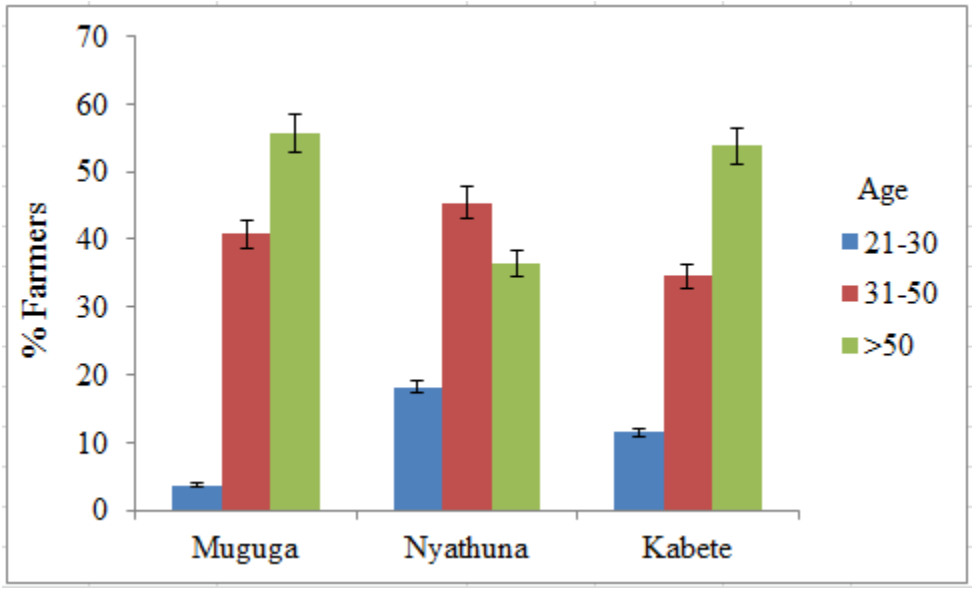

Figure 9: Age of the farmers in the three wards

The gender of the farmers in the three wards (Muguga, Nyathuna and Kabete) is shown in Table 17. Over 61% of the farmers in the three wards were women. Women tend to be involved more in agriculture than men. Also women generally stay at home looking after agricultural activities while men tend to seek income earning activities away from home (Okitoi *et al.*, 2007). It has also been shown that about 43% of the agricultural labour force globally and in developing countries is comprised of women (Doss *et al*., 2011).

Above 75% of farmers in the study area were married. This may be that they have enough money to start poultry production compared to single or widowed farmers. On average above 94% of studied farmers had formal education. In Muguga, Nyathuna and Kabete wards 96.3, 92.7 and 92.2% of the farmers, respectively had formal education. There was no significance difference in

level of education of the farmers between the three wards ($p>0.05$). Most of them had secondary school or higher level of education. This is important as the level of education of farmers influence adoption of technologies and is associated with better management of agriculture enterprises. If the farmers involved in poultry business are more educated, the production of meat and egg will sustain. This is in agreement with (Kirui, 2014) who found that the performance of poultry reared by farmers with post-secondary school was higher than those reared by farmers with just primary and secondary education.

Table 17: Gender, marital status and level of education of the farmers in Kabete sub-county (%)

Category	Muguga (n=54)	Nyathuna (n=55)	Kabete (n=26)	Mean	SD
Gender					
Female	66.7	67.3	61.5	65.2	2.6
Male	33.3	32.7	38.5	34.8	2.6
Marital status					
Married	87.0	69.1	69.2	75.1	8.4
Single	7.4	21.8	23.1	17.4	7.1
Widow/Widower	5.6	9.1	7.7	7.5	1.4
Level of education					
Secondary	57.4	45.5	53.8	52.2	5.0
Post-secondary	13.0	23.6	26.9	21.2	5.9
Primary	25.9	23.6	11.5	20.3	6.3
None	3.7	7.3	7.7	6.2	1.8
Farmers with formal education	96.3	92.7	92.2	93.7	2.2

4.5 Characteristics of the farms

4.5.1 Land size

The average land size in the study area was 0.4±0.3 ha (Table 18). The average land size of the three wards was the same ($p>0.05$). Population density influences land size such that where the population is high the land size tends to be small and over time the land size has been decreasing because of sub-division due to inheritance practices (Muyanga and Jayne, 2014). Data from Kiambu county gives an average small holder farm size of 0.36 ha (County Government of Kiambu, 2018).

Table 18: Average land size of the farmers in three wards covered

Land size (hectares/farmers)	Mean	SD
Muguga (n=54)	0.4	0.3
Nyathuna (n=55)	0.4	0.3
Kabete (n=26)	0.5	0.4
Mean	0.4	0.3

4.5.2 Types of animals kept

The farmers kept large animals (cattle, sheep, goat and pigs), cats, dogs and chickens. Over 80% of farmers from all three wards kept cattle, goats, sheep and pigs together with layers. The reason for keeping other livestock together with layers may be to support the income of the family from different sources and to produce large quantities of meat, milk and eggs at a lowest possible cost (Reijntjes, Haverkort and Waters, 1992). Farmers keep different species of food animals to minimize the risk during disease outbreaks and droughts. They also provide different livestock products required for nutrition and income needs (Reijntjes, Haverkort and Waters, 1992).

Cats and dogs are important in relation to the layer welfare because they can induce fear to the birds (Table 19). Dogs were kept by more than 30% of the farmers in all wards for security purposes. Cats were kept to prevent rats from invading the compounds by 36.5, 42.3 and 65.2% in Muguga, Nyathuna and Kabete, respectively. On average each house had two flocks of layers. One of the flocks was studied for assessment of welfare status.

Table 19: Proportion of farmers keeping pets and large animals (%)

Animal	Muguga (n=54)	Nyathuna (n=55)	Kabete (n=26)	Mean	SD
Cats	36.5	42.3	65.2	48.0	12.4
Large animals	84.6	80.8	100	88.5	8.3
Dogs	44.4	34.5	30.8	36.6	5.7

About 31% of the farmers kept poultry for one to five years, 19% six to ten years (Fig. 10) and the rest more than 15 years. This shows that most of the farmers had kept poultry for a period long enough to have learnt management of the birds that would ensure good welfare.

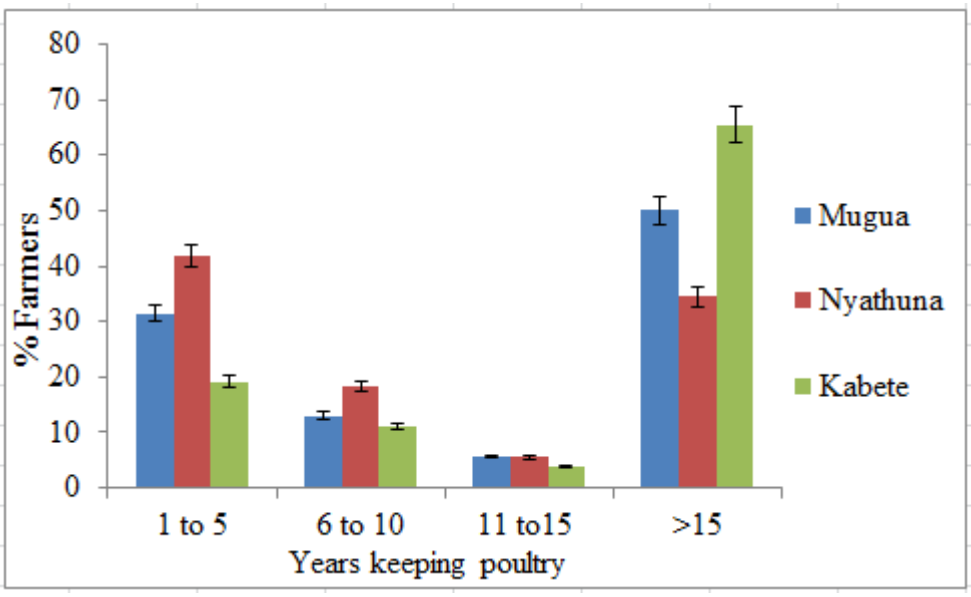

Figure 10: Number of years farmers have been keeping poultry

4.6 Influence of extension services on the welfare of layers

Data on training on poultry management as well as the trainers is shown in Table 20. About 61% of the farmers received training in poultry management. Most of the farmers reported that they were trained by feed millers (38%) followed by agro vets (28%). Other trainers reported were state extension services (18%) and poultry breeders (16%). This shows that feed millers had more frequent interactions with the farmers and gave them more training on poultry management (Table 20) as well as information on poultry welfare than other extension service providers (Table 5). Majority of farmers were trained by feed millers; 34. 37 and 44%, agro vets; 24, 29 and 31%, poultry breeders were 21, 26 and 0% and the state extension was 21, 8 and 25% for Muguga, Nyathuna and Kabete, respectively. This shows that the state extension service is constrained in the area. During focus group discussion it was reported that state extension service has higher quality than to private sectors. Private extension services are concentrated in high potential area where they can get more profit. Thus farmers producing low value products in remote areas are neglected as public extension services are constrained by inadequate resources (Muyanga and Jayne, 2008).

This study assessed whether farmers had received extension services in the last twelve months prior to the study and what type of information received (Table 20). On average 11.8% of the farmer had received extension services in the last 12 months prior to the study. In Muguga 33% of the farmers received extension services on livestock management and 67% on crop management. While in the other two wards 100% of it was about livestock management. This shows limited state extension service as the average farmers who receive extension service was 18%.

Table 20: proportion of farmers received training in poultry management and extension services (%)

Training/extension services	Muguga	Nyathuna	Kabete	Mean
Training on poultry management	53.7	69	61.5	61.4
Trainers				
Feed millers	34	37	44	38
Agro vets	24	29	31	28
Government extension service	21	8	25	18
Poultry breeders	21	26	0	16
Extension services for last 12 months	16.7	11	7.7	11.8
Extension on livestock management	33.3	100	100	77.8

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

1. It was found that 60% of the farmers had knowledge on animal welfare and most of them learnt it through feed millers, the media and state extension service. Most of the farmers (69%) beak trimmed the birds with the aim of controlling cannibalism which was reported to be a problem while all of them vaccinated the birds against New Castle disease and Infectious bursal disease (Gumboro).
2. Welfare needs for layers were met in terms of good feeding, suitable house temperature, good litter quality and depth, acceptable ammonia level and disease control through vaccination and treatments while welfare needs were not met in terms of stocking density, availability of perching and nesting spaces as well as sand bathing facilities.
3. There was no correlation between hen-day egg production and house ammonia level, litter quality because these factors were within the recommended levels for layers.
4. The overall assessment was that the welfare of the layers was compromised because some of their requirements were not fully met.

5.2 Recommendations

1. State extension programmes should be promoted to train the farmers on layers' welfare needs.
2. Welfare standards should be formulated and the existing livestock acts should be enforced by the relevant national authority.
3. Through the extension agents farmers should promote facilities for normal behaviour and use the recommended stocking density of layers for better performance.

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APPENDIX I

Appendix 1: Survey questionnaire on welfare and production of layers in small holder poultry farmers in Kabete Sub-county, Kenya

I. GENERAL INFORMATION

1. Questionnaire number_____

2. Date _____

3. Enumerator name _____

4. GPS coordinates: Eastings _____Southings_____

5. Sub -County _____

6. Ward _____

II. CHARACTERISTICS OF THE FARM

7. Name of respondent _____

8. Telephone number of respondent_____

9. Please indicate your position in the household (tick appropriate)

    1. Husband_____

    2. Wife_____

    3. Daughter_____

    4. Son_____

    5. Employee _____

    6. Other (specify)___

10. Please indicate your gender (tick appropriate)

    1. Male _____

    2. Female_____

11. How old are you? (Years)

1	21-30	2.	31-40	3.	41-50	4.	>50

12. Please indicate your marital status (Tick appropriate)

1. Single_____
2. Married_____
3. Divorced_____
4. Widow(er)____

13. Please indicate the highest level of education you have attained. (Tick appropriate)

1. None_____
2. Primary level_____
3. Secondary_____
4. Post-secondary_____

14. Please indicate the land size of your farm (Acres) _____

15. Do you keep the following animals in your household? (Show number kept)

1. Dogs_____
2. Cattle_____
3. Goats_____
4. Sheep_____
5. Other (specify) ___

III. PRODUCTION CHARACTERISTICS

16. For how long have you been keeping poultry? (Years)

1	1-5	2	6-10	3	11-15	4	>15

17. How many birds for egg production are you keeping?(All chicks, pullets, layers) (Number)

1	<500	2	500-1500	3	1501-2500	4	2501-3500	5	>3500

18. How many laying flocks are in the farm? (Number)

1	1-3	2	4-5	3	>5

Choose ONE flock and collect data on it

19. When did the birds in this flock start laying? (Show month and year) ____

20. How many laying hens are in this flock? (Tick appropriate)

    1. <300 _____

    2. 300-500 _____

    3. >500 _____

21. How long does it take the birds to start laying? (months)

    1. 3-4 months _____

    2. 5-7 months _____

22. Do you keep any production records? (Tick appropriate)

    1. Yes_____

    2. No_____

23. If yes, look at it and record what is important _____

24. What is your daily egg production by this flock? (Trays) _____

25. Have you had diseases that affect egg production of this flock? (Mark the appropriate answer)

    1. Yes_____

    2. No_____

26. If yes what was the drop in egg production? (Trays)_____

IV. KNOWLEDGE AND PRACTICES OF FARMERS ON CHICKEN WELFARE

IV A. *Freedom from hunger and thirsty*

27. Are you familiar with the concept of animal welfare? (Masilahi wanyama)

    1. Yes_____

    2. No_____

28. If yes, whom did you learn from? (Tick appropriate)

    1. Government extension agents_____

    2. Feed millers_____

    3. News paper_____

    4. Radio/TV_____

    5. Agro-vet _____

29. Do the birds have access to feed throughout the day all the time?

    1. YES_____

    2. NO_____

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

    1. Deliberately feed restrict the birds._____

    2. When there is no money to buy feed _____

    3. When there is no one to feed the birds _____

31. How much feed do you use per day for this flock? (50kg bags) _____

32. What type of feeding equipment do you use? (Tick the appropriate)

    1. Pan feeders only _____
    2. Feeding troughs only _____
    3. Both pan feeders and troughs ____

33. How much feeding space have you provided? (Count and take measurements)

    1. Number of feed troughs _____
    2. Length of each feed trough (m) _____
    3. Number of pan feeders_____
    4. Diameter of each pan feeder (cm) _____

34. What type of watering equipment do you use?

    1. Trough waterers only __
    2. Cylindrical waterers only __
    3. Both trough and cylindrical waterers ___

35. How much watering space do you provide? (Count and take measurements)

    1. Number of water troughs _____
    2. Length of each water trough (m) _____
    3. Number of cylindrical waterers _____
    4. Diameter of each waterers (cm) _____

IV.B. Freedom from discomfort

36. What is the size of the pen occupied by this flock? (Take measurements)

    1. Length (meters) _____
    2. Width (meters) _____

37. Please indicate if ammonia in the house is a problem. (Tick appropriate)

1. No irritation of the eyes of enumerator _____
2. slight irritations of the eyes of enumerator_____
3. Very uncomfortable to work in the house _____
4. The ammonia reading from the chart is_____

38. Assess the depth of litter (Tick appropriate)

1. Normal depth (5 to 10 cm) _____
2. Deep (11 to 12 cm) _____
3. Too deep (>12 cm)_____

39. Assess the quality of the litter

1. Too dry ____
2. Dry_____
3. Too wet ____

40. Take measurement on the temperature of the house.

1. 18^{o}C-24^{o}C (comfortable) _____
2. 25^{o}C-30^{o}C (slightly uncomfortable) _____
3. >30^{o}C (very uncomfortable) _____

IV.C. Freedom from pain injury or disease

41. Do your birds suffer any disease?

1. Yes _____
2. No _____

42. In the last one month about how many birds have died? _____

43. Please indicate the two most important causes of death from your flock? _____

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

    1. Slaughter before it dies for food _____
    2. Call the vet _____

45. What do you do if you see a dead bird?

    1. Throw it away _____
    2. Give it to dogs _____
    3. Call the vet _____

46. Assess the feet of the birds (Tick appropriate)

    1. Healthy _____
    2. Few wounds ____
    3. Highly injured ____

47. What type of management practices are used to prevent/control diseases from the chicken? (Mark the appropriate answer)

    1. Vaccination _____
    2. De-beaking _____
    3. Isolation of sick birds _____
    4. Others (specify) _____

48. Which diseases do you vaccinate the birds against? (List two diseases) ___

49. Where do you get the vaccines and drugs from? ((Mark the appropriate one)).

    A. Government _____
    B. NGOs_____
    C. Private vets_____
    D. Agro-vets _____
    E. Others (specify) _____

50. Who helps you to prevent and control diseases? (Mark the appropriate answer)

A. Government vets_____

B. Private vets _____

C. Agro-vets _____

D. Others (specify)_____

51. Is cannibalism a problem in your flock?

1. YES _____
2. NO _____

52. How do you manage cannibalism? (Mark appropriate one)

1. Beak trimming _____
2. Providing green leaves to perk ____
3. Divide the birds into two houses _____
4. Reduce the light in the house _____
5. Provide more feed and water _____
6. Removing the badly injured birds from the flock _____
7. Others (specify) _____

IV.D. Freedom to express normal behaviour

53. Have you provided facilities such that birds are able to perch? (Ask and observe)

1. YES _____
2. NO _____

54. If yes, count and take measurements

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

55. Have you provided nesting boxes?

1. Yes _____

2. No _____

55.1 If yes, take measurements.

1. Length(m) _____

2. Width(cm) _____

3. Height(cm) _____

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

1. Too often (4 times a day) _____

2. Less often (2 times a day)_____

3. Never _____

57. Have you provided facilities such that birds are able to sand bath? (Ask and observe)

1. Yes _____

2. No _____

58.1 If yes, how many sand bathing equipments are there? (Numbers) ___

58. Do you provide green leaves such that birds are able to peck? (Ask and observe)

1. Yes _____

2. No _____

IV. E. *Freedom from fear or distress*

59. How frequently do you notice your birds expressing fear by flying aimlessly? (Mark appropriate one).

A. Never _____

B. Less often (twice a day) _____

C. Too often (four times a day)_____

60. What factors bring this kind of fear? (Mark the appropriate one)

A. Noise from people _____

B. Dogs bark around the pen____

C. Vehicles moving near pen ___

D. Wild animals_____

61. Are there any predators that attack chickens at night or even during day time? (Mark the appropriate one)

1. YES _____
2. NO _____

61.1. If yes, mention them _____

V. EXTENTION SERVICES

62. Do you get any training on poultry management and feed formulation? (Mark the appropriate one)

1. YES ____
2. NO _____

62.1. If yes, who provides you the training? (Mark the appropriate one)

A. Government _____
B. NGO (Name it) _____
C. Private Vets_____
D. Agro-vets _____
E. Others (Specify)_____

63. Do you have extension services for the last 12 months?

1. YES _____
2. NO _____

63.1 If yes, what was it about? _____

THANK YOU SO MUCH

APPENDIX II

Appendix 2: Focus group questions

A focus group questions about welfare and production of layers was asked to a group of layer farmers from the three wards (Muguga, Nyathuna and Kabete).

1. Which are the common feel brands?
2. Do you have some feed brands result in poor production of the birds
3. Do birds reduce feed intake sometime? What do you think can cause this?
4. Are you familiar with the concept of animal welfare? (Masilahi wanyama), If yes what does it mean to you?
5. Do you know the importance of keeping layers in a well-lit house? What do you think should be done such that birds receive enough light?
6. We have visited a number of farmers and most of them we don't see perches, do you know the importance of perches?
7. What do you think is the importance of litter in poultry house? And in which condition do you think that litter should be?
8. In which way do you think the quality of litter can affect the production?
9. What are the key challenges you face?
10. This study is about layers welfare, is there anything else that we have not added which you want to cover?

Focus group questions about welfare and production of layers was asked to a group of extension agents working the area (Kabete sub-county).

1. What is the stocking density that you recommend for laying hens in this area?

2. How much emphasis do you place on ventilation and lighting of poultry house in your extension messages?
3. What are the challenges of litter use in this area?
4. How do farmers balance between use of litter and production of poultry manure for feeding on dairy cattle?
5. Which are the important poultry diseases in this area and how do farmers handle it?
6. Do you have a standard extension package for the laying hens?
7. Which is the main source of extension services to the farmers? (Government, private sector and NGO), what do you think is the quality of extension messages from these agencies?
8. What is your understanding of the importance of animal welfare? Especially welfare of laying hens? What is the impact of welfare on production?