# MORPHOLOGICAL CHARACTERISTICS AND GROWTH PERFORMANCE OF KUCHI INDIGENOUS CHICKEN ECOTYPE UNDER THREE FEEDING SYSTEMS

**BY**

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# DECLARATION

**Declaration by the Student**

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## DEDICATION

This thesis is dedicated to my loving family.

## ABSTRACT

The low genetic potential and the lack of better feeding systems of the local chicken ecotypes has constrained the productivity of Indigenous chicken. Therefore, the present study was conducted to characterize the Kuchi indigenous chicken (IC) ecotype of Kenya. This ecotype has become popular for its high mature body weight. From week 9 to 30 of the Kuchi, three studies were carried out: First, were observations of some morphological traits namely: feather colours, comb types, shank colours of 18 Kuchi birds(8 cocks,10 hens) and the meat yield at 30 weeks of age of 6 birds (3cocks and 3 hens) expressed as Killing Out percentage (K O %). Second, the growth performance of Kuchi growers was evaluated under three feeding systems: Extensive (ES), Extensive with Supplementation (ESS) and Intensive (IS). Third, the growth performance of the Kuchi growers under each of the three feeding systems(ES, ESS and IS) was evaluated on the effects of three levels of energy diets: High (HE) 2700.5 MEKcal/Kg, Low (LE) 2564 MEKcal/Kg and Maize Grain (MG); The HE and LE rations were specifically formulated for the study, and then fed on a two week change-over basis from week 12 to 17;The mean weekly weights were computed and analyzed through ANOVA using SAS (2011) software tool. The first experiment involved descriptive statistics through visual appraisal and observations. No significant ($p>0.05$) differences among feeding systems was found. Diet LE 2564 MEKcal/kg had significant ($p<0.05$) effect on the growth of Kuchi growers. While diets: HE and MG had no significance ($p>0.05$). Diet (LE), therefore, was different ($p>0.05$) from diets HE and MG, respectively. In the third experiment, 27.8%, 33.4% and 39%, for Solid-one, Mixed-two and Heterogeneity–several feather colours were observed respectively. Kuchi cock and hen had 67.8% and 65.9%, KO%, respectively. It is concluded that, Kuchi IC do not need an intensified feeding system. However, a grower's supplementation ration of about 2564.5MEKcal/Kg is required for the optimal growth of Kuchi chicken during week 12 to 17 of age. Kuchi IC ecotype exhibit large phenotypic variations in morphological traits with mature males being heavier by 1.9 % (KO %) than females of the same age. This diversity may be utilized as bases for selection towards desired breeding objectives of Kuchi and other indigenous chicken, not only in Kenya, but also other tropical countries.

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| | |
|---|---|
| ANOVA | Analysis of Variance |
| CADSAL | Community Agricultural Development in Semi-Arid Lands |
| CDW | Cold Dressed Weight |
| CRD | completely Randomized Design |
| DNA | Deoxyribonucleic Acid |
| EHC | Extensive with Half-day Confinement |
| ENC | Extensive with no confinement |
| FAO | Food and Agriculture Organization |
| GDP | Gross Domestic Product |
| GLM | Generalized Linear Model |
| GnR | Genetic Resources |
| GoK | Government of Kenya |
| HE | High Energy |
| IC | Indigenous Chicken |
| IFC | Intensive with full confinement |
| KARI | Kenya Agricultural Research Institute |
| KO% | Killing Out Percentage |
| LBW | Live Body Weight |
| LE | Low Energy |
| MDG | Millennium Development Goal |
| MG | Maize Grain |
| NAHRC | National Animal Husbandry Research Centre |
| NCD | New Castle Disease |
| SAS | Statistical Analysis System |
| SI | Semi-Intensive |
| UoE | University of Eldoret |

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# CHAPTER ONE

# INTRODUCTION

## 1.1 Background Information

Indigenous chicken(IC) (*Gallus domesticus*) is any flock of chicken whose progenitor is the Red jungle fowl (*Gallus gallus*), mostly kept under free-range management system with no selection for breeding or improvement (Ondwasy, 2006). They lay between 8-15 eggs per clutch depending on feed availability (Kingori *et al.*, 2010). Broodiness is a well expressed trait during the egg laying period and they hatch about 80% of the eggs they sit-on. About 20-30% of the hatched chicks do not attain maturity due to mortalities that are occasioned by predation, poor nutrition, diseases and parasites (Sonaiya and Swan, 2007).These birds, though under poor management, have been in households for many years, mainly contributing to socio-economic role besides being a valuable source of animal protein. Despite these roles, indigenous chicken has not attained their full production potential due to exposure to risks that militate against their survival and productivity. If managed well, this chicken can be profitable and may serve as good source of animal protein whose shortage has been a chronic challenge in developing countries (Pedersen, 2002; Nielsen *et al*., 2003). Their short generation interval makes them to have a high potential to off-set the low protein intake by man and be means of alleviating poverty. The situation is further aggravated by high poverty incidence among rural households. Since the majority of the people in developing countries live in rural areas where Indigenous chicken is predominantly kept, putting an emphasis on them would have an immediate positive impact on animal protein intake and income by most of the people in these countries, Kenya included. The low genetic potential for production traits and frequent outbreak of diseases particularly New Castle Disease (NCD) has been observed in a number of studies to be among the major factors limiting their productivity both under intensive and extensive management systems (Mwalusanya *et al.,* 2002; Alexander, 2001; Msoffe *et al.*, 2005). Crossbreeding programs with specialized meat or egg type chicken have been shown to improve productivity significantly (Ali *et al*., 2000; Segula-Correa *et al*., 2004). However, these programs have been threatened by the current global initiatives on conservation of indigenous genetic resources (GnR) which campaign against genetic dilution of indigenous GnR (Msoffe, 2003; Kosgey, 2004). This therefore, necessitate the utilization of an alternative breed for the genetic improvement of local chicken ecotypes, such as the Kuchi whose phenotypic attributes have shown that it can serve as a good starting genetic material for meat production under semi-intensive management conditions (Lwelamira *et al.,* 2008).

Kuchi Indigenous chicken ecotype, like other indigenous chicken, has its own distinct phenotypic characteristics. Kuchi is one of the many Indigenous chicken ecotypes in Kenya. It is a native chicken to the Coastal region particularly Faza Island of Lamu County and Mombasa (Chesoo *et al.*, 2014; Ngeno *et al.,* 2014).

Kuchi IC ecotype has proved to be a viable source of income to the farmers who rear it. For instance, farmers in Elgeyo Marakwet County (see appendix IV) consider these chicken a gateway out of poverty. This disease resistant chicken that weighs twice as much as conventional breeds is currently enjoying impressive uptake among poultry farmers in the county for economic empowerment. According to the residents, the chicken sells at Shs1500 and Shs2000 for the pullet and cockerel respectively when fully matured while eggs retail at Sh30 compared to Sh8 to Sh10 of other breeds (Wesonga, 2013). Owing to high demand, the prices of the chicken and eggs have shot up. Currently a pullet and cockerel are being sold at Ksh. 2000 and Ksh. 2500 respectively, while eggs are currently Ksh. 100 each.

## 1.2 Statement of the Problem

The performances of this ecotype in terms of growth potential under different feeding systems such as extensive, semi-intensive and intensive systems have not been adequately studied and documented. Furthermore, knowledge on morphological traits of the Kuchi which may be utilized towards desirable selection and breeding objectives are also lacking. Some of these traits include the feather colours, comb type, shank colour and meat yield at maturity.

The low genetic potential and the lack of better feeding systems of the local chicken ecotypes has constrained the productivity of Indigenous chicken. The free-ranging feeding system is a predominant practice in Kenya with Indigenous chicken ecotypes being the major strains kept. Among these ecotypes is the Kuchi which is a native of Lamu County mainly Faza Island (see appendix III), other coastal regions of Kenya and the drier north eastern parts of Tanzania (Chesoo *et al.,* 2014; Ngeno *et al.,* 2014; Lwelamira *et al*., 2008). Therefore, this study aimed at assessing the growth performance and morphological characteristics of Kuchi indigenous chicken under different feeding conditions and energy diets.

## 1.3 Justification

Consumers prefer meat and eggs from Indigenous chicken because of its characteristics which are leaner and appealing in pigmentation. In developing countries, there is a tremendous potential for increasing the production of indigenous chickens. This can be achieved by improving and providing appropriate infrastructure, disease control and good nutrition (Ndegwa *et al*., 1996).

Indigenous chicken serve as an immediate source of meat and income when money is needed for urgent family needs (Guèye, 2000). Indigenous chicken constitutes a major contribution to human livelihood and plays a significant role in food security (Gondwe, 2004). They are cheaply reared as scavenging flocks, fed with household left-overs and require a small house or shelter to spend their night (Dessie and Ogle, 2001).

Every egg or quantity of meat produced under the scavenging system for Indigenous chicken represents a net increase in food or income and other functions in rural households. An On-farm supplementation of local birds with protein and energy nutrients gives a significant improvement in egg production (Abdelqader *et al.,* 2007). It is, therefore, imperative to study and investigate the growth potentials of the various ecotypes under different feeding systems such as semi-intensive, extensive and intensive production systems. According to the findings of a study done in Ethiopia, improving the feeding system of Indigenous chicken ecotypes could bring measurable changes in their growth performance (Tadelle *et al.,* 2003).

In the African tropics, there are many local chicken ecotypes that are well adapted to their production environments. Although Kuchi ecotype is an example, which has shown a high genetic potential in terms of growth performance and meat yield if properly managed (Lwelamira *et al*., 2008) few studies have been carried out on this indigenous chicken.

Furthermore, due to paucity of information on the optimal management practice, a study to investigate the growth and morphological characteristics for the Kuchi Indigenous chicken ecotype of Kenya under three feeding systems namely: Extensive(ES), Semi-Intensive(SI) and Intensive(IS) were carried out.

### 1.4 Broad Objective

The objective of the study was to assess the morphological characteristics and growth performance of Kuchi Indigenous chicken ecotype managed under three different feeding systems and energy diets.

#### 1.4.1 Specific Objectives

i. To assess the feather colours, comb type, shank colours and the Killing Out percentage (KO %), of Kuchi Indigenous chicken ecotype at 30 weeks of age,
ii. To evaluate the growth of Kuchi Indigenous chicken ecotype under three feeding systems.
iii. To evaluate the growth of Kuchi Indigenous chicken ecotype fed with three levels of energy diets under three different feeding systems.

### 1.5 Research Hypotheses

i. There are no significant differences in feather colour, comb type, shank colours and the Killing Out percentage (KO %) of Kuchi Indigenous chicken ecotype at 30 weeks of age,
ii. There is no significant difference in the growth of Kuchi Indigenous chicken ecotype under three feeding systems.

iii. There is no significant difference in growth of Kuchi Indigenous chicken ecotype fed with three levels of energy diets under three different feeding systems.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Origin of Domesticated Chicken

The origin of domestic chicken is highly debated within the archeologists' and the geneticists' communities (Gifford-Gonzalez and Hanotte, 2011). However, most scholars have agreed that the Red Jungle Fowl (*Gallus gallus)* is the main progenitor of the present day domestic species (Liu *et al.*, 2006). Although some evidence exist on inter-species hybridization within the genus (Nishibori *et al*., 2005). Within the *G.gallus*, several subspecies namely:*G.g. murghi*, *G.g .spadiceus*, *G.gjabaullei*, *G.g. gallus* and *G.gbankiva,* could have contributed to the present day domestic stock. Mitochondrial DNA information obtained by researchers in the 1990's showed that one continental population of Red Jungle fowl, the G.*gallus gallus*, probably from Thailand, is a likely the maternal origin of all domestic chicken (Akishinonomiya *et al*., 1996). The mitochondrial DNA of the Chinese native chicken was examined and showed evidence that the likely origin is Thailand and its adjacent geographical regions (Niu, *et al*., 2002). Recent genetic analyses revealed at least the gene for yellow skin was incorporated into the domestic chicken through hybridization with the Grey Jungle fowl, G. *Sonneratti* (Eriksson *et al*., 2008).

### 2.1.1 Domestication and Dispersal of Chicken

The chicken is one of the earliest domesticated animals kept by man (Hurst, 2008). Humans first domesticated chicken of Indian origin for the purpose of cock fighting in Asia, Africa and Europe (Smith & Daniel, 2000). Very little formal attention was given to egg and meat production. Domesticated chicken appeared at Mohenjo Daro in Indus valley by about 2000 BC, from where they spread into Europe and Africa. The earliest firm evidence for chicken in Africa, are illustrations from several sites in the new Kingdom Egypt. Chicken arrived in Western Africa at Iron Age to sites such as Jennejeno in Mali, Kirikongo in Burkina Faso and Dabouna in Ghana by the mid of first Millennium AD (Mwacharo *et al.*, 2013). Scanty information exists regarding the real period of arrival of chicken into Africa. According to Smith (2000), chicken were already in Africa at the time of the first contact with Europeans. A paucity of data exists from Sub-Saharan Africa makes it difficult to lay out a clear map of the spread of chicken in all African areas including East Africa and Kenya in particular. Every region in Africa has its own indigenous chicken which is native (ecotypes) to their respective areas hence the use of the term ecotype as reference to each chicken strain found in any given ecological area.

### 2.1.2 Global Chicken Farming

After the domestication and spread of chicken to all the continents through trade and human migration, it is currently the most widely farmed animal in the world. The rearing of Indigenous chicken in the world is not hindered by climate, tradition, living standard or belief especially as to the consumption of eggs and meat when compared to products from other farm animals like pigs (Malago and Baitilwake, 2009; Tadelle,2003). Furthermore, chicken is widely acknowledged as the livestock of the poor, hence part of the most small-holder farming systems (Guèye, 2000; Kryger *et al.*, 2010). It is reported that 65-80% of the total population in Sub-Sahara Africa keeps Indigenous chicken (Ndegwa *et al.*, 1998). Similarly, about 80% of the populations in Kenya, live in the rural areas eking out a living from subsistence farming mainly of Indigenous chicken, often under harsh climatic and economic conditions (Ndegwa *et al*., 1998; Guèye, 2000).

### 2.1.3 Economic Importance of Indigenous Chicken Farming in Kenya

The current population of poultry in Kenya is estimated to be 32 million. Among this, 6 million is represented by commercial hybrids, while the rest are Indigenous Chicken (Kibet, 2013).This Indigenous chicken therefore, account for approximately 81% of the total poultry population in Kenya.

Over the years, poultry industry in Kenya has grown rapidly owing to the demand for meat and eggs particularly in the urban areas due to the middle class households whose proportion has increased rapidly. The rising health consciousness amongst consumers has also led to an expanded poultry production system in the urban and a peri-urban area of Kenya (GavickPro, 2011). Chicken is therefore an important component of households, as a source of nutrition, income and insurance against emergencies. They also have a potential for commercialization and poverty reduction (GoK, 2005, 2008). Poultry industry contributes 1.6% of the agricultural GDP which is about 25% of the total National GDP (GoK, 2008).

The poultry sub-sector is also linked to other sectors of the Kenyan economy including the feed production industries, hotel industries and input suppliers. About 70% of feeds produced in the country are poultry feeds. There is a great potential for the growth of this industry given the growing demand for value added products that can satisfy the local and export market (GavickPro, 2011).

This sub-sector, particularly the Indigenous chicken has the potential to generate high incomes to transform the living standards of its players (Chesoo, *et al.*, 2013). It is among the leading livestock enterprises that may contribute the most towards the attainment of the Millennium Development Goal (MDGs) (Dunford, 2006). It is therefore an industry that is poised to play a strategic role in the ongoing socio-economic development under the vision 2030 (GavickPro, 2011).

## 2.2 Distribution and types of Indigenous Chicken in Kenya

Any flock of chicken that are kept under scavenging/free range management system without improvement through selection for cross-breeding is referred to as indigenous chicken (Ondwasy *et al.*,2006). Kenya has a rich genetic diversity of Indigenous chicken comprising of several ecotypes that are named according to their native regions such as, the West Pokot, Narok, Kakamega and Bondo ecotypes with various phenotypic and genotypic characteristics(Ngeno, 2011). The names used to describe the common Indigenous chicken ecotypes are, among others, frizzled feathers, naked-neck, barred-feathered, feathered-shanks, bearded, dwarf size (Nyaga, 2007; Ngeno, 2011). Plumage colours vary widely with black, brown or red dominating (Halima *et al.*, 2007).Rare colour patterns are light orange, yellow, grey and white laced and mottled (Kingori *et al.*, 2010). Variations also exist in comb type, length and colour of wattles, ear lobes and beaks (Kingori *et al.*, 2010). An Indigenous chicken whose phenotypic and genotypic characteristics are having a paucity of data is the Kuchi ecotype (Chesoo *et al.*, 2014; Ngeno *et al.*, 2014; Lwelamira *et al.*, 2008).

Indigenous Chicken is predominantly distributed in all agro-ecological zones except in very arid northern areas of Kenya such as ecological zone seven. Each agro-ecological zone has its own unique birds (Indigenous chicken) termed ecotypes, which is a product of mutation, migration, genetic drift, adaptation, evolution and selection imposed by climate, parasites, disease and nutrition (Ngeno, 2011).

### 2.2.1 Production Systems of Indigenous Chicken in Kenya

Broadly, Indigenous chicken production may be classified into subsistence and commercial levels based on the scale of operation, the way in which outputs are used and the level of management interventions of the flock (Ngeno, 2011). This Indigenous chicken is managed under subsistence system where they have shown not only remarkable ability to perform, albeit poorly, under constant diseases and parasite challenges, but also to sustain their populations through natural selection (Kitalyi, 1998). Based on the levels of inputs and various outputs, three production systems therefore exist namely: Traditional/Free-range/Scavenge/Extensive, Semi-Intensive and Intensive /confined full ration system.

#### 2.2.1.1 Free-range system

Most literature refers to this system as extensive or scavenging production system. In most developing countries in Africa, approximately 80% of the poultry population is found in this system with 95% of them being Indigenous chicken (Ngeno, 2011; Tadelle *et al.*, 2003; Gueye, 1998). Scavenging system is an integral part of the farming systems requiring low-inputs with periodic challenges like disease, inadequate feeds (both in quality and quantity), poor housing and health care (Ochieng *et al.*, 2012; Gueye, 1998; Kitalyi, 1998). The flock size in this system varies from 1-10 birds per rural household with both the chicks and mature chicken being left to scavenge within the homestead without feed supplementation (Kitalyi, 1998).

#### 2.2.1.2 Semi- Intensive

Farmers adopting this Semi -Scavenging system keep about 5-10 birds, which are semi-confined within an enclosure in line with prevailing arable farming situations (Ngeno, 2011). These confined chickens interfere with neighbors' crops and are therefore provided with crop by products grains and kitchen wastes to supplement their daily feed requirements without regular vaccination against common poultry diseases.

#### 2.2.1.3 Intensive System

In this system, the flock is confined all the time and supplied with a balanced diet either commercial feeds or home- made ration feeds. The size of the flock varies between 50 and 200 birds and their level of production ranges between 80 and 160 eggs per year and the growth rate is above 20g per day (Guèye, 2000). This system is adopted by medium to large scale commercial enterprises and also at household level. The capital outlay is high as the birds are totally dependent on their owners for all their requirements (Miller *et al.,* 2011).

## 2.3 Kuchi Indigenous Chicken

Kuchi Indigenous chicken ecotype, like other indigenous chicken, has its own distinct phenotypic characteristics. Kuchi is one of the many Indigenous chicken ecotypes in Kenya. It is a native chicken to the Coastal region particularly Faza Island of Lamu County and Mombasa (Chesoo *et al.,* 2014; Ngeno *et al.,* 2014). This Indigenous chicken ecotype is also found in the drier parts of north eastern areas of Tanzania, (Lwelamira *et al.,* 2008).

In 2010 the Ministry of Livestock Development in Collaboration with the Community Agricultural Development in Semi-Arid Lands (CADSAL), sourced the Kuchi ecotype from Lamu Faza Island into Kerio-valley of Elgeyo-Marakwet County, for cross-breeding purposes (Chesoo *et al*., 2013). Other institutions like the Kenya Agricultural Research Institute (KARI), Naivasha and Egerton University, currently breed Kuchi Indigenous chicken ecotype for both research and academic purposes respectively (Magoth*e et al*., 2010). In 2012, the University of Eldoret, Animal Science department in the School of Agriculture and Biotechnology, embarked on a pure breed multiplication Project for Kuchi ecotype leading towards its characterization (Chesoo *et al*., 2014).

### 2.3.1 Characteristics of the Kuchi Indigenous Chicken Ecotype

Chesoo *et al.* (2014), reported two types of Kuchi namely, the ornamental and the non-ornamental. The former is a tall light bird with a parrot- like beak, and the latter is a long legged, heavy with a parrot-like beak. The Kuchi has a big, Cobra-like head with a rounded comb, white eyes, long neck, wide girth, long and strong legs, tall in height and is good in scavenging. It makes a shortened crow and is aggressive in attacking predators (Ngeno *et al.,* 2010; Chesoo *et al.,* 2014). The Kuchi's long legs allow it to meander through thickets while scavenging with agility (Magothe *et al*., 2010).

Kuchi has a cushion–like comb and wattles are non-existent. The eyes of the young are yellowish, but become pearly pale (milkfish) with age. The tail is full and lobster–like. The feather colours are variable (heterogeneity) white/ brown/ black and grey. It is tame in behaviour but can be aggressive in the presence of other chicken and therefore new birds should be removed and kept separate from others until they are acquainted with each other (Chesoo *et al.*, 2014).

The Kuchi Indigenous chicken ecotype is better in scavenging than being fed under confinement. It is tolerant to some common poultry diseases like Salmonella infection but not safe from New castle disease (NCD) (Lwelamira *et al*., 2008). Mature weight ranges from 6 – 9 kg and 3 – 6kg, for males and females respectively (Figure 2.1) (Ngeno *et al.*, 2014). The egg production per clutch ranges from 12 – 13, but can be as low as 8 under scavenging system (Magothe *et al.*, 2010). However, under an On- Station management, egg production of a mature Kuchi can reach 40 eggs per clutch with an average weight of 50g (Figure 2.2) (Chesoo *et al.*, 2014).

**Figure 2.1: Male (left) and Female (right) Kuchi respectively (Source: Author, 2015)**

**Figure 2.2: Kuchi eggs (50g mean weight; N=20) (Source: Author, 2015)**

Halima *et al*. (2007) reported on Indigenous chicken of Ethiopia and indicated that there are great variations in plumage colours, which have been acquired perhaps due to geographical isolation or periods of natural or artificial selections. Head shape, shank colours and comb types also had some variations (Mcainsh *et al*., 2004; Bhuiyan *et al*., 2005). Others like V- shaped and Duplex comb types have been reported (Bhuiyan *et al*., 2005; Mengesha, 2012).It is therefore expected that the Kuchi will exhibit variations for both qualitative and quantitative traits when managed under different production systems and diets (Halima *et al*., 2007). This will result to adequate utilization of these genetic resources(IC) in a sustainable way (Lwelamira, 2008; Halima *et al*., 2007; Msoffe, 2003).The difference or similarities that may arise might be due to environmental or genetic in nature (Msoffe *et al.*, 2005).

### 2.3.2 Growth of Kuchi Chicken Ecotype

Kuchi Indigenous chicken is a viable bird and performs better under dry environmental conditions. Naturally, Kuchi is a game bird and prefers a free range and bushy environment which is facilitated by having long legs for meandering through the thickets especially while defending itself from any impending predation (Magothe *et al*., 2010).

Managed under both intensive and extensive systems, Kuchi is superior to medium ecotype of Tanzania in terms of body weight and converse was true for most of egg production and related traits, and further, its performance can better be enhanced by improving both management system and their genetic potential through ecotype selection .The Kuchi ecotype therefore, could be a good starting genetic material for further improvement in body weight traits (Lwelamira *et al*., 2008).

### 2.3.3 Nutritional Requirement of Kuchi Indigenous Chicken Ecotype

Indigenous chicken are able to survive, grow and lay eggs in harsh conditions, due to their adaptation and their capacity for foraging make a significant contribution towards food security in terms of protein intake for human populations. Normally the low productivity of these genotypes mean that it is generally not cost effective to rear them under intensive management systems considering the fact that poultry diets are expensive, particularly if all the materials required are imported(FAO, 1998).

Chicken nutrition and feeding is therefore an important part of production often accounting for 70% of the total production cost. Essential nutrients needed are energy, protein, mineral and vitamins which must be available in the feed in well balanced amounts. Indigenous chicken are able to obtain some of their nutrients from insects, worms and plants when on pasture, thus reducing costs. Chemjor (1998) recommended some energy and protein rations for indigenous chicken to be 2400ME Kcal/kg and 2600MEKcal/kg for Light and Medium ecotypes respectively. The performance of

Indigenous chicken improves under commercial confinement rearing and feeding conditions, but generally not to a point that makes the production economically viable, mainly owing to the cost of compounded feeds (Pym *et al.,* 2006). In order to increase the production of scavenging Indigenous chicken, specific feed supplementation diet of low energy of 2378MEKcal/kg is required besides scavenge feed resource (Okitoi *et al*., 2009).

## 2.4 Limitations of Kuchi Productivity

A number of constraints limit the productivity of Kuchi Indigenous chicken as in other local ecotypes. The extensive production system under which poor nutritional conditions prevail has resulted to the low output (Bwalya and Kalinda, 2014). Feed supplementation therefore, has the potential to mitigate this nutrition problem (Ogle, 2004). Indigenous chicken's feed and need to have an energy supplementation rich in both quality and quantity, preferably formulated to meet their nutritional requirements (Mapiye, *et al*., 2008),

The long believed notion that indigenous chicken ecotypes are poor producers may not hold enough scientific bases. The poor performance of Indigenous chicken is not due to genetic potential but lack of good management (Tadelle *et al*., 2000). Findings from National Animal Husbandry and Research Centre-Naivasha indicate that, at the traditional farm level, an average egg production is about 40 eggs per year (Ndegwa *et al*., 1998). Similarly, the MoLD (1994) gives a range of 40-60 eggs. Kuchi Indigenous chicken ecotype is reported to lay 40 eggs per clutch with three clutches per year under On-Station management at the University of Eldoret (Chesoo *et al.,* 2014).This therefore mean that the Kuchi, in three clutches, has the potential of laying up to 120 eggs annually.

Under clean and well equipped environment, this number can be raised to 150 eggs per year (Ndegwa *et al.*, 1998).Environmental factors are therefore the major constraint that militates against the production of Indigenous chicken, particularly the Kuchi ecotype.

# CHAPTER THREE

# MATERIALS AND METHODS

## 3.1 Research Site

The study was carried out at the Animal Science Department farm of the University of Eldoret (UoE) Uasin Gishu County, Kenya (see appendix III). The farm is situated at latitude $0^o$ 31"N, longitude $35^o$ 17" E, with an elevation of 2154M above sea level (Kareri, 2010). An average unimodal rainfall pattern of 1000 mm to 1520 mm per annum has been recorded over the last ten years. The rains span from February to August and the temperatures of the site ranged from 23.6$^o$C day to 9.6$^o$C night (Owen *et al.*, 2008).

## 3.2 Kuchi Chicken

The experimental birds were derived from 209 one to five day old fertile randomly bought Kuchi eggs that were sourced from three sites, two in Kerio Valley (Sambalat and Muskut) of Elgeyo Marakwet County and eggs collected from pure Kuchi flock kept for the current study at the UoE farm.

The eggs were hatched using an artificial commercial incubator at Iten Youth Polytechnic. Required hatchery sanitation processes were followed with strict adherence to the incubator manual. Then the hatched chicks had their day old weights taken and put into a brooder for three weeks before transferring them to the study site at the UoE. Following disease control requirements, the chicks were vaccinated against Gumboro, Marek's, New castle, Fowl pox and Fowl typhoid diseases. A commercial chick and Grower's mash were fed *ad libitum* to the chicks from day old to 8 weeks of age.

## 3.3 Experiment One

### 3.3.1 Morphological Characteristics

At 18 week of age, 18Kuchi Indigenous chicken were allowed to scavenge throughout the day; that is from 0700 in the morning to 1800 hours in the evening within a scavenging area of 100m$^2$under a cafeteria feeding system (Chemjor, 1998). The amount of supplementation that was given daily to Kuchi chicken up to 30 weeks of age was 1000g of commercial layers mash. A weekly wheelbarrow load of sheep and goat manure was spread within the scavenging area to allow the chicken exploit their innate characteristics of always scratching the ground searching for insects as always observed among indigenous chicken in rural households. Water was provided *ad libitum.* The housing dimension was of 12m$^2$floor pens. This feeding system was done for a period of 12 weeks. When the chicken\ were 30 weeks of age, the morphological characteristic of Kuchi were studied. The traits that were studied included: feather colours, comb type, shank colours and the Killing out percentage (KO %).

### 3.3.2 Feather Colours

The phenotypic characteristics of Kuchi Indigenous chicken ecotype were observed and recorded using visual appraisal of the appearance following the Standard Chicken descriptors (Halima *et al.*, 2007). Three types of feather colours were categorized into: Solid-one (exclusively Solid- One white or black), Mixed-two (a mixture of both white and black feather colours), and several-heterogeneity (a combination of multi-colour) including the recessive frizzled type.

### 3.3.3 Comb Types

This trait in Kuchi Indigenous chicken ecotype were observed and categorized into Pea, Rose and Single comb types (Jadhav and Siddiqui, 1999).

### 3.3.4 Shank Colours

The shank colours were observed using the Standard Chicken descriptors (Halima *et al.,* 2007).The shank colours were categorized into two: yellow and white.

### 3.3.5 Killing out Percentage (KO %) of male (3) and female (3) Kuchi

At week 30 of age, 6 out 18 Kuchi chicken were randomly selected for slaughter and used for the Killing Out Percentage (KO %) assessment between mature cock and hen. The average weights for the cocks and hens were recorded after 12 hours after an over-night deprivation of feed (Tougan *et al.,* 2013).The Live body weights (Lbwt) were recorded and means computed. The Killing Out% for Kuchi Indigenous chicken was calculated by the following equation:

$$KO\% = Lbwt\ (g) - \frac{(Legs+head+neck+feathers+blood+liver+gizzard+heart+others)}{Lbwt\ (g)} \} \times 100$$

#### 3.3.5.1 Slaughtering Process

The six 30 week old Kuchi chicken were manually de-feathered when still alive then their mean de-feathered weights taken to arrive at the mean weights of the feathers for both sexes. Then their jugular veins were cut and bled, and blood volumes taken. Evisceration was done and mean weights for the heart, kidney, crop, gizzard, visceral and offal organs taken. The legs were then sectioned at tibiotarsus-metatarsal articulation as recommended by Tougan *et al*. (2013).The mean weights for feathers, legs, wing breast meat, thigh, back, neck, heart, liver, gizzard and shank were computed for KO% assessment for each sex in relation to their Live Body Weight (Lbwt).

**3.3.5.2 Data Source**

Means for live body weights, de-feathered live weights and all other body parts (head, neck, breast muscle, heart, liver, gizzard, kidneys, legs and others) were taken and computed

**3.3.5.3 Data Analysis**

The feather colours, comb type and shank colour were qualitative characteristics. The data generated through field observation were analyzed using descriptive statistics and compared as percentage using Excel Software tool.

The data generated on the live body weights and carcass were analyzed using Excel 2007 Software package for mean assessment and summarized into percentage in relation to live body weights .The KO% for Kuchi male and Female at 30 weeks of age were assessed.

**3.4 Experiment Two**

**3.4.1 Evaluation of Growth Performance for Kuchi Growers Managed under Three Different Feeding Systems (ENC, EHC and IFC).**

At 9 weeks of age, 18 Kuchi growers were randomly picked and allocated to three feeding systems (treatments) of management: Extensive with no confinement (ENC),Extensive with half-day confinement (EHC) and Intensive with full confinement (IFC). Six growers were allocated to each treatment. All the growers were weighted at the start of the experiment and their baseline mean weights computed. Mean weekly weight gains were also recorded and computed for the 3weeks (week 9 to week11). A commercial grower's mash was fed *ad libitum* to the growers in IFC. A supplement of 60g growers mash was provided to those in EHC in the morning (7am to 12pm) and then allowed to roam and scavenge from 1p.m – 6p.m) in the evening. Those growers in the ENC system were not fed nor given any feed supplement but allowed to scavenge from morning to evening (7a.m to 6p.m). Manure was supplied weekly to EHC and ENC systems for the experimental Kuchi growers to exercise their inherent behaviour of scratching the ground while scavenging as always observed with Indigenous chicken in most rural households. Water was provided ad *libitum* to the three systems and habitat.

The housing in the three systems was of floor pens of $12m^2$ as recommended by Smith (1990), with saw dust deep- litter. Scavenging areas of $49m^2$ and $30m^2$ was provided for ENC and EHC groups respectively. Those in IFC were intensively maintained in $12m^2$ deep litter area with *ad litum* feeding of growers mash. Table 3.1 shows the layout procedure for the three feeding systems of management.

**Table 3.1: Layout Procedure for the Feeding Systems during Three weeks Period**

| Weeks (Replications) | Treatments(management system) | Number of growers | Pen space($m^2$) | Scavenging area($m^2$) |
|---|---|---|---|---|
| 1 | ENC | 6 | 12 | 49 |
| 2 | EHC | 6 | 12 | 30 |
| 3 | IFC | 6 | 12 | Nil |

### 3.4.2 Experimental Design

A completely Randomized Design (CRD) was used in this experiment, with three treatments/systems, replicated three times (period in weeks) each 6 birds (Kuchi growers).

### 3.4.3 Experimental Model

The general linear model used during the execution of this experiment was:

$$\boldsymbol{Y_{ijk} = \mu + T_i + e_{ijk}}$$

Where;

$\mathbf{Y}_{ijk}$= Observation of the k$^{th}$ the Kuchi grower of the j$^{th}$ treatment

$\boldsymbol{\mu}$ = Overall population mean,

$\boldsymbol{T_i}$ = Effect due to the i$^{th}$ treatment (deviation of each treatment mean from overall mean: $(\mu_1 - \mu)$.

$E_{ijk}$= Random error term associated with $Y_{ijk}$.

### 3.4.4 Data Source and Analysis

The Kuchi growers were weighed weekly and means recorded for the period under which the experiment was conducted. Mean of weekly weights per treatment were subjected to t-test and ANOVA, Proc. GLM of SAS version 2011, Software tool using 95% confidence level.

## 3.5 Experiment Three

### 3.5.1 Evaluation of Growth Performance of Kuchi Growers Fed with Three Levels of Energy Diets (HE, LE and MG) under Three Feeding Systems (ENC, EHC and IFC)

#### 3.5.1.1 Experimental Kuchi Chicken and Diets

At 12 weeks of age, the same Kuchi growers used in experiment two were subjected to a feeding regime of three levels of energy diets under three feeding systems: High energy, (HE) Low energy (LE) and ordinary maize grain (MG) for a period of two weeks / system /diet. The energy levels in the three diets were 2700.5MEKcal/Kg, 2554ME Kcal

/Kg and Maize Grain (MG) respectively. Maize Grain (MG) was assumed to have an Apparent Metabolizable Energy (AMEn) of 2692±339 (Chemjor,1998).The HE and LE rations were specifically formulated (Table 3.2 and 3.3) for the experiment and were fed to the growers from week 12 to week 17.

**Table 3.2: Ration for HE Energy Diet (2700.5 ME kcal/kg)**

| Ingredient | Qty(kg) | MEKcal/kg | %CP | %Lysine | % Methionine | %C F | $\%Ca^{++}$ |
|---|---|---|---|---|---|---|---|
| Maize Grain | 30 | 1005 | 2.55 | 0.0075 | 0.06 | 0.6 | 0.06 |
| Maize Germ | 20 | 450 | 4.2 | 0.19 | 0.076 | 2.1 | 0.012 |
| Wheat pollard | 20 | 460 | 2.6 | 0.1 | 0.04 | 1.5 | 0.01 |
| Sun flower | 5 | 75 | 1.5 | 0.05 | 0.035 | 0.13 | 0.045 |
| Cotton cake | 11 | 203.5 | 4.51 | 0.05 | 0.066 | 1.43 | 0.0165 |
| Fish meal | 5 | 155 | 2.75 | 0.209 | 0.275 | 1.3 | 0.3 |
| Vegetable oil | 4 | 352 | - | 0.275 | - | - | - |
| Iodized salt | 0.3g | - | - | - | - | - | - |
| Limestone | 0.3g | - | - | - | - | - | 0.114 |
| Sand | 0.2g | - | - | - | - | - | - |
| Grower Premix | 3 | - | - | - | - | - | - |
| **Total** | **98.8** | **2700.5** | **18.11** | **0.899** | **0.55** | **7.06** | **0.5033** |

The initial weights were recorded and means computed. The weekly mean weights were taken for each system of management (treatment) on a change-over period (replicates) of 2 weeks under each ration. The experiment was carried for a period of 6 weeks ending at week 17 of the Kuchi growers. The layout procedure as in Table 3.1 was maintained.

**Table 3.3: Ration for LE Energy Diet (2564 ME Kcal/kg)**

| Ingredient | Qty(kg) | MEKcal/kg | %CP | %LYS | %Meth | %CF | $\%Ca^{++}$ |
|---|---|---|---|---|---|---|---|
| Maize Grain | 28 | 938 | 2.38 | 0.07 | 0.56 | 0.56 | 0.0056 |
| Maize Germ | 20 | 450 | 4.2 | 0.19 | 0.074 | 2.1 | 0.012 |
| Wheat pollard | 20 | 460 | 2.6 | 0.1 | 0.04 | 1.5 | 0.01 |
| Sun flower | 5 | 75 | 1.5 | 0.02 | 0.014 | 0.052 | 0.018 |
| Cotton cake | 12 | 222 | 4.92 | 0.228 | 0.072 | 1.56 | 0.018 |
| Fish meal | 5 | 155 | 2.75 | 0.275 | 0.08 | 1.3 | 0.3 |
| Vegetable oil | 4 | 264 | - | - | - | - | - |
| Iodized salt | 0.3 | - | - | - | - | - | - |
| Limestone | 0.3 | - | - | - | - | - | 0.114 |
| Sand | 0.2 | - | - | - | - | - | - |
| Grower mix | 3 | - | - | - | - | - | - |
| **Total** | **97.8** | **2564** | **18.35** | **0.883** | **0.336** | **7.012** | **0.4776** |

**Table 3.4: Layout procedure for experimental diets: HE, LE and MG under ENC, EHC and IFC**

| | **System** | | |
|---|---|---|---|
| **Period** | ENC | ENC | EHC |
| Week 12-13 | MG | HE | LE |
| Week 14-15 | LE | MG | HE |
| Week 16-17 | HE | LE | MG |

### 3.5.1.2 Experimental Design

This experiment was executed in a Randomized complete Block Design (RCBD), with 3 treatments/Diets (HE, LE, MG), 2 replications (period in weeks) per treatment with 6 animals per replicate. The feeding systems: Extensive with no confinement (ENC), Extensive with half-day confinement (EHC) and Intensive with full confinement (IFC) served as the blocks. While the diets; High energy (2700.5MEKcal/Kg), Low energy (2564MEKcal/Kg) and milled Maize grain (MG), were taken as the treatments.

#### 3.5.1.3 Experimental Model

The general linear model used was:

$$Y_{ijk} = \mu + T_i + B_{ij} + e_{ijk}$$

*Where;*

**$Y_{ijk}$ =** Observation on the k$^{th}$ Indigenous chicken grower of the i$^{th}$ treatment of the j$^{th}$ block.

$\mu$ = Overall population mean

$T_i$ = Effect due to i$^{th}$ treatment (Deviation of each treatment mean from the overall mean $(\mu_1 - \mu)$

$B_{ij}$= Effect due to J$^{th}$ block (Deviation of each Block mean from the overall mean $(\mu_1 - \mu)$

$e_{ijk}$= Random error term associated with $Y_{ijk}$.

#### 3.5.1.4 Data Source and Analysis

The weekly mean weights for the Kuchi growers were generated from the different diets (HE, LE and MG) and management systems (ENC, EHC and IFC) during the study period**.**

All weekly mean weights per diet/system were analyzed for significant difference through ANOVA, using SAS 2011, software tool; Proc. GLM. Duncan's Multiple Range grouping, t-test and LSD were used to separate treatment means; at ALPHA 0.05.

# CHAPTER FOUR

# RESULTS

## 4.1 Egg and Chick Parameters

During the collection and hatching period, the egg and chick growth parameters were recorded as in Table 4.1.

**Table 4.1: Egg and Chick parameters**

| Parameters | Egg (N=209) | Day Old Chicks; N=22 |
|---|---|---|
| Weight (g) | 45.091±4.704 | 29.03±2.43 |
| Hatching (%) | 10.53 | |
| Survival (%) day1-8 weeks | | 81.82 |
| Mortalities (%) | | 4 |

## 4.2 Morphological Characteristics of Kuchi Indigenous Chicken Adults

### 4.2.1 Feather Colours

At week 30 of age, three categories of phenotypic characteristics on feather colours were observed (Table 4.2). A Large variation of feather colours were exhibited which were grouped into three categories: (A) Solid (one) colour(B) Mixed (two) colours and (C) Heterogeneity (several) colours were: 27.8%, 33.4% and 27.8% respectively. Solid one colour (white) was predominantly seen in hens which was twice as those of cocks. Similarly, Solid (brown) colour was also a hen colour and was not observed in cocks. Mixed (two) colours were predominantly hens, while Heterogeneity for both several colours and Frizzled feathers (11.2%) were predominantly exhibited in cocks.

**Table 4.2: Categories of Feather Colours**

| CATEGORY | | % | Sex | | Total |
|---|---|---|---|---|---|
| (A) Solid (one) colour: | | | F | M | |
| • White | | 16.5 | 2 | 1 | 3 |
| • Brown | | 11.1 | 2 | - | 2 |
| | **Total** | **27.8** | 4 | 1 | 5 |
| (B) Mixed (two) colours: | | | | | |
| • Brown/Grey | | 11.1 | 2 | - | 2 |
| • Brown/Black | | 16.7 | 3 | - | 3 |
| • White/Black | | 5.6 | 1 | - | 1 |
| | **Total** | **33.4** | 6 | 0 | 6 |
| (C) Heterogeneity (several) colours: | | | | | |
| i. Silky/grey/black/white/brown | | 11.1 | - | 2 | 2 |
| ii. Grey/brown/black | | 11.1 | - | 2 | 2 |
| iii. White/black/grey/brown | | 5.6 | - | 1 | 1 |
| | | **27.8** | 0 | 5 | 5 |
| iv. Frizzled: white/grey/brown/black | | 5.6 | - | 1 | 1 |
| v. Frizzled: white/grey/black | | 5.6 | - | 1 | 1 |
| | Total | **11.2** | 0 | 2 | 2 |
| | Total | **100.2** | 10 | 8 | **18** |

The feather colour frequencies for: one-colour: brown; two-colours: brown/grey, brown/black, or white/black and several colour Combinations of both Frizzled feather colours: white/grey/brown/black and white/grey/black, all constituted 44.4 %, each constituting about 11.1%. While one colour white and two colour brown/black feather had nearly similar frequencies of 16.5 and 16.7%, respectively.

**Figure 4.1: Solid-one colour feathers (Source: Author, 2015)**

**Figure 4.2: Mixed - two colour feathers (Source: Author, 2015)**

**Figure 4.3: Mixed Colour Feathers (several/heterogeneity) (Source: Author, 2015)**

**Figure 4.4: Heterogeneity-Frizzle feathers (Source: Author, 2015)**

### 4.2.2 Comb Types

The comb types of adult Kuchi were categorized into three phenotypic characteristics (Table4.3). Pea type (55.6%) was more than twice as those of Single (22.2%) and Rose (22.2%) types. The latter was predominantly observed in hens while Pea and Single types exhibited in males with a male/female ratio of 4:1 and 1:1, respectively. Rose type was exclusively a female comb.

**Table 4.3: Categories of Comb Type**

| **Comb Type: Category** | **%** | **Male** | **Female** | **Total** |
|---|---|---|---|---|
| (i) Pea | 55.6 | 8 | 2 | 10 |
| (ii) Single | 22.2 | 2 | 2 | 4 |
| (iii) Rose | 22.2 | - | 4 | 4 |
| Total | 100.0 | 10 | 8 | 18 |

**Figure 4.5: Pea Comb Type (Source: Author, 2015)**

**Figure 4.6: Rose comb Type (Source: Author, 2015)**

**Figure 4.7: Single Comb type (Source: Author, 2015)**

### 4.2.3 Shank Colour

In the Table 4.4, the shank observed among the Kuchi chicken appeared in two main colours. Yellow constituted 77.8% and white formed 22.2%. The yellow colour was observed mainly in males than female at the ration of 4:3 but white was predominantly female colour with a ratio of 0:4.

**Table 4.4: Categories of Shank Colour**

| Shank Colour: Category | % | Sex | | Total |
|---|---|---|---|---|
| | | Male | Female | |
| Yellow | 77.8 | 8 | 6 | 14 |
| White | 22.2 | - | 4 | 4 |
| Total | 100.0 | 8 | 10 | 18 |

**Figure 4.8: White Shank Colour (Source: Author, 2015)**

**Figure 4.9: Yellow Shank Colour (Source: Author, 2015)**

### 4.2.4 Killing-out Percentage of Kuchi Cock and Hen

The meat yield expressed in Killing Out percentage (KO %) for both Kuchi male and female were as in Tables 4.5 and 4.6

**Table 4.5: Morphological characteristics of Kuchi chicken at 30weeks**

| Parameter | Sex(M/F) | Range(g/cm) | | Mean± | SD |
|---|---|---|---|---|---|
| | | Minimum | Maximum | | |
| Lbwt(g) | M | 2047 | 2465 | 2243 | ±210.3 |
| | F | 1487 | 1913 | 683 | ±214.2 |
| Bwt(de-feathered)(g) | M | 1941 | 2340 | 2144 | 199.6 |
| | F | 1414 | 1799 | 1600 | ±192.8 |
| Feathers(g) | M | 100 | 125 | 115.7 | ±9.5 |
| | F | 60 | 114 | 83 | ±27.9 |
| Legs(g) | M | 84 | 116 | 105.3 | ±18.5 |
| | F | 47 | 61 | 52.7 | ±7.4 |
| Neck(g) | M | 95 | 117 | 104 | ±11.5 |
| | F | 39 | 53 | 47.3 | ±7.4 |
| Blood(ml) | M | 80 | 120 | 100 | ±20 |
| | F | 50 | 100 | 66 | ±28.9 |
| Wing-Bone | M | 501 | 670 | 595.7 | ±86.3 |
| muscle(g) | F | 394 | 492 | 441.3 | ±49.1 |
| Head(g) | M | 51 | 86 | 72 | ±18.5 |
| | F | 47 | 93 | 63.7 | ±25.5 |
| Back bone(g) | M | 300 | 377 | 334 | ±39.3 |
| | F | 238 | 350 | 293 | ±56.03 |
| Shank length(cm) | M | 14 | 15 | 14.67 | ±0.53 |
| | F | 10 | 13 | 11.33 | ±1.53 |
| Drumstick(thigh)(g) | M | 547 | 632 | 591.33 | ±42.62 |
| | F | 311 | 385 | 346.3 | ±37.11 |
| Gizzard(g) | M | 38 | 48 | 42.33 | ±5.13 |
| | F | 39 | 64 | 48.7 | ±13.43 |
| Heart(g) | M | 12 | 16 | 14 | ±2. |
| | F | 6 | 13 | 9.33 | ±3.51 |
| Liver(g) | M | 25 | 38 | 30.67 | ±6.7 |
| | F | 31 | 39 | 35 | ±4.0 |

## 4.3 Killing out Percentage (KO %) of Kuchi Indigenous Chicken

### 4.3.1 Kuchi Cock

Kuchi cocks had a Mean Live Body Weights (Lbwt) of 2242.67g and Killing (Dressed) weight of 1520.33g, which translated to a Killing Out percentage (KO %) of 67.8%.

### 4.3.2 Kuchi Hen

The live body weight (Lbwt) of Kuchi hen was 1683.33g and the Killing weight of 1109.22g which is 65.9% KO%.

This indicated that the KO% of Kuchi cock at 30 weeks of age was higher than Kuchi hen of the same age by a KO% of 1.9%.

**Table 4.6: Killing out percentage for Kuchi Chicken**

| | | Replications | | | | | |
|---|---|---|---|---|---|---|---|
| **Cock** | Age(30weeks) | **1** | **2** | **3** | **Total** | **Mean(g)±SD** | **KO%** |
| | Lbwt(g) | 2047 | 2216 | 2465 | 6728 | 2243.67±210.3 | **67.8** |
| | Dressed wt(g) | 1346 | 1536 | 1679 | 4561 | 1520.33 | |
| **Hen** | Lbwt(g) | 1646 | 1489 | 1913 | 5050 | 1618.33±214.2 | **65.9** |
| | Dressed wt(g) | 1073 | 1028 | 1227 | 3328 | 1109.33 | |

### 4.4 Effects of Management Systems on Growth of Kuchi Growers

The growth performance of Kuchi chicks from day old to 8 weeks of age was shown in Figure 4.10. Results showed that increase in increase in time (weeks) led to an increase in chicks' weight, therefore positive regression ($R^2$=0.9679).

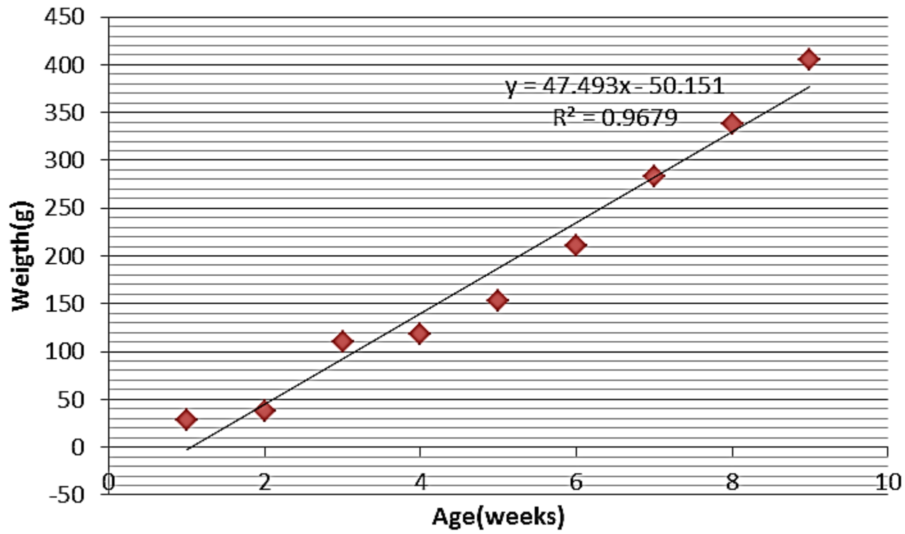


**Figure 4.10: Growth of Kuchi chicks from day1to 8 weeks**

The mean weights of the growers during the study period (3weeks) (Figure 4.11) were as follows: 57.83g, 53.28g and 40.22g for ENC, EHC and IFC respectively. There were no significant ($p$>0.05) differences among the systems of production on the growth of Kuchi growers.

**Figure 4.11: Kuchi Pullet (8 Weeks Old) (Source: Author, 2015)**

**Table 4.7: Mean weight (g) gain/bird during three weeks**

| | System (Treatments) | | |
|---|---|---|---|
| **(Replication) weeks** | **ENC** | **EHC** | **IFC** |
| 1 | 35 | 51.17 | 30.84 |
| 2 | 34.67 | 58.17 | 47 |
| 3 | 103.83 | 50.5 | 42.83 |
| **Mean(g)** | **57.83$^{a}$** | **53.28$^{a}$** | **40.22$^{a}$** |

Means with the same letter are not significantly (p>0.05) different

### 4.5 Effects of Three Energy Diets on Growth of Kuchi Growers under Different Feeding Systems

The growth performance of Kuchi growers from week 12 to 17 fed under three levels of energy diets (HE, LE, MG) and three different feeding systems(ENC, EHC and IFC), were as shown in Table 4.8.

**Table 4.8: Mean weight gains (g/bird)/energy diet under three different feeding systems**

| **System/Blocks** | **Diet (Treatments)** | | | **Block means** |
|---|---|---|---|---|
| | **HE** | **LE** | **MG** | |
| ENC | 190.97 | 227.5 | 138.87 | 185.78$^{c}$ |
| EHC | 172.67 | 281.33 | 94.33 | 182.78$^{c}$ |
| IFC | 150.00 | 269.70 | 46.3 | 153.33$^{c}$ |
| Diet means(g) LSD=80.501 SEM=20.5;CV=20.33;$R^2$=0.896 | 171.21$^{a}$ | 259.561$^{b}$ | 93.17$^{a}$ | |

Means with the same letter are not significantly (p>0.05) different

# CHAPTER FIVE

# DISCUSSION

## 5.1 Morphological Characteristics

### 5.1.1 Feather Colours

Several phenotypic variations existed in the feather colours (Table 4.2) of Kuchi Indigenous chicken ecotype: Solid-one colour (white/brown) was 27.8%, with male/female ratio of 1:4; Mixed- two colours was 33.6%, and Heterogeneity (several colours) was 39%, which included Frizzled feathers exhibiting 11.2%. Heterogeneity was lightly above the findings of 35.76% reported by Halima *et al.* (2007), on mature indigenous chicken of Ethiopia. The Frizzled feather colours of 11.2% were also slightly above those reported (8.33%) by Adomake (2009) of Local domestic Fowl of Ghana. According to Adomake (2009), Frizzle feather trait is a thermoregulatory gene which in this study, was predominantly expressed in Kuchi males (Table 4.2). It is a trait that has been reported to be under the blink of extinction (Fayeye & Oketoyin, 2006; Adomake 2009).

Solid-one colour reported by Halima *et al.* (2007) of white and grey (22.3%) is above that found in this study of 16.7% and 11.1% for white and grey feathers respectively. This slight difference in Kuchi Indigenous chicken may be attributed to the small population size in this study or several other factors like random genetic drift (Adomake 2009), diseases and selection by man against/for this (frizzled). Native chicken for Bangladesh (Faruque *et al.*, 2010), exhibited 33.33, 28.33 and 18.33%, for black brownish, white with black strips and red brownish plumage colours respectively. This related well with results in the current study on Kuchi Indigenous chicken. The slight variations were most likely as a result of genetic intermixing under panmixia, human migration, exchanges in trade, mutation and genetic drift.

Mixed-two colours (Brown/Grey, Brown/Black and White/Black) were dominant among Kuchi females while Heterogeneity-several colours (Silky Grey/Black/White/Brown; Grey/Brown/Black; and White/Black/Grey/Brown were exclusively a male feather colour. Similarly, frizzle feathers: white/grey/brown/black and white/grey/brown were a male colour in Kuchi Indigenous chicken ecotype. These great variations in feather colours agree with observations by several authors (Halima *et al*., 2007; Bhuiyan *et al*., 2005; Msoffe *et al.*, 2005; Mcainsh *et al.*, 2004; Alemu and Tadelle, 1997) of other indigenous chicken.

### 5.1.2 Comb Type

Rose comb type was only expressed in females while other known combs such as Strawberry and Walnut (Mogesse, 2007) were not observed in this study. This observation may be due to the small sample size used in this study. The Pea comb type forming 55.6% in the present study was closer to that reported by Halima *et al.* (2007) in Indigenous chicken of Ethiopia which had 50.72%. Single and Rose comb types were not observed in the Ethiopian Indigenous chicken. The native chicken of Bangladesh predominantly exhibited 100%, Single comb type; Pea and Rose comb types were not reported (Faruque *et al.*, 2010).

### 5.1.3 Shank Colour

White shank colour was not observed in Kuchi males as was predominantly seen in females. This may be due to loss of carotene contained in the egg yolk. A third of the female Kuchi hens were laying at this age (30 weeks) hence the white shank colour in this study. The yellow shank colour of 77.8% in this study was far above that reported (64.42%) by Halima *et al.,* (2007) in Ethiopian Indigenous chicken. White shank colour was not reported in the Indigenous chicken of Ethiopia as was observed in Kuchi ecotype. Native chicken for Bangladesh (Faruque *et al.*, 2010) predominantly had 35 and 31.68%, for white and yellow shank colours respectively. The two shank colours (yellow and white) confirm the report given by (Eriksson *et al.*, 2008), that the present indigenous chicken is a descendant of hybridization between the Grey and Red jungle birds. In the present study, Kuchi showed more than twice the frequency of yellow shank colour to that reported on Bangladesh native chicken. An obvious assumption may be inferred that the Kuchi in current study is having the grey jungle fowl as its main progenitor. The presence of yellow legs in the majority of chickens used for commercial egg and meat production in the Western world are genotypic for homozygous yellow skin allele thus the phenotypic appearance of yellow legs. This therefore brings the assumption that Kuchi chicken has the desirable commercial traits to be selected for both egg and meat breeding objectives.

### 5.1.4 Killing out Percentage (KO %) of Males and Females

The Live body weight (Lbwt) of 2442.67g for Kuchi cock was higher (Table 4.5) than the ranges of 600-800g reported by Payne (1999), and lower than the mean adult weights of 2708g, at same weight as reported by Yongolo (1996) under On-Farm Free range/roaming management system.

Kuchi male at 30 weeks weight (2244g) is closer to those reported by Jadhav and Siddiqui (2007), for egg type Leghorn 2000g at 30 weeks of age. A Kuchi hen at the same age was weighing 1683.33g, which is similar to 1600g reported for the same egg type Leghorn. The results from this study is in agreement to the findings of many workers that males of all Indigenous chicken are significantly heavier than females of the same age Moreki *et al*.(2012)on Tswana naked neck ecotype; Vali (2008)on Iranian naked neck; Badubi *et al*. (2006)on Tswana male and female naked neck; Igbal and Pampori (2008) on Indigenous chicken of Kashmir; Adebambo (2003) on Tswana strains; Islam and Nishibori (2009) on dressed weight of naked neck of Bangladesh Indigenous chicken and Safalaoh (1998) on Malawi local chicken.

Additionally, KO% (Table 4.6) of adult Kuchi (cock 67.8% and hen 65.9%), are lower than, but consistent with reports of MoLD (1994), that Cold Dressed Weight (CDW) of broilers and culled hybrid layers are 82% and 75%,respectively.

### 5.2 Effects of Three Management Systems on the Growth of Kuchi Growers

Body weight gain for the chicks increased from day old to 3 weeks of age (Figure 4.10), then leveled and increased afterwards up to week 8 during which the experiment started. The mean chick weights during this growth phase increased by over tenfold. This growth pattern is consistent with those reported by Fayeye and Oketoyin, (2006), on Fulani ecotype of Nigeria.

Body weight is a direct reflection of growth and it influences production and reproduction traits of birds (Alemu and Tadelle, 1997). It can be observed (Table 4.7) that the weekly means for both ENC and EHC are numerically higher than that of IFC, however, ANOVA results showed that the means were not significantly different($p > 0.05$) from each other.

### 5.2.1 Mean Weekly Body Weights

In this study, the mean body weights of Kuchi Indigenous chicken ecotype at week 10 under ENC, EHC and IFC were 505.2g, 536.7g and 505.2g respectively. These are closer to those of the Nigerian Light ecotype: 560±4.31 at 12 weeks of age (Momo *et al*., 2010). Results reported by Ngeno *et al.* (2014), for Western Kenya, Narok and Bondo Indigenous chicken ecotypes of Kenya at week 8 under Intensive management were similar to that of Kuchi ecotype in this study at week 10. Lwelamira, *et al*., (2008), reported a mean body weight of 685 g for male and female Kuchi ecotype of Tanzania at 12 weeks of age under extensive system, which is closely consistent to those found in the current study of 600.8g under the same management (intensive)at 11 weeks of age. The slight weight difference could be due to effects of age in which the two studies were taken.

### 5.2.2 Average Daily Gain (ADG)

Tadelle *et al*. (2000) on Ethiopian Indigenous chicken reported similar (ADG) for Fayoumi ecotype between week 6 to 12 under intensive management as 5.5±0.2g;Kuchi in this study showed ADGs of 4.95g, 8.3g and 6.7g for ENC,EHC and IFC respectively. This clearly indicates that the type of feeding system does not greatly influence the ADG of Indigenous chicken.

### 5.2.3 Confined Feeding of Kuchi Indigenous Chicken

Results from the study showed that there was no significant difference in the three (ENC, EHC and IFC) feeding systems. FAO (1998) reported that the benefit arising from confining of indigenous chicken is not cost effective. The low productivity of these genotypes means that it is generally not economical to rear them, under confined/intensive management system. The cost of poultry feeds constitutes about 70% of production expenses, considering the fact that poultry diets are always expensive, particularly if all the ingredients required are imported (FAO, 1998).Often, Indigenous chicken is able to obtain some of their nutrients from insects, worms and plants when on pasture, thus reducing costs (Fanatico *et al.,* 2005). However, recommendation of low energy and protein rations for Indigenous chicken has been put forward (Chemjor, 1998; Okitoi *et al*., 2006).

## 5.3 Energy Requirement of Kuchi growers under Different Systems of Management

### 5.3.1 Metabolizable Energy Requirements of Kuchi Indigenous Chicken Growers

The energy diet (Table 4.8) of 2564.5 MEKcal/Kg had significant ($p<0.05$) effect on the growth of Kuchi. The findings from present study are consistent to recommendations made by (Okitoi *et al*., 2006) that an energy diet of 2378ME Kcal/Kg optimizes the growth performance of scavenging indigenous chicken.

Therefore, the choice of a scavenger feed concentrate containing moderate energy is a valuable supplement for Kuchi. The growth of Kuchi Indigenous chicken at weeks 12-17, performed significantly ($p<0.05$) when fed on an energy diet of 2564MEKcal/Kg. Chemjor (1998) also reported 2400MEKcal/Kg as the energy requirement during the same growth period for indigenous chicken. This finding is almost similar with the findings obtained in the present study.

### 5.3.2 Mean Weight Gain

During the three weeks of the study mean weight gain of LE was 259.51g (Table 4.8); whereas HE and MG showed no significant effect on the growth of Kuchi growers. Both

HE and MG had showed mean weight gains of 171.21g and 93.17g respectively. This means that the higher (2700.5MEKcal/Kg as in this study) the concentration of energy level in a chicken diet, feed the lesser is the intake. And therefore growth performance is affected. Similarly MG, whose AME is 2693±339 had the same effects as HE on the growth of Kuchi growers. This is consistent to reports by Smith (2000).

Mean weights of Kuchi growers under ENC, EHC and IFC fed on HE, LE and MG, were not significant ($p>0.05$), during the three weeks of the study. This agrees with the results in experiment one which indicates that the three management systems ENC, EHC and IFC had no effect ($p>0.05$), on the growth of Kuchi growers.

**5.4 Mean Egg Weight**

The mean egg weight observed in this study was 45.01g which is consistent with reports given on Kuchi egg weight of 45g by Lwelamira *et al*.(2008) and those given by Okitoi *et al.*(2006);and Kingori *et al.*, (2010) on Indigenous chicken of Kenya. In a study by Mengesha (2012) on Ethiopia Indigenous chicken, the egg weight range between 43g to 48g.However, according to Chesoo *et al.* (2014), under On-Station management of Kuchi Indigenous chicken, the mean egg weight of 50.0g (n=40). This indicated that the nutritional regime for Indigenous chicken affects egg weight and a subsequent direct correlation to chick hatching weight (Mwalusanya *et al*., 2002).

# CHAPTER SIX

# CONCLUSION AND RECOMMENDATION

## 6.1 Conclusions

Based on the findings from this study, the following conclusions were made;

- Different morphological traits within the Kuchi Indigenous chicken ecotype revealed the existence of phenotypic diversity in the population. This implied that the Kuchi ecotype constitute a pool of diverse genetic variability that can be utilized for selection on desirable characters within and between the ecotypes. This will lead to a significant progress in Indigenous chicken improvement programs in Kenya and also other tropical regions.
- There are great variations in feathers colours. This may be a result of gene frequencies in Kuchi ecotype brought by many factors such as mutation, genetic drift, gene migration, natural selection by and/or environmental factors like disease out breaks. The frizzle feather gene is present within the population of Kuchi Indigenous chicken ecotype under random mating. However; their combined frequency within the population is low. This is a thermoregulatory gene and therefore it should be selected for when breeding Indigenous chicken for hot environments. More research is needed to investigate how other feather colours/plumage are correlated to sex-linked or fit into any known quantitative and qualitative traits of economic considerations.
- Comb type in Indigenous chicken is traits of economic importance (Halima *et al.*, 2007). Five comb types have been reported; Pea Rose, Single, Walnut and Strawberry comb types (Jadhav and Siddiqui, 2007).In the present study, walnut

and strawberry comb types were not observed. This may be as a result of pleiothrophic effects of genes and linkage effects which operate in these traits. The expressions of these traits (comb types) are not environmentally dependent variables. It is highly recommended to characterize the Indigenous chicken of Kenya, using both morphological and molecular analysis in order to come up with information based on correlations of traits for better selection and breeding.

- The shank colours that were predominant in the present study were only two: yellow and white. Adult Kuchi cocks exhibited yellow shank colour while females had both yellow and white shank colours. Yellow skin in chicken is dictated by xanthophylls and carotene which is lost in laying hens through the yoke and egg shell pigmentation. These two colours (yellow and white) indicate that both the grey and red jungle fowls are sole progenitor of Kuchi Indigenous chicken (Eriksson *et al*., 2008). Furthermore, recommendation is therefore made for more research to investigate how shank colour and length traits in adult Kuchi ecotype influence or correlate with growth, carcass yield and other traits of economic importance.
- Male Kuchi was 1.9% heavier in Killing Out percentage than female of the same age in the current study. Leeson (2000) suggest that males have an inherent trait of being heavier than females. This indicates that males of Kuchi may be good for meat production (Lwelamira *et al.,* (2008). Therefore, it is concluded that more research should be undertaken to:

  - Ascertain how the genetic potential of Kuchi ecotype in terms of meat traits and can be utilized towards local chicken improvement strategies in order to curtail the importation of exotic genes,
  - Do selection based on live body weight and correlation response on carcass yield since positive phenotypic correlations is reported (Berri *et al.*, 2007) to translate into positive genetic correlations, and
  - Assess and determine a relatively cost effective age at which the meat yield for both male and female Kuchi Indigenous chicken is optimal for the market.
- The three management systems (Extensive not confined, Extensive Half-day Confined and Intensive Fully Confined) had no effect on the growth performance of Kuchi ecotype in an intensive system at growers between 9 to 11 weeks of age. It is therefore recommended not to keep Kuchi at grower stage as it does relatively better under scavenging conditions with supplementation. The period under which the experiment was carried out was perhaps a bit short to allow for the systems of production to take effect on the growth performance of the Kuchi growers. It is therefore recommended that further studies be carried out under a reasonably longer period so that treatment effects may be exhaustively recorded.
- Kuchi Indigenous chicken growers performed equally well in growth regardless of the management system under an energy level of 2564.5MEKcal/kg. The diets with 2700.5 MEKcal/Kg and Maize Grain did not match energy level of 2564MEKcal/kg in terms of growth effect on the Kuchi growers and therefore a low energy diet (2564.5) MEKcal/kg could be recommended for Kuchi

Indigenous chicken and by extension for other scavenging indigenous chicken in rural households of Kenya.

- The low energy diet of 2564.5MEKcal/kg is better for the growth of Kuchi between ages 12 to 17 weeks of age. It is therefore concluded that an energy diet of about 2564 MEKcal/Kg is optimal for Kuchi Indigenous chicken at the age of between 12 to17weeks old under any of the feeding systems namely ENC, EHC or IFC. However, some essential dietary requirements should be available in adequate quantities in any given ration; thus, it is recommended that a Kuchi ration should have energy level of 2564 MEKcal/Kg, 18.35 Crude Protein, 0.883 Lysine, 0.336 Methionine, 7.072 Crude Fibre and 0.4776 Calcium.

## 6.2 Recommendations

- ***To Poultry Breeders:*** To avoid genetic dilution and erosion of local chicken genetic resource, it is recommended that further characterization of the Kuchi ecotype is made through within and between ecotype selection in order to utilize and conserve these indigenous genomes in a sustainable way,
- ***To Policy Makers:*** It is recommended that the line department in the Ministry of Agriculture, Livestock and Fisheries, collaborates with Animal Scientists who are interested in researching into indigenous chicken, particularly the Kuchi, for the purpose of patenting, conservation (Gene-banking) and production since this ecotype has the potential of being harnessed towards rural livelihood improvement, not only in Kenya but also in other developing tropical countries; and ,

- ***To Farmers:*** Findings From this study indicate that the semi-intensive feeding system with a low level of energy diet is an appropriate technology for rearing indigenous chickens as long as the birds are vaccinated against common poultry diseases particularly New castle Disease, proper housing infrastructure and protection from predators.

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# APPENDICES

## Appendix I: Pictures of Different Ecotypes of Kuchi Indigenous Chicken

**Kuchi cockerel (Source: Author, 2015)**

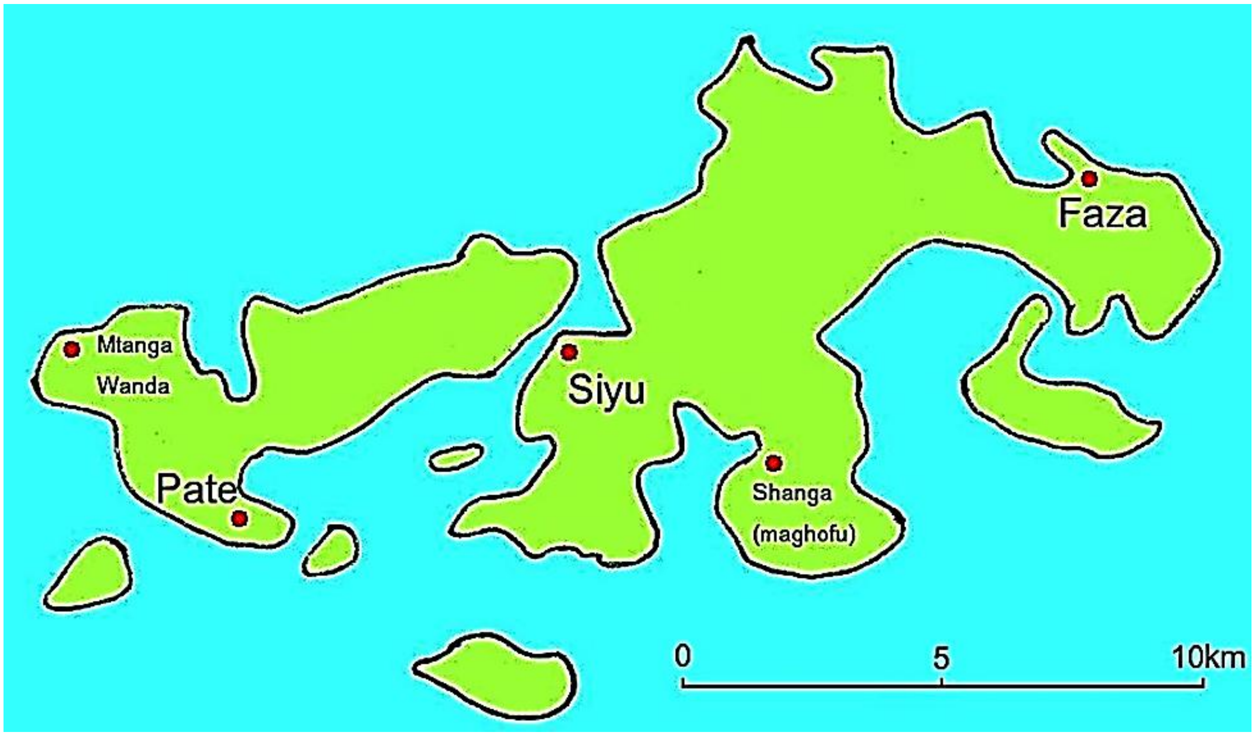
**Kuchi cock (Source: Author, 2015)**

**Kuchi cock (6.8 Kgs; 18 months) (Source: Author, 2015)**

**Kuchi Hen (4.8 Kgs; 18 months old) (Source: Author, 2015)**

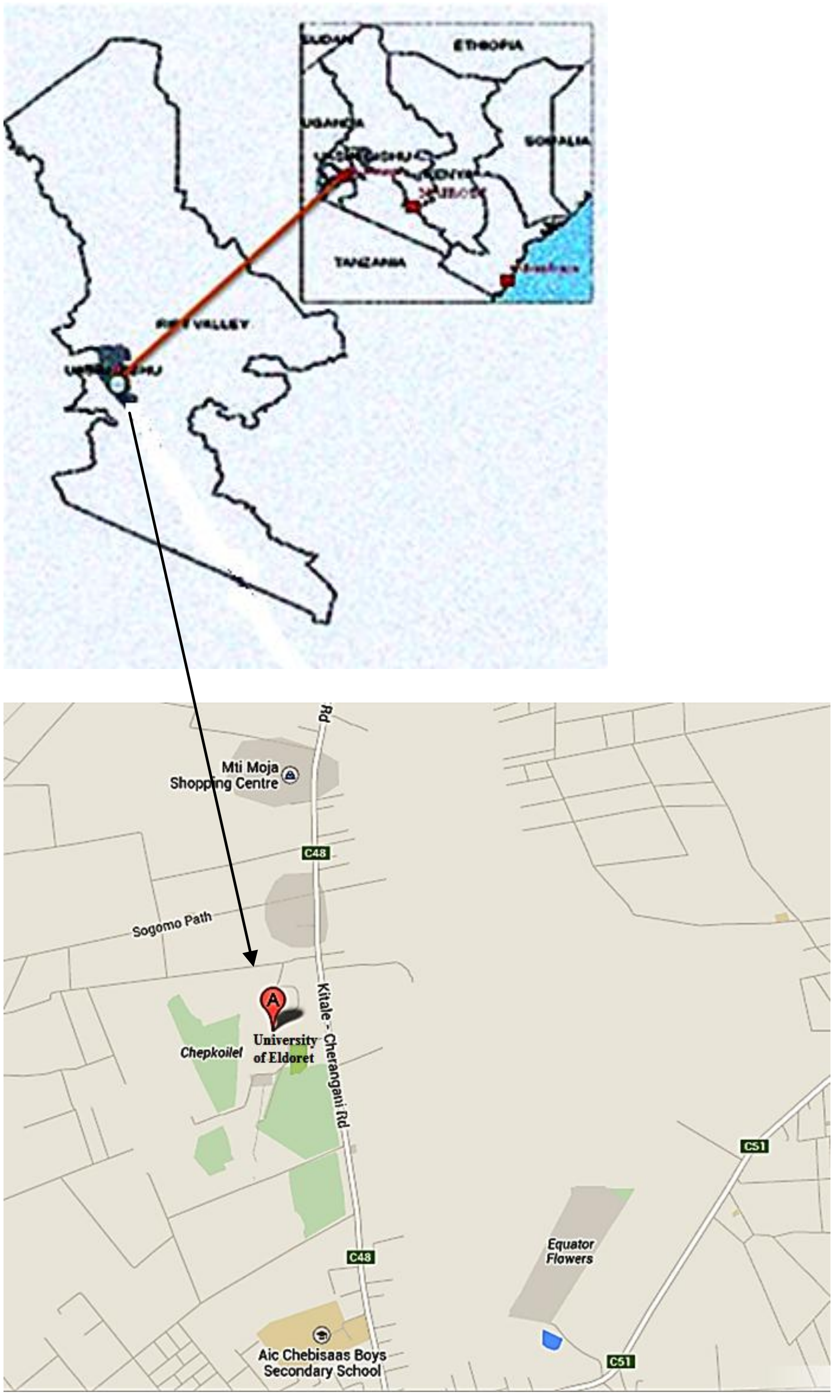
**Kuchi cock dwarfing other local chicken (Source: Author, 2015)**

**Appendix II: Map of Pate Island, Lamu County (Location of Faza)**




**Source: Freeman-Grenville (1962)**

**Appendix III: Map of University of Eldoret, Uasin Gishu County**




**Source: Google Maps**

**Appendix IV: Map of Elgeyo Marakwet**


**Source: Google maps**