MANAGEMENT SYSTEMS AND LOCATION EFFECTS ON GROWTH AND CARCASS TRAITS OF KUROILER AND LOCAL CHICKENS

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DECLARATION

I, Kayitesi Aline declare that this research work under the title **"Management Systems and Location effects on Growth and Carcass Traits of Kuroiler and Local chickens"** is from my own research work and has never been submitted to any University for the award of a Master's or any other degree; and no part of this thesis is plagiarized work.

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DEDICATION

This work is dedicated to
My husband NDANGA Thierry
My daughter NDANGA ISHIMWE Gianna
My Mother UZAMUKUNDA Caritas
My Aunty KABARAME Soline

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LIST OF ACRONYMS AND ABBREVIATIONS

CAADP: Comprehensive Africa Agriculture Development Programme

CRD: Completely Randomized Design

^{0}C: Degree Celsius

ELOCHIP: Enhancing Local Chicken Productivity through Strategic Breeding and Nutrition Management in Northern Uganda

FAO: Food and Agriculture Organization of the United Nations

FCR: Feed Conversion Ratio

g : Gram (s)

g/d: Gram per day

LSD: Least Significant Difference

MAAIF: Ministry of Agriculture, Animal Industry and Fisheries

MDG: Millennium Development Goal

MT: Metric Tons

NAGRC: National Animal Genetic Resource Center and Data Bank

NAADS: National Agricultural Advisory Services

PAR: Participatory Action Research

R4D: Research for Development

RUFORUM: Regional University Forum for Capacity Building in Agriculture

SAS: Statistical Analysis Systems

SPSS: Statistical Package for the Social Sciences

UBOS: Uganda Bureau of Statistics

ABSTRACT

This study was conducted to assess the influence of management systems and location on performance of Kuroiler and Local chickens. Initially, a survey using a standard questionnaire was done to characterize local chicken production systems in Northern Uganda. On farm trials were then conducted in two locations (Gulu and Kiryandongo districts) to determine the growth performance of these birds under intensive and extensive management systems. At the end of the growth trials, Kuroiler and Local cockerels were sacrificed to determine their meat characteristics. Chickens age at sexual maturity in both districts was six months, they had three laying cycles per year with an average clutch size of 13 eggs. Farmers in both districts kept local ecotypes and did not practice cross breeding for flock genetic improvement. Farmers in both districts carry out selection for breeding purposes. Most of the farmers provide night shelters for their chickens but some farmers in Gulu prefer to let them perch in trees overnight. The highest mortality rates were reported among chicks. Newcastle disease was reported by farmers to be the major cause of death in chickens in both districts. On farm trials showed that breed, management systems, location and sex, had significant effect on live weight and the growth rate of chickens. Kuroiler chickens grew faster and were heavier than the local chickens. Intensive management increased the growth rate of chickens better than the extensive system. Chickens reared in Gulu district had higher growth rate than those in Kiryandongo. Kuroiler chickens consumed more feed ($P<0.05$) than the local chickens under the intensive management system, but had better FCR. Kuroiler cocks also had a high carcass yield ($P<0.05$), however, local cocks had higher wing and neck yield. Kuroiler cocks' muscles and breast, drumsticks and thighs were significantly heavier than those of the local chickens. Differences in meat chemical and physical properties were only observed with regard to body pH, with cocks from extensive management having a lower body pH. Whereas growth of chickens was influenced by the breed, management system, location and the sex of the birds, Kuroiler chicken did not differ much from local chicken in the physical and chemical properties, meaning that Kuroiler chicken will easily gain acceptance by consumers. This study recommends improving chicken management practices by farmers through strengthening extension systems and pathways. Kuroiler chickens and where possible, the intensive system of management should be promoted. Future studies should focus on evaluating performance of crosses of the two breeds.

CHAPTER ONE

INTRODUCTION

1.1 Background

At 106 million MT produced worldwide poultry meat production ranks second to pigs (Chemnitz, 2014). In the first world, it was the most trade meat (13.3 million MT) in 2013 (Chemnitz, 2014). This status has been achieved because poultry has been the most responsive species to selection, breeding and commercialization among the domestic livestock species. In developing countries the poultry subsector thrives on unimproved ecotypes, which contribute over 90% of poultry meat and eggs (Besbes et al., 2007; Aberra et al., 2013). The productivity of these chickens is characteristically low because of limited selection for productivity and commensurate improvement in management for optimal expression of genetic potential. The need to address these issues is becoming increasingly compulsory to address in order to reduce endemic food/nutrition insecurity and poverty in developing countries such as Uganda.

The most recent estimate of the national chicken flock of Uganda put the population at 37.4 million in 2008 (MAAIF, 2010). Over 90% of Ugandan chickens are indigenous/native stock reared under the backyard system (Kugonza et al., 2008). Between 80 and 90% of the households in rural areas keep poultry, mostly in the hands of women. Studies in Uganda have shown that a small flock of ten hens can provide the same income a day of women's labour (Kugonza et al. 2008). Such a flock can, when managed well, expand and enable to owner sell or exchange some chickens for goats, which are also later used to acquire cattle. In this way the farmer is enabled to climb and eventually get out of the poverty ladder. Therefore, the contribution of chickens to livelihoods cannot be overemphasized.

The introduction of new chicken genotypes in the country has been one of the keys ways used for improving the productivity of rural chickens. The Kuroiler chickens, one of the exotic chickens introduced in Uganda recently; was developed by Keggfarms, a company based in Gurgaon, India and known for its pioneering efforts to improve rural conditions and provide nutritional security through household poultry keeping (Harth, 2011).

1.2 Problem statement

Poor genetic potential and inappropriate breeding methods such as negative selection and inbreeding in local chickens in Northern Uganda are rampant. There is an urgent need to evaluate the growth performance of selected local chickens, under free range and intensive management systems. Increased investment in local chickens production must include improvement in breeding methods.

A number of initiatives have attempted to improve rural poultry in Africa with limited sustainable success because they depended on highly demanding genotypes without commensurate improvement in the production environment. The Kuroiler chickens are an Indian selection that has been successfully used to provide nutritional security household in India (Harth, 2011). However, it is potential as an intervention for improving rural livelihood in Uganda has not been empirically validated.

Productivity of rural chickens is based on the mature body weight which directly reflects meat production potential and is also related to the quality of the meat. Meat quality is a trait which is expressed differently in different chicken genotypes and is controlled by environmental factors, including the management systems. A study on the meat characteristics of Kuroiler and local chicken reared in Nothern region of Uganda under intensive and extensive management systems had hither to this study not been done.

1.3 Justification of the study

This study responds the Comprehensive Africa Agriculture Development Programme (CAADP); and the Sustainable Development Goal (SDGs) targets for addressing poverty and hunger. It was undertaken as a participatory action research (PAR) focusing on smallholder chicken farmers, because these are the majority in Uganda, currently keeping over 80% of the national stock (UBOS, 2010). Northern Uganda is reeling from the effects several decades of war and pestilence and is at the dawn of real peace. This research for development (R4D) evaluated of the performances of Kuroiler in comparison to the local chickens of Nothern Uganda, under two management systems. The study was intended to provide information with regard to the best chicken ecotypes that can be reared in rural areas and the best management system that can be used by small holder farmers. It is expected that policy makers will use the information to make informed decision on which chicken genotypes to promote.

1.4 Objectives of the study

1.4.1 Overall objective

The overall objective was to assess the influence of management systems and location on performance of Kuroiler and local chickens, so as to enhance chicken production in rural area.

1.4.2 Specific Objectives

The overall objective was achieved through three specific objectives, namely:

1. To determine the breeding practices and management systems of local chickens in Gulu and Kiryandongo Districts;
2. To evaluate the growth performance and mortality of Kuroiler and Local chickens under extensive and intensive management systems, in different geographical location.
3. To determine the carcass yield and meat characteristics of Kuroiler and Local chickens reared under extensive and intensive management systems.

1.5 Research question

Are the breeding practices used by farmers in Gulu and Kiryandongo similar?

1.6 Hypotheses

1 Productivity of improved chickens does not differ from productivity of indigenous chickens under extensive and intensive management system.

2 Kuroiler and local cocks have similar carcass characteristics when reared under intensive or extensive systems.

CHAPTER TWO
LITERATURE REVIEW

2.1 Poultry production Systems

2.1.1 Overview

Poultry production systems have recently been classified by FAO into four management systems, namely: large-scale commercial operation, small scale commercial farms, backyard and scavenging production (FAO, 2010). Backyard and scavenging production systems are largely based on indigenous birds or local breeds. Local breeds are generally defined as groups of stock that have been kept for many years in a particular area and are well adapted to local conditions. Earlier classifications of poultry production systems in the world grouped them into intensive, semi-intensive and extensive (Reddy, 1991; Kitalyi, 1998). These are differentiated on the basis of flock sizes and input-output relationships. On the other hand, Bessei (1987) reported that family chickens are kept under a wide range of conditions, which can be grouped into four broad production systems: free-range extensive, backyard extensive, semi-intensive and intensive systems.

2.1.2 Free-range and backyard extensive systems

In Africa, Asia and Latin America, 80 percent of farmers keep poultry in the free range and backyard extensive systems. Under free-range conditions, the birds are not confined and can scavenge for food over a wide area. Rudimentary shelters may be provided, and these may or may not be used. The birds may roost outside, usually in trees, and nest in the bush. The flock is composed of birds of different species and varying ages (FAO, 2004). According to Guèye (1998); Guèye (2000) and Garcia et al. (2007) chicken production in many developing countries is based mainly on traditional extensive production systems with local chicken ecotypes and limited purchased-inputs. Thear (1997) found that the extensive chicken production system in Africa, where birds are kept on free range, differs from the more latest extensive free range system coming up in developed countries, due to the hot chicken welfare issues in the western world.

Under backyard extensive system, poultry are housed at night but allowed to free-range during the day. They are usually fed a handful of grain in the morning and evening to supplement scavenging (FAO, 2004). Backyard poultry is considered as powerful tool for poverty alleviation, as eggs are a low-cost protein source for household consumption, and are valuable for children's growth. Alternatively, it can provide additional income where market is available (Mack et al., 2005; Roothaert et al., 2011) and is further promoted as a way of empowering women in communities where there is gender bias in poultry raising. The backyard system is a low input system, based on local breeds that are perfectly suited to their environment (Moula et al., 2012).

Chickens under free range and backyard extensive system require low input cost, and their ability of broodiness behavior, high hatchability, disease resistance, good eggs and meat flavor with high dressing percentage make them to be more preferable by farmers (Abera, 2000). The chickens in free-range and backyard production systems are a function of natural selection which is mainly local or indigenous breeds. As a result the performance of chickens under rural conditions remain generally poor as evidenced by highly pronounced broodiness, slow growth rates, small body size and low production of meat and eggs (Kitalyi, 1998).

2.1.3 Semi-intensive systems

The semi intensive system is the practice of the part-extensive and part-intensive systems where birds are confined to a certain area with access to shelter. They are commonly found in urban, peri-urban situations. In the "run" system, the birds are confined in an enclosed/fenced area during the day and housed at night (FAO, 2004; Magala et al., 2012a). Feed and water are available in the house to avoid wastage by rain, wind and wild animals.

In the European system of free-range poultry keeping, there are two other types of housing. The first of these is the "ark" system, where the poultry are confined overnight (for security against predators) in a building mounted on two rails or skids (usually wooden), which enable it to be moved from place to place with draught power. A typical size is 2 × 2.5 m to hold about 40 birds. The second type of housing is the "fold" unit, with a space allowance (stock density) for adult birds of typically 3 to 4 birds per square meter (birds/m^2), both inside and outside. The fold unit is usually small enough to be moved by one person. Neither of these two systems is commonly found in developing countries (FAO, 2004). Advantages of semi-intensive management system are low investments and higher returns, significant savings in feed costs and better meat quality. Meats are free fat compared to chickens grown in confined cages.

2.1.4 Intensive systems

These systems are used by medium to large-scale commercial enterprises, and are also used at the household level. Birds are fully confined either in houses or cages. Capital outlay is higher and the birds are totally dependent on their owners for all their requirements; production however, is higher. There are three types of intensive systems, namely: the deep litter system, the slatted floor system and the battery cage system.

In the deep litter system, birds are fully confined (with floor space allowance of 3 to 4 birds/m^2) within a house, but the birds can move around freely. The floor is covered with deep litter (a 5 to 10 cm deep layer) of either grain husks (maize or rice) or straw or coffee or husks, wood shavings or a similarly absorbent (but non-toxic) material. The fully enclosed system protects the birds from thieves and predators and is suitable for specially selected commercial strains of egg or meat producing poultry (layers, breeder flocks and broilers). In the slatted floor system, wire or wooden slatted floors are used instead of deep litter, and this allows stocking rates to be increased to five birds/m^2 of floor space. Birds have reduced contact with feces and are allowed some freedom of movement (FAO, 2004).

Battery cage system involves keeping chickens especially laying hens in small individual cages which can then be assembled in a multistoried way and the birds are kept throughout their productive life. The system requires a high capital investment hence the system is mostly confined to large scale commercial egg layer operations mainly in developed countries (FAO, 2004).

2.2 The Status of local chicken industry in Uganda

In Uganda the traditional poultry production systems are mainly based on free-range indigenous chickens which are kept at subsistence level and are found in almost all rural households The national chicken flock of Uganda was estimated to be 37.4 million in 2008 (MAAIF, 2010).

Regionally, the Eastern region had the highest number of chicken estimated to be 10.7 million (28.6%), followed by Central with 10.47 million (28%), Northern with 7.7 million (20.4%), Western region with 7.2 million (19.3%) and Karamoja had the least number of chicken estimated to be 1.36 million (3.6%). The districts of Wakiso (2.8 million), Bugiri (0.9 million), Lira (1.1 million) and Masindi (1.0 million) had the highest number of chicken in Central, Eastern, Northern and Western regions respectively (MAAIF, 2010). In 2006, the national chicken flock was 23.5 million, composed of 3.7 million exotic/crossbred chickens and 19.8 million (84.2%) local/backyard chickens (UBOS 2007), but population of the local chickens increased by over 47% by 2008. These are interesting statistics to note and it's desirable that the local chicken population despite all the known challenges continues to increase.

A recent study reported that local chickens produced in Uganda were mainly marketed alive in Kampala City markets and the majority of the traders (52.9%) obtained local chickens from Eastern Uganda (Emuron et al., 2010). Half of the Kampala chicken traders obtained local chicken from middlemen while 46% of the traders personally bought the birds from rural farm households. Chicken trade was the major source of household income to 72.7% of the chicken traders, meaning that the trade is well established and stable (Emuron et al., 2010). The demand for these chickens is highest in the festive months of December and April. The cost of local chickens is more than twice as much as that of exotic chickens (Emuron et al., 2010). Most of the local chickens are kept for consumption of their meat but many households rely on them for provision of eggs.

2.3 Importance of indigenous chicken in rural economies

Indigenous chickens are widely distributed throughout the world. Their contribution varies with regions, especially in the developing countries where they are of great importance (Besbes et al., 2007). They provide employment to family members from which income is obtained during the crop off season periods (Mandal et al., 2006). Poultry keeping also creates employment for many other categories of people which include; primary and secondary traders, processors and caterers; thus promoting economic development (Kingori et al., 2010). Gender is a major focus in rural development and poultry is an obvious starting point to reach poor women (Fakhrul and Jabber, 2005). Since local chickens are mainly owned by women in the rural areas (Mapiye and Sibanda, 2005), the chickens can serve as a tool for women's empowerment (Badubi et al., 2006).

The indigenous chickens have an important role to play in provision of much needed protein to a large segment of the Ugandan population (Mugga, 2007). This could be the only source of animal protein for resource poor households (Kyarisiima et al., 2004). Ajetomobi et al. (2010) affirmed that the chicken protein is a rich biological and a good source of iron, copper, B-complex vitamins and essential fatty acids. Chickens can be kept by the landless members of the community unlike the large livestock (Kyarisiima et al., 2004). Hence, the chickens are an important hedge against unexpected cash needs such as medical and school fees (Kingori et al., 2010). Other roles include their use in traditional medicine and for various cultural rites (Kingori et al., 2010).

Local chickens have several characteristics that are not found in any exotic breeds and that are appropriate to traditional low input/low output farming systems (Aboe et al. 2006). They allow farmers to use locally available resources, they can hatch their own eggs, brood their offspring and tolerate the common local poultry diseases (Kyarisiima et al. 2004). Increased local chicken productivity would result in a positive impact on household food security, of poor farmers, by both increasing dietary intake and income generation. Though this is true, it is only of recent endeavor that some farmers have started to undertake the rearing of local chickens at a commercial scale enterprise (Emuron et al. 2010; Natukunda et al. 2011).

Local chickens and their products are sold to generate household income and are used as source of meat for home consumption, food for visitors, gifts to friends and the church. Chickens also are exchanged for labour and other livestock such as goats, and few chickens are sometimes used for cultural functions and rituals (Kugonza et al., 2008). Chicken and egg marketing are affected by low output of marketable chicken products due to disease outbreak, predation and low productivity (Natukunda et al., 2011).

2.4 Chicken genetic resources

2.4.1 Local ecotypes

Local chicken are widely spread in rural area of developing countries, especially in tropical and sub-tropical region. Local chicken are more preferred by rural farmers generally because of their adaptive characteristics to the village environment (Guèye, 2003; FAO, 2004). Local chickens are the result of centuries of crossbreeding with exotic breeds and haphazard breeding within the flocks. Different types of local chickens are found in the smallholder chicken production systems of Africa, and are largely defined as family poultry (Kingori et al., 2010).

Breeding stock is rarely replaced, and when done, replacement stocks originate from the chicks hatched from the same flock, purchase of chicks from local markets, neighbors or given as gifts. Inbreeding is common and leads to low flock productivity. In some cases, commercial farmers select the best birds according to disease resistance, productivity, ability to withstand harsh climate, and adaptation to poor and inadequate water supply (Mugga, 2007). The genetic resource base of the indigenous chickens in the tropics is rich and should form the basis for genetic improvement and diversification to produce a breed adapted to the tropics. A considerable amount of phenotypic diversity for various traits in the indigenous chicken genetic resources of Ethiopia has been reported by Halima (2007) and it is attributed to the presence of diverse agro-ecology, ethnic groups, socio-economic, religious and cultural considerations. In Nigeria local chickens are categorized according the genetic lines of feathers, plumage colour, body structure and variants in colour (black, white, brown and mottled) (Ajayi and Agaviezor, 2009). Nigerian local chicken are classified on the basis of agro-ecological zone, and are grouped into two major chicken ecotypes on the basis of the body size as heavy (0.9-2.5 kg) and light ecotype (0.68-1.5 kg) (Momoh et al., 2007; Ajayi, 2010).

The genetic diversity and relationships between chicken populations from several African countries have recently been investigated using autosomal microsatellite and mitochondrial DNA markers. The studies have included chicken populations from Eastern Africa (Kenya, Ethiopia, Sudan, and Uganda) (Wimmers et al., 2000; Dessie, 2007; Muchadeyi et al., 2007; Mwacharo et al., 2007; Hassan et al., 2009; Goraga et al., 2011; Mwacharo et al., 2011) and fifteen other African countries. African indigenous chickens are closely related genetically but are clearly distinct from commercial breeds (Mwacharo et al., 2007; Leroy et al., 2012; Mwacharo et al., 2013). Their genetic diversities are roughly comparable across studies/populations and correspond to the values usually observed in other free-range scavenging chicken populations worldwide (Mwacharo et al., 2007; Mwacharo et al., 2013).

Namasagali chickens are one of local chickens ectypes in the East region of Uganda, they have black spotted plumages, with feathering up to the shanks especially for male chickens. They have shown a good performance with regard to growth and eggs production than other indigenous chickens of the region. But little is known with respect to the performance of other chicken ecotypes in Uganda. The different ecotypes are largely differentiated by the name of the ethnic group on the community that rear them. Typical ecotypes names are Teso (chicken form Teso in Eastern Uganda); Nganda (chicken from the central province/zone of Uganda) and Nyoro (chicken from western Uganda particularly in Bunyoro Sub-region). The Nyoro chickens are relatively smaller than the other ecotypes but are best in terms of egg production (Ssewannyana and Rees, 2004; FAO, 2009b).

2.4.1.1 Growth performance of Local chickens

Local chickens are known to possess small body size and slow growth rate (Ajayi, 2010; Magala et al., 2012a). Local chickens in the tropics have been found to have major genes which affect their performance (Ibe, 1992). Other findings have shown that frizzle feathered and naked neck chickens have better feed conversion compared to the normal feathered chickens (Horst, 1997; Gunn, 2008; Ajayi, 2010). Research on growth performance of local chicken when fed diets containing different levels of energy and protein indicated that the growth of chickens is not affected (Magala et al., 2012b). However, other findings reported that local chicken performed better when fed a diet of 21% CP and 3000 kcal/kg ME as opposed to those fed a diet of 16% CP and 2700 Kcal/kg ME during a growth stage of 7-13 week (Magala, 2008; Mbajiorgu et al., 2011). Management systems are also one of the key factors which affect the growth of local chickens. Under the extensive the system, local chickens perform poorly with low body weight gain mostly because of the harsh condition of this system characterized by low quantity and poor quality of feeds (Goromela et al., 2008; Kingori et al., 2010), use of more energy inn moving long distance searching for feed and long exposure to high temperatures (Fanatico et al., 2007; Wang et al., 2009). Chicken reared under intensive and semi-intensive systems show increased body weight gain (Magala et al., 2012a).

2.4.1.2 Reproductive performance of local chickens

Reproductive performance of local chickens is highly influenced by their genotype (Keambou et al., 2013) of being slow growing and this makes them to reach sexual maturity at advanced age compared exotic breeds. Many studies in Uganda have shown that local chicken mostly attain their maturity within a range of five to seven months (Mwalusanya et al., 2001; Kyarisiima et al., 2004; Kugonza et al., 2008). Other studies in Africa also have reported the same range; a study in North West of Ethiopia reported that the age at first mating for cockerels was six months while for hens is seven months (Fisseha et al., 2010; Alem, 2014). Another study in south of Ethiopia reported that the average age at first laying for village hens was 6.5 months (Nebiyu et al 2013). Local chicken reproduction rate depends on the fertility and hatchability. Local chickens have been recognized to be good incubator and their hatchability has been reported by many studies to range from 81.7% to 83.7 % in nothern and southern region of Ethiopia respectively (Fisseha et al., 2010; Alem, 2014). Hatchabiity of 84% has been reported for chickens in Bangladesh (Hossen, 2010) and is much higher than 75% in Ghana (Aboe et al., 2006); but lower than 90% for chicken in Eastern Uganda (Kugonza et al., 2008).

2.4.2 Exotic chicken types

Exotics genotypes are mainly characterized according to their mode of productions. Broiler chickens are genetically selected to provide meat, layers to provide eggs and Kuroilers which are dual purpose chickens for meat and eggs productions. Broilers are chickens bred and raised specifically for meat production. They have been developed from several parent breeds which are not usually disclosed by breeder companies and, hence, are marketed as commercial hybrids under trade names. Typical broilers have white feathers and yellowish skin. Most commercial broilers bred for meat reach slaughter weight at the age of five to seven weeks of age, although these are slower growing strains which reach slaughter weight at approximately 14 weeks of age. Broilers are usually grown as mixed-sex flocks in large sheds under intensive conditions, but some strains can be grown as free-range flocks (Kruchtem, 2002). A good Broiler chicken should appear healthy, with shiny feathers, large size and straight legs and toes (FAO, 2009a).

The second groups of exotic strains of chickens are the layers, whose main role is to produce eggs. From the early twentieth century, selection of egg-type chickens led to tremendous improvements in their productivity. Laying hens have improved their eggs production per hen per year from 170 eggs in 1925 to as many as 325 eggs in 2006 (Besbes et al., 2007). The average hen begins laying eggs at the age of 18 – 20 weeks (depending on the season and the breed of hen that is raised). Over a period of one year, a hen will lay approximately 320 eggs or one egg daily for every seven out of eight days. This level of egg production represents a significant increase over what the ancestors of these modern strains of hens produced, and is the result of genetic selection.

Kuroiler chickens on their part are well suited to resource-poor village environments. They have been genetically selected to provide both meat and eggs but are able to survive and thrive on agricultural and household waste, requiring no additional feed, unlike the other exotic strains described above. The Kuroiler chicken strain was developed by Keggfarms, a company based in Gurgaon, India which is known for its pioneering efforts to improve rural conditions and provide human nutritional security through household poultry keeping. Kuroiler chickens have been distributed in India to over one million households (Harth, 2011). In Uganda, the chicken is gaining popularity through a national popularization campaign spearheaded by the National Animal Genetic Resource Center and Data Bank (NAGRC). Kuroiler chickens are distributed by poverty eradication programmes of both government agencies such as the National Agricultural Advisory Services (NAADS) and non-governmental organizations (NGOs).

2.5 Effect of the genotypes on meat characteristics

Chicken for meat production has been improved through selection mainly to increase growth performance, mature size and body composition. However, in most societies the colour of meat and skin, the texture, the taste and flavour are the most characteristics which are considered by consumers. The appearance of chicken meat and skin is due to an interaction between genotype and production system of local chickens. Skin of local chicken becomes more yellow when birds are kept outdoor (Fanatico et al., 2007). However, this does not occur when fast growing birds are raised outdoor (Fanatico et al., 2007).

Skin colour results from the bird's genetic ability to produce melanin pigments in the dermal or epidermal melanophores and to absorb and then deposit carotenoid pigments in the epidermis (Fletcher, 1999). Also Skin colour is caused by the presence of myoglobin and hemoglobin pigments in muscles, while the discoloration of meat can be associated with the amount, chemical state and the way light is reflected off meat on these pigment (Northcutt, 2009). Jaturasitha et al. (2008) confirmed in his study that local chicken has yellow skin while exotic breed skin is darker. Fletcher (1999) reported a correlation between muscle pH and meat colour; high muscle pH is associated with darker meat and low pH values are associated with lighter meat. In the extremes, high pH meat is often characterized as being dark, firm and dry and the lighter meat being pale, and soft. Other studies have reported that lower pH of chicken might be due to the better welfare conditions that reduce the stress during pre-slaughter and, thus, consumption of glycogen (Castellini et al., 2002; Musa et al., 2006).

Meat of local chicken has more advantages than exotic breed, especially the price at market level, and this is due to genetic potential and production system which make muscle of slow growing chicken to have poor water holding capacity. This makes meat to be more tender (Fanatico et al., 2007) with low fat content. These characteristics make local chicken meat to be the most preferred by consumers.

CHAPTER THREE
GENERAL METHODOLOGY

3.1 Study setup

This study was conducted in two stages. Initially, a survey using a standard questionnaire was undertaken. This was aimed at characterizing the local poultry production system in Uganda. The survey was conducted two sub-counties in each of Gulu and Kiryandongo districts. Two parishes were purposively selected from each selected sub-county, with participation of local leaders and extension staff. After a feedback meeting with farmers, to inform their position on salient features of the baseline survey, the second stage of the study was undertaken. The second study involved an on farm experiment on growth performance of Kuroiler and Local chickens. This was followed by a study on meat characteristics of Kuroiler and local cocks.

3.2 Study location

The study was based in two districts of Kiryandongo and Gulu, located 210 and 340 km respectively north of Kampala City. The region was targeted because of its rampant poverty and malnutrition, exacerbated by a recent war and geo-political changes in Southern Sudan which have opened up a huge market for chickens and their products. Two sub-counties which are representative of the chicken production system were selected from each district. Two parishes were then selected from each sub-county, making a total of four parishes per district.

Kiryandongo district is one of the youngest districts of Uganda, having been carved out of Masindi district in 2010, and is made up of Kibanda county. The district lies between 1^0 22’ and 2^0 20’ North of the Equator; and 31^0 22’ and 32^0 23’ East of Greenwich. The District is bordered by Nwoya District to the north, Oyam District to the northeast, Apac District to the east, and Masindi District to the south and west. Kiryandongo district has a total area of 3,624.1 sq. km with a density of 87.6 persons/km. The soil texture in Kiryandongo is more of sandy loam soils dominated with clay loam in Kitwara Parish. Sandy soils are more pronounced in Masindi Port Sub-County. There are two rain seasons, the first experience between March and May, and the second between August and November. The mean annual rainfall varies from 800 to 1000 mm and an annual average temperature is 25^0C. The major economic activities carried out include: maize production, cassava production, sugar cane production, banana growing.

Gulu District is in northern Uganda located approximately 340 kilometers north of Uganda's capital city, Kampala. Gulu District lies between 2^0 46’28.45” North of the Equator and $32^0$17’56.36” East of Greenwich. The District is bordered by Lamwo District to the north, Pader District to the east, Oyam District to the south, Nwoya District to the southwest and Amuru District to the west. Gulu district has a total area of 11,715.7 sq. km with a density of 13 persons/km.

Generally the altitude ranges from 1000 to 1200 meters above sea level. The District experiences both dry and wet season. The average total rainfall received is 1500 mm per annum with the monthly average ranging from 14 mm in January to 230 mm in August. Normally the wet season extends from April to November with the highest peaks in May, August and October while the Dry season extends from November to March. The average maximum temperature is 50^0C while the minimum is 18^0C. The relative humidity is high during wet season and low in dry season. Agriculture is the main economic activity in the district with main emphasis on food crops such as millet, cassava, cowpeas, potatoes, beans, simsim and sunflower. Cash crops include cotton, tobacco, sugar cane and simsim. The vegetable that is grown mainly is cabbage.

3.3 The baseline survey on status and performance of local chickens

3.3.1 Study design

The study used a descriptive survey design with both qualitative and quantitative questions for data collection and farmers were selected randomly.

3.3.2 Sampling procedure and sample size

In all regions of Uganda, there is a hierarchy of administrative units. First, the country is divided into districts. In this study two districts were purposively selected. The administrative layer below the district is the county. In this study one county was selected per district. The county (Isaza) is divided into sub-counties (Gomborora) that are decentralized governments. These are made of several parishes (muruka), which in turn are sub-divided into villages (Local Administration Units) whose residents form the Local Council 1 (LC1), the lowest constitutionally recognized administrative authority. Within each LC1, there are several households. Two parishes were sampled from each of the four sub-counties selected.

Two perpendicular transects were drawn across each parish, and the villages along each transect were selected. Within the parish, accessibility to, and production system on the farm were considered during sampling.

3.3.3 The Research Instrument

A standard questionnaire (Appendix 1) was administered to 120 farming households. The instrument was tested for validity by experts in livestock breeding to make sure that questions asked were appropriate for the study objective. Additional survey materials consisted of a GPS and a digital camera. The questionnaire was pre-tested prior to the actual survey using ten farmers from Kiryandongo district, but in villages that were not participating in the actual study. The aims of pre-testing was: to evaluate the appropriateness of the questionnaire design, assess the suitability and clarity of questions, evaluate the interpretation of the questions by farmers, relevance of the questions, quality of the data recorded and the time taken for an interview. Validity during interview was tested on some responses through observation. Reliability of the instruments was tested using the internal cross checking, by having some selected questions asked in two different ways. Results from the pre-test were used to make a final refinement to the questionnaire.

3.3.4 Data analysis

3.3.4.1 Data entry and statistical analysis

Each filled questionnaire was coded, and entered separately in computer software SPSS ver. 16. After all the field data from each sub-county were entered, the data were verified. The data were then analysed using district as the main classifying variable.

3.4 Evaluation of growth performance and mortality of Kuroiler and Local chickens

3.4.1 Study sites

The experiment was conducted at selected farms in both Kiryandongo and Gulu districts. The farms were selected from the list of households that had participated in the baseline study.

3.4.2 Study design

The experiment was a 2x2x2 factorial with 2 genotypes, 2 management system and 2 locations; the design was completely randomized design (CRD) with three (3) replications. The two genotypes treatments were: Kuroiler (Kur) and Local. The two management systems to be evaluated were: Intensive (I) and Extensive (E) while the two location effects were Kiryandongo and Gulu districts. An experimental unit was composed of ten (10) grower chickens per farmer, giving a total of 240 growers.

3.4.3 Experimental birds and their management

A total of 240 growers were used in the experiment under intensive (I) and extensive (E) management systems in both districts. They were procured at day-old from established hatcheries nearest to the study sites. In each district and management system, three households were selected to keep 30 Kuroiler chicks and 30 local chicks, hence, each household kept 10 growers. At the beginning of the experiment, all the chicks were weighed in batches and housed in open-sided buildings whose floor was covered with wood shavings. The chicks were fed a standard commercial chick mash. The chick mash was obtained from a feed industry in Gulu and contained 20% CP, 3000 kcal/kg and 1% calcium. The chicks were artificially brooded for three weeks using a charcoal stove as the source of heat and drinking water was provided *ad libitum*. Vaccinations against Marek’s disease, Newcastle disease, Gumboro, infectious bronchitis, Fowl pox and Fowl typhoid were carried out following veterinary vaccination schedules, to prevent common infections. The birds (both hens and cockerels) which were under free-range management system were dewormed monthly.

In the free range system, the birds were housed at night and released to an unlimited range area near the homes of selected households in the two study districts. In the intensive system, chickens were placed in pens of open-sided poultry houses at a stocking density of three birds per m^2. At the age of 18 weeks, three cockerels from each replicate were selected and fasted for 18 hours before slaughter.

3.4.4 Data collection

3.4.4.1 Growth performance

Chicks were weighed from day old and individual body weight measurements continued be taken weekly. Feed intake per batch was recorded every fortnight. The birds were fasted overnight and weighed on empty crops the following morning to obtain live body weight measurements. The feed offered to each batch was also weighed. After every fortnight, left over feed were bulked and weighed so as to compute feed intake per bird. Feed conversion ratio (FCR), was calculated as total of feed intake divided by weight gain. Growth rate was calculated as the differences between two weights divided by the time in between. Mortality was recorded on a daily basis throughout the experimental period.

3.4.4.2 Chicken carcass characteristics

Dressing percentage and carcass yield: After slaughtering and evisceration the weight of hot carcasses, organs (intestines, liver, gizzard, heart, proventriculus and the testes) and head were recorded. The weight of hot carcass, organs and head were expressed as percentage of live body weight. Dressing percentage was computed as the ratio between hot carcass weight (without organs, intestines and head) and live body weight. The eviscerated carcasses were chilled at 4^oC for twenty four hours. The cold carcass weight was then recorded. Carcass yield was computed as the ratio between the cold carcass (without head) and live body weight. The cold carcass was partitioned into breast, wings, back, neck, thighs, drumsticks and feet. The weight of breast, wings, back, neck, thighs and drumsticks was expressed as percentages of the cold carcass weight.

Carcass pH: The pH of the carcass was recorded on whole intact raw breast muscle (*pectoralis major*), one hour after slaughter (initial pH) as well as after chilling the carcasses for twenty four hours at $1\text{-}4^0C$ (ultimate pH) as described by Qi et al. (2009). A portable pH meter was used. .

Drip loss: A sample of muscle from the left side of the breast was weighed and suspended in a plastic bag using a string in a refrigerator at 1-4^{0}C as described by Omojola and Adesahinwa (2007). After forty eight hours, the muscles were weighed again. Drip loss was expressed as the percentage weight loss during refrigeration.

Cooking loss: Samples cooking loss were taken from the breast (*pectoralis major*) and thigh muscles sealed individually in plastic bags (30 microns) and cooked in a thermostatically controlled water bath at 75^{0}C for 45 minutes as described by Rizz et al. (2007). After cooking, the samples were put under running cold water to cool for fifteen minutes. The samples were then dried and weighed. The weight loss during cooking was expressed as the cooking loss percentage

3.4.5 Secondary data

Secondary data collected included the monthly climatic/weather data from the meteorological station of each of the districts.

3.4.6 Data analysis

Data analysis was performed using Statistical Analysis Systems, Portable Version 9.1.3 (SAS, 2004). Weight, growth rate and slaughter parameters were assessed using General Linear Models, with breed management system, location and sex of chickens as fixed effects. Mortality was analyzed using chi-square test.

The model used was:

$$Y_{ijklmn} = \mu + b_i + m_j + l_k + s_l + f_m + (b\times m)_{ij} + (b\times l)_{ik} + (b\times s)_{il} + e_{ijklmn} \sim N(0, \sigma^2) \ldots..(i)$$

where, y is observation of the trait in breed *i*, under management system *j*, in location *k*, of chicken sex *l*, and kept at farmer *f*. μ = overall mean, b_i = effect of breed (i = 2), m_j = management system effect (j = 2), l_k is the effect of location (k = 2), s_l is the effect of sex (l = 2), f_m is the effect of farmer (m =12), b×m, b×l and b×s were interactions between the main independent variables, e_{ijklmn} is the random effect on the trait, independently and identically distributed with mean = 0 and variance = σ^2.

CHAPTER FOUR

LOCAL CHICKEN PRODUCTION IN NORTHERN UGANDA: BREEDING PRACTICES AND FLOCK PRODUCTIVITY

4.1 Introduction

In Uganda, local chicken population is estimated at 40 million (UBOS, 2011) and these chickens play an integral role in the smallholder farming systems. Local chickens have an important role to play in provision of much needed protein to a large segment of the Ugandan population (Mugga, 2007). This could be the only source of animal protein for resource poor households (Kyarisiima et al., 2004). Local chickens also contribute directly to food security through family consumption and as key means of income generation in rural resource poor households in developing countries. Local chickens also have a vital role in the human livelihoods and contribute significantly to food security of the rural communities as chicken products have no cultural or religious taboos (Tadelle et al., 2003).

Contribution of local chickens in rural household economies is mainly limited by its low outup, mostly because of their poor breeding and management system and these results into poor productivity. Farmers often do not have access to appropriate technical knowledge, quality breeding stock, and the necessary feed resources needed for birds to attain full production potential for meat and egg production. It is against this research gap that the present study was designed to characterize the production system. The aim of the study was to identify the breeding methods and management systems of local chickens in Gulu and Kiryandongo districts of Northern Uganda.

4.2 Materials and methods

4.2.1 Study location

The study was based in two districts of Kiryandongo and Gulu (Fig. 4.1), located 210 and 330 km North of Kampala City, respectively. These districts were targeted because of existence of rampant poverty and malnutrition, exacerbated by a recent war moreover the recent geo-political changes in Southern Sudan have opened up a huge market for chickens and their products. Two sub-counties that are representative of the chicken production system were selected from each district. Two parishes were then being selected from each sub-county, making a total of four parishes per district.

Study areas

Figure 4.1: Map of Uganda showing the study areas

Kiryandongo district is one of the youngest districts in Uganda, having been carved out of Masindi district in 2010, and is made up of Kibanda county. The district lies between 1^0 22' and 2^0 20' North of the Equator, and between 31^0 22' and 32^0 23' East of Greenwich. Gulu District headquarters is in northern Uganda located approximately 340 kilometers north of Uganda's capital city, Kampala. Gulu District lies between 2^0 46'28.45" North of the Equator and $32^0$17'56.36" East of Greenwich longitudes.

4.2.2 Study design

The study used a household survey design with both qualitative and quantitative questions for data collection and farmers were selected randomly.

4.2.3 Sampling procedure and sample size

In all regions of Uganda, households come under a hierarchy of administrative units. First, the country is divided into districts. Two districts were purposively selected to be targets of this study. The administrative layer below the district is the county. In the case of this study each district was composed of one county only. The county (Isaza) is divided into sub-counties (Gomborora) that are decentralized governments. These are made of several parishes (muruka), are sub-divided into villages (Local Administration Units) whose residents form the Local Council 1 (LC1), the lowest constitutionally recognized administrative authority. Within each LC1, there are several households. In all the four sub-counties, two parishes were sampled.

Two perpendicular transects were drawn across each parish, and the villages along each transect were selected. Within the parish, accessibility to, and production system on the farm was considered during sampling.

4.2.4 The Research Instrument

A standard questionnaire (Appendix 1) was administered to 120 farming households. The instrument was tested for validity by experts in livestock breeding to make sure that the questions asked were sufficient for the study objective. Additional survey materials consisted of a GPS and a digital camera. The questionnaire was pre-tested prior to the actual survey using ten farmers from Kiryandongo district, and this was conducted in villages that did not participate in the actual study. The aims of this pre-testing was: to evaluate the appropriateness of the questionnaire design, assess the suitability and clarity of questions, evaluate the interpretation of the questions by farmers, relevance of the questions, quality of the data recorded and the time taken for an interview. Validity during the interview was tested for some responses using observation. Reliability of the instruments was tested using the internal check, by having selected questions asked in two different ways. Results from the pre-testing were used to make a few final refinements to the questionnaire.

4.2.5 Data analysis

4.2.5.1 Data entry and statistical analysis

Data collected from the field were focusing on general information of household, on chicken production, breeding management, housing and finally on mortality and diseases management. Each questionnaire was coded, and entered separately in computer software SPSS ver. 16. After all the field data from each district were entered, the data were verified. The Data were then analysed using district as the main class variables. The ranking index was used on traits selected by farmers for the breeding stock.

4.3 Results

4.3.1 Household characteristics

Household size was approximately 10 people in Kiryandongo and 11 people in Gulu districts. There was a non significant difference (P>0.05) in family size between Gulu and Kiryandongo. Most household heads were male in Kiryandongo (90.2%) and Gulu (76.7%), but in Gulu there were more female as household head (23.3%) than in Kiryandongo (9.8%). Most head of households were aged between 30 and 50 years and in both districts (Table 4.1). Most of the farmers had primary school education level in Kiryandongo (39.3%) and Gulu (70.0%).

Table 4.1: Status of the household head of the study area

Variable	Category	Percentage Kiryandongo n= 60	 Gulu n= 60	P value
Gender of Household head	Male	90.2	76.7	**0.046**
	Female	9.8	23.3	
Age (years)	≤30	8.5	5.9	0.297
	30-50	59.3	55.9	
	≥ 50	32.2	39	
Education level attained	Illiterate	9.8	5	0.061
	Primary	39.3	70	
	Secondary	39.3	21.7	
	Tertiary	11.6	3.3	
Marital status of household head	Married	95.1	81.7	**0.042**
	Single	1.6	0.0	
	Divorce	0.0	3.3	
	Widower	3.3	15.0	

4.3.2 Chicken ownership, rearing chicken experience and source of knowledge

Chicken ownership was mostly a joint family venture (56.2%) in both districts. However, more chickens were owned by the female spouses in Kiryandongo districts (18%) whereas in Gulu district male spouses owned more chickens (28.3%) compared to their female counterparts (13.3%). In general, the majority of the farmers in both sites of study reported that they have been rearing local chickens for a period of 1-20 years (67.3%), while 25.5% had reared birds for a period of 21-40 years. Parent to child flow of information was the most common pathway through which skills and knowledge on local chicken rearing was passed on from generation to generation. This was observed in 77.0% of household in Kiryandongo and 78.3% of Gulu households. The self initiative of the farmer and formal training were reported to be the least source of knowledge for farmers in both study sites (Table 4.2).

Table 4.2: Chicken rearing experience, ownership and source of knowledge

	District			P value
Variable	Kiryandongo n=60	Gulu n= 60	Overall n=120	
	Percentages			
Chicken rearing experience (years)				0.55
1-20	66.7	67.8	67.3	
21-40	25.5	25.4	25.5	
>40	7.8	6.8	7.3	
Chicken ownership				**0.05**
Female Spouse	18.0	13.3	15.7	
Male Spouse	16.4	28.3	22.3	
Children	6.6	0.0	3.3	
Joint ownership in the family	54.1	58.3	56.2	
Source of knowledge				0.55
From parents	77.0	78.3	77.7	
From own initiative	14.8	15.0	14.9	
From colleague and neighbours	1.6	5.0	3.3	
Formal training	6.6	1.7	4.1	

4.3.3 Flock productivity

Sexual maturity of local cocks and hens in Kiryandongo and Gulu districts were reported to be the same ($P>0.05$). The egg laying cycle were also found to be the same ($P>0.05$) in Gulu and Kiryandongo being three times a year (Table 4.3). A significant difference ($P<0.01$) was observed on number of eggs per laying cycle between Kiryandongo and Gulu. Also egg given for incubation and the number of chicks hatched per lay was significantly different (P<0.05) between the two district and a significant difference (P<0.01) was observed on the number of surviving chicks between the two districts (Table 4.3).

Table 4.3: Flock Productivity

	District			
Variables	**Kiryandongo (n=60)**	**Gulu (n=60)**	**Overall mean (n=120)**	**P values**
Age of cocks at Sexual maturity (months)	6.12 ± 0.20	6.36 ± 0.12	6.25 ± 0.12	0.333
Age of hens at Sexual maturity (months)	5.91 ± 0.22	6.28 ± 0.15	6.10 ± 0.13	0.175
clutch number/bird/year	3.33 ± 0.12	3.10 ± 0.07	3.21 ± 0.07	0.104
Number of eggs per clutch	13.87 ± 0.34	12.27 ± 0.26	13.07 ± 0.22	**0.001**
Eggs given for incubation	10.57 ± 0.28	11.93 ± 0.29	11.25 ± 0.21	**0.015**
Number of chicks hatched per clutch	8.73 ± 0.32	9.83 ± 0.31	9.28 ± 0.22	**0.015**
Number of surviving chicks at weaning	5.80 ± 0.24	6.73 ± 0.28	6.27 ± 1.93	**0.001**

4.3.4 Breeds and breeding management of chickens

In Kiryandongo, the Nyoro ecotype was reared by 64% of the households. The rest of the households were rearing Luo, Acholi, Lango and Nduli ecotypes (Table 4.4). In Gulu district, all households reared the Acholi ecotype. All farmers in Gulu practiced selection of breeding stock where as in Kiryandongo a small portion (4.9%) of farmers do not practice selection (Table 4.4). Breeding cocks in both study sites were kept mostly for a period of one to three years in the flock. In both sites of the study farmers flocks were comprised of unimproved birds since most of them were not practicing cross breeding. Only a small proportion of 10.2% and 1.7% out of the farmers were practicing crossbreeding in Kiryandongo and Gulu respectively (Table 4.4).

4.3.5 Source of breeding stock

Breeding stock was mostly acquired through purchasing in 88.5% and 93.3% of the household in Kiryandongo and Gulu respectively. Overall, few farmers acquired chickens as gifts (8.3%) and through exchange for labour (0.8%).

Table 4.4: Breeding Management of local chicken

	District (%)			
Variable	**Kiryandongo (n=60)**	**Gulu (n=60)**	**Overall Mean (n=120)**	**P value**
Chicken ecotypes				**0.001**
Nyoro	64.0	0.0	32.0	
Acholi	8.0	100	54.0	
Luo	16.0	0.0	8.0	
Lango	6.0	0.0	3.0	
Nduli	6.0	0.0	3.0	
Carrying out selection				0.261
Yes	95.1	100	97.5	
No	4.9	0.0	2.45	
Duration of keeping a breeding cock				0.419
1-3 years	85.7	90.0	88.1	
3 years	14.3	10.0	11.9	
Do you practice crossbreeding				**0.049**
Yes	10.2	1.7	5.9	
No	88.3	98.3	94.1	

4.3.6 Incubation method

All farmers rely on natural incubation by hens as a mode of egg incubation in both Gulu and Kiryandongo, but the facilities for incubation differed widely among the respondents. The grass nest was mostly used in Kiryandongo (28.3%), while the use of grass with sand as nesting material was mostly reported in Gulu (38.3%). The use of sand together with other facilities for natural incubation was reported frequently (Table 4.5).

Table 4.5: Egg incubation facilities used by broody hens

Variable	District (%) Kiryandongo (n=60)	Gulu (n=60)	Overall Mean (n=120)	P value
Incubation facility				**0.0001**
Grass nest + sand	3.3	38.3	20.8	
Acholi traditional nest	21.7	16.7	19.2	
Grass nest only	28.3	5.0	16.7	
Brick ring +sand	1.7	16.7	9.2	
Basin + sand	18.3	0.0	9.2	
Basin + sand+ Grass	3.3	13.3	8.3	
Paper box+ grass	10.0	0.0	5.0	
Hole + sand + grass	1.7	5.0	3.5	
Basket + sand	6.7	0.0	3.3	
Basin + clothes	1.7	3.3	2.3	
Hole + sacs	3.3	0.0	1.7	
Wood stem cut in the cylindrical way	0.0	1.7	0.8	

4.3.7 Selection criteria of breeding stock

Farmers in the study area use a variety of criteria when selecting hens and cocks for a breeding stock. Body size for both cocks and hens was the most important traits used in the selection criteria. Big cocks and hens were reported to be always selected. Specifically for cocks body height evidenced by long legs was also a good physical trait for selection. Other traits of interest in the selection of cocks included fast growth, plumage and the degree of activeness of the flock as shown in Table 4.6. In addition to the big body size in females, farmers also selected based on egg production, mothering and hatching ability. In contrast some farmers preferred small bodied hens and related them with good egg production and mothering ability (Table 4. 7).

4.3.8 Housing and maintenance

All farmers in Kiryandongo said that they provide a complete enclosure for their birds as a shelter for overnight (Table 4.8).In Gulu, 43.3% of the respondent’s birds were staying on trees overnight. Cleaning was the major maintenance done by farmers in both Districts followed by spraying chemical in the facilities against parasites. About 6.5% of the farmers do not practices undertake any management measures for chicken houses (Table 4.8).

4.3.9 Mortality levels and associated causes

Chicks were reported to be the chicken group with the highest level of mortality. This was reported by 98% of the respondents. Diseases were the major cause of deaths and loss of the chickens followed by predators, parasites, cold weather and thieves. Newcastle disease was the most prevalent disease reported by 46% (Kiryandongo) and 34% of farmers (Gulu), followed by Infectious bronchitis (17% in Kiryandongo and 31% in Gulu), chicken pox (13% in Kiryandongo and 14% in Gulu) and bacillary white diarrhea (7% in Kiryandongo). Most diseases in Kiryandongo were reported to occur in the dry season (51.7%) while in Gulu it was during the rainy season (56.3%). With respect to treatment and diseases prevention, the majority of the farmers used local herbs such as pawpaw roots, *Aloe vera*, *Moringa olifera* and others. Other measure taken to reduce mortality level among flocks were commercial veterinary drugs, vaccination and isolation of the sick birds.

Table 4.6: Selection criteria for breeding cocks

	Kiryandongo				Gulu				Total			
Variables	HH[a]	HH[b]	Total[c]	Index	HH[a]	HH[b]	Total[c]	Index	HH[a]	HH[b]	Total[c]	Index
Big body size	46	34	124	0.51	51	42	144	0.53	97	76	268	0.51
Tall	26	11	62	0.25	39	11	83	0.30	65	22	145	0.28
Fast growth rate	16	8	38	0.16	10	3	20	0.07	26	11	58	0.11
Uniform feathering	6	2	12	0.05	5	1	10	0.04	11	3	22	0.04
Plumage color[1]	1	0	2	0.01	3	1	7	0.03	4	1	9	0.02
Big comb size	2	0	4	0.02	1	0	1	0.00	3	0	5	0.01
High vigour	4	1	9	0.04	3	2	7	0.03	8	3	17	0.03
Total	101	56	245		112	60	272		214	116	524	

HH[a]: total number of households ranked a trait as a criterion for selection

HH[b]: number of households ranked a trait as first criterion (e.g. body size)

Total[c]: Total number of households that selected a particular trait

[1]: plumage color preferred was spotted black and white.

Table 4.7: Selection criteria for breeding hen

	Kiryandongo				Gulu				Total			
	HH[a]	HH[b]	Total[c]	Index	HH[a]	HH[b]	Total[c]	Index	HH[a]	HH[b]	Total[c]	Index
Big size	26	22	73	0.40	30	23	82	0.36	56	45	155	0.38
Good layer	13	10	36	0.20	23	19	64	0.28	36	29	100	0.24
Small size	12	12	36	0.20	9	6	24	0.11	21	18	60	0.15
Good mothering ability & hatchability	7	3	16	0.09	22	9	51	0.22	29	12	67	0.16
Fast growth	7	3	17	0.09	0	0	0	0.00	5	3	13	0.03
Tall	2	0	4	0.02	3	0	6	0.03	7	0	14	0.03
Total	67	50	182		87	57	227		154	107	409	

HH[a]: total number of households ranked a trait as a criterion for selection

HH[b]: number of households ranked a trait as first criterion (e.g. body size)

Total[c]: Total number of households that selected a particular trait

Table 4.8: Overnight housing facilities for birds and their maintenance

	District (%)			
Variable	**Kiryandongo (n=60)**	**Gulu (n=60)**	**Overall Mean (n=120)**	**P value**
Birds facilities overnight				**0.0001**
Complete enclosure	100	56.7	78.5	
Rest on the trees	0.0	43.3	21.5	
Mode of maintenance of chicken housing facilities				**0.02**
Cleaning/ sweeping	65.5	66.6	66.1	
Spraying with pesticides	13.1	8.3	10.7	
Use hot ash[1]	14.7	0.0	7.4	
Smearing floor with cattle dung to make smooth	0.0	21.7	1.9	
Provide litter on the floor	3.2	0.0	1.6	
Repair of house	1.6	1.7	1.2	
No management	11.4	1.7	6.5	

[1] Hot ash is broadcast on the floor to dry the dung and kill pathogens in the house/ use as disinfectant

4.4. Discussion

4.4.1 Household characteristics

The current study found that household size has increased compared to the household size reported by UBOS (2010). According to the UBOS (2010) report the average size of households in rural areas of Nothern Uganda was 5.2. In this study, the average was 10 people per household in Kiryandongo and 11 in Gulu district. Most of the households in the northern region are composed of a father and his married sons. The proportion of male headed households in Kiryandongo (90.2%) is comparable to that of chicken farming households in Eastern Uganda districts Kumi (91.2%) (Kugonza et al., 2008) and Kamuli (98%) (Natukunda et al., 2011). On the other hand, significant proportions (23.3%) of households in Gulu were female headed. This can be attributed to the recently ended twenty year civil war in the region that ravaged the region and caused loss and displacement of the population. Household heads with the age of 30-50 years were the majority and their proportion in the two districts was close to the 59.2% national average of Ugandans with the age of 26-50 years (UBOS, 2010). Most farmers attained some form of education in both Kiryandongo and Gulu. The literacy levels in both districts were much higher than the average for Nothern Uganda (77.3%) (UBOS, 2010) and Eastern Uganda (87%) (Kugonza et al., 2008).

4.4.2 Ownership of local chickens

In most of households chicken were owned jointly by family members in both districts. This shows how local chicken management in rural areas involves all family members. The majority of the farmers in both study sites reported that they have experience of up to 20 years in managing local chickens. Parent to child was the most common pathway through which skills and knowledge on local chicken rearing are passed on from generation to generation. This under scores the big role of informal education in most agricultural communities but also points to a weak extension system especially for traditionally enterprises such as family/local/native chicken farming.

4.4.3 Flock productivity

Flock productivity indices namely: age at sexual maturity, egg number or clutch size and number of clutches per hen are very critical for the growth and expansion of a given flock of chickens. These parameters to a great extent impact on the life time performance of a breeder chicken. In this study, both hens and cocks attained sexual maturity at six months. Studies elsewhere have shown comparable results of sexual maturity to age of 5-7 months for male and 6-7 months for females (Kugonza et al., 2008); 6-8 months for both sexes (Mwalusanya et al., 2001) and of 5-7 months for both sexes (Kyarisiima et al., 2004). The number of clutches per hen in the current study was three per year, with a mean of 13 eggs per clutch. This agrees with the observation of Aboe et al. (2006) who reported 3-4 clutches per year, with a clutch size of 10 - 20 eggs. Similarly Kugonza et al, (2008) reported 3-4 clutches per year with an average of 13 eggs. Another study done in Uganda reported 2.5 - 3 clutches and a mean of 6 - 20 eggs per clutch (Kyarisiima et al., 2004). Most farmers in Gulu and Kiryandongo reported high hatchability with an overall mean of 81.8%, which is comparable to 84% for chickens in Bangladesh (Hossen,

2010) but much higher than the hatchability of 75% in Ghana (Aboe et al., 2006); and lower than the hatchability of 90% for chickens in Eastern of Uganda (Kugonza et al., 2008).

4.4.4 Breeding Management

Farmers in Gulu and Kiryandongo do practice selection of their breeding stock. The reason behind that is they want to maintain good traits that are present in their flocks such as body size and egg production. Furthermore, farmers do not practice cross breeding in their flocks because they want to conserve the disease resistance trait that is paramount in the rearing of local chickens under the free range system. Breeding cocks are generally kept in the flock up to three years, but this practice increases the possibility of inbreeding even though the farmers expect to balance by out breeding using cocks from the neighbours. In most households, the breeding stocks were almost exclusively acquired through purchase. In Teso communities, purchase of breeding cocks is dominant, but exchange for labour and acquisition as gifts are also very common modes of acquiring chickens (Kugonza et al., 2008).

The farmer's selection criteria are mainly focused on improving productivity of their flocks as opposed to the traditional focus on aesthetic traits. Most traits, namely, big body size, tall height, fast growth rate and vigour (Table 4.6) aim at having heavy weight birds as early as possible for marketing. Additionally, when selecting hens, emphasis is put on reproductive rate and efficiency. Good laying ability, laying egg with a high hatchability and having good mothering ability are highly regarded traits. The positive attributes sought by farmers are good brooders and hens with excellent mothering ability (Kyarisiima et al., 2004). Farmers in the Middle East rank good layers more highly than birds superior in other traits, because they contribute significantly to flock productivity (Abdelqader et al., 2007).

4.4.5 Housing

This study found that farmers provide shelter during night, categorized into household kitchens, houses for human beings, separately built chicken houses and trees. The findings in this study relate to the system used by farmer in Kamuli (Natukunda et al., 2011) and Kumi districts of Uganda (Kugonza et al., 2008). Gondwe and Wollny (2007) reported that in Malawi human dwelling units (84.5%), household kitchens (8.05%) built separately from main house, and traditional poultry houses (locally called *khola*) are used. There is a need for farmers to invest in better housing for their birds. Indeed, it is surprising that almost one quarter of the farmers would rely on trees as shelters to accommodate birds despite the exultance of thefts and predation threats.

4.4.6 Mortality and diseases

In both Kiryandongo and Gulu, chicks were the age group of chickens that dies most. The observed mortality rate of 98% is significantly higher than 73.7% for chicks in Eastern Uganda (Kugonza et al., 2008) and 75% in the Accra plains of Ghana (Aboe at al., 2006). Chicken deaths/losses mostly occur because of diseases, predators, thieves and bad weather. Newcastle disease was the major disease reported in this study. Similar findings have been reported by Ambali et al. (2007), who reported that seasonal outbreaks of chicken diseases, specifically Newcastle disease is the major cause of death for local chickens in North-West Amhara in Ethiopia. Similarly, Kugonza et al. (2008) found that Newcastle is the most reported disease by farmers of Kumi district in Uganda.. High level of chick mortality has been also reported by Mwalusanya et al. (2001) at 60% from hatching up to weaning at 10 weeks. On treatment and diseases prevention, the majority of the farmers reported that they use local herbs such as pawpaw roots, *aloe vera* leaves, *Moring oleifera* leaves and others. The use of herbs was also reported by Kyarisiima et al. (2004). Other measures taken to reduce mortality level among flocks are commercial veterinary drugs, vaccination and isolation of the sick birds. Reliance on herbs for treatment of disease has declined, and this could be a result of increased investment and/or improved returns from investment in better health care of the birds.

4.5. Conclusion

Farmers in Kiryandongo and Gulu districts are quite interrested in rearing local chickens. Most of the farmers exeprience in rearing chickens is acquired generation to generation from parents to children. The productivity of local chickens in the regions is mostly limited by breeding method, mostly because of the long period of keeping a breeding cock in the flock which most likely results into inbreeding. The productivity is also affected by the low genetic potential of local chickens. This ia also affected by the loss of a high number of chicks at anearly age because of predation, diseases and an unfriendly environement. Chicken farmers should therefore be empowered through training and provision of new breeds to increase the productivity.

CHAPTER FIVE

EVALUATION OF THE GROWTH PERFORMANCE OF KUROILER AND LOCAL CHICKENS REARED UNDER EXTENSIVE AND INTENSIVE MANAGEMENT SYSTEMS

5.1 Introduction

Management systems of chickens are the major factor which influences their productivity. They have been categorized by FAO (2004) into intensive, semi-intensive and extensive systems. Intensive system increases the productivity of chickens mainly because of high investment on feeding, housing and health care. This system is used for special used breeds of chickens that either target eggs or meat production, while in semi-intensive system crossbreds of local and exotic breeds are used and occasionally supplementation after scavenging and moderate confined shelter at night are provided (FAO, 2004; FAO, 2009b; Kingori et al., 2010).

Extensive system is the most commonly used system by smallholder farmers in rural areas especially in developing countries because it is easier to practice and does not require any investment (FAO, 2004). Birds under extensive system are mostly self-reliant and hardy, capable of withstanding the abuses of a harsh climate. They are left outside to scavenge for feeds during the day and confined at night or perch on trees (Apuno et al., 2011). Local chicken scavenge for insects, food waste, green grass, leafy vegetables and any scattered grains (Kingori et al., 2010). Local chickens survive better than exotic breed under this system due to their genetic merit of being relatively more hardy, disease tolerant, able to breed naturally and to survive under harsh conditions (Kyarisiima et al., 2004; Besbes et al., 2007; Adedeji et al., 2008; Aberra et al., 2013). Local chickens are mainly used as source of animal protein and income (Tadelle et al., 2003) in rural families.

Chickens in general play important roles in economic development of various rural communities of developing countries. Local chickens are sources of animal protein, provide extra cash income and are used for religious or cultural needs (Alders and Pym, 2009; Fisseha et al., 2010). However, their productivity is low due to poor management system in rural areas and, the breeding system usually is characterized by rare replacement of breeding stock. This leads to inbreeding and results in low flock productivity (Kingori et al., 2010). Moreover, local chickens are genetically poor producers of eggs and meat with small mature carcass weight (Aboe et al., 2006; FAO, 2009b; Magala et al., 2012a). To increase production of local chickens there is a need to improve the management system and their genetic potential either by selection for body size traits or by crossing them with improved breeds which can increase their growth rate. This is the reason for introduction of exotic chicken breeds which are egg or meat producers in developing countries.

In Uganda recently, there has been introduction of new breed of chickens called Kuroiler. The Kuroiler chicken breed was developed by Keggfarms, a company based in Gurgaon, India and known for its pioneering efforts to improve rural conditions and provide human nutritional security through household poultry keeping. Kuroiler chickens were initially distributed in India to over one million households (Harth, 2011). Kuroiler chickens are well suited to resource-poor village environments. They have been genetically selected to provide both meat and eggs but are able to survive and thrive on agricultural and household waste, requiring no additional feed, unlike the other exotic breeds described above.

In Uganda, there is a gap of information on their performance under different managements systems and also the effect of different locations on their productivity in rural areas compared to the local chickens. For these reason this study was carried out.

5.2 Materials and methods

5.2.1 Study sites

The experiment was conducted at selected farms in both Kiryandongo and Gulu districts (Fig 4.1). The farms were selected from households that had participated in the baseline study.

5.2.2 Study design

The experiment was a factorial experiment with 2 genotypes × 2 management system × 2 locations under completely randomized design (CRD) with three (3) replications. The two genotype treatments were: Kuroiler (Kur) and Local (Loc) chickens. The two management systems evaluated were: Intensive (I) and Extensive (E) while the two location effects were

Kiryandongo and Gulu districts. An experimental unit was composed of ten (10) grower chickens, giving a total of 240 birds.

5.2.3 Experimental birds and their management

Day old Kuroiler chicks were procured from NAGRC which is the only source of pure breed because they got them from Kegg farm in India where they were produced and local chicks were obtained from a hatchery in Gulu. After three weeks of brooding 240 growers were used in the intensive (I) and Extensive (E) management system in Kiryandongo and Gulu districts. In each district and management system, six households were selected; 3 households kept at least 30 Kuroiler chicks and 3 households kept at least 30 local chicks.

At the beginning of the experiment, all the chicks were housed in open-sided buildings with floors covered with wood shavings. Chicks were fed a standard commercial chick mash. Chick mash was obtained from a feed mixing industry in Gulu town and contained 20% CP, 3000 kcal/kg ME and 1% calcium. The chicks were artificially brooded for three weeks using a charcoal stove as the source of heat and drinking water was provided *ad libitum*. Vaccinations against Marek's disease, New Castle disease, Gumboro, infectious bronchitis, fowl pox and fowl typhoid were carried out following veterinary vaccination schedules to prevent those infections. The birds (both hens and cockerels) which were under free-range were dewormed monthly after initial release from the house. In the free range system, the birds were housed at night in poultry house of farmers and released in the morning to an unlimited range area at the homes of selected households within the two study districts and water were provided *ad libtum.* In the intensive system, chickens were placed in pens located in open-sided poultry houses at a stocking rate of 3 birds per m^2. Litter was provided in the form of wood shavings or ground nut husks and the litter was kept dry by regular raking to avoid caking. The chickens had *ad libitum* access to food and cool fresh water.

5.2.4 Data collection

5.2.4.1 Growth performance

Chicks were weighed from day old and individual body weight measurements continued to be taken every week until the 20^{th}week. Birds were fasted overnight and weighed on empty crops the following morning to obtain live body weight measurements. The feed offered to each batch of chicks was also weighed. After every fortnight, left over feeds were weighed so as to compute feed intake per bird. Feed conversion ratio (FCR), was calculated as total of feed intake divided by weight gain. Growth rate was calculated as the differences between initial and final weights divided by the time (day) in between. Mortality was recorded wherever it occured throughout the experimental period.

5.2.5 Data analysis

Data analysis was performed using Statistical Analysis Systems, Portable Version 9.1.3 (SAS, 2004). Weight, growth rate, and mortality were assessed using General Linear Models procedure, with breed, management system, location and sex of chickens as fixed effects. The model used was:

$$Y_{ijklmn} = \mu + b_i + m_j + l_k + s_l + f_m + (b\times m)_{ij} + (b\times l)_{ik} + (b\times s)_{il} + e_{ijklmn} \sim N(0, \sigma^2) \ldots..(i)$$

where, y is observation of the trait in breed *i*, under management system *j*, in location *k*, of chicken sex *l*, and kept at farmer *m*. μ = overall mean, b_i = effect of breed (i = 2), m_j = management system effect (j = 2), l_k is the effect of location (k = 2), s_l is the effect of sex (l = 2), f_m is the effect of farmer (m =12), b×m, b×l and b×s were interactions between the main independent variables, e_{ijklmn} is the random effect on the trait, independently and identically distributed with mean = 0 and variance = σ^2.

5.3 Results

5.3.1 Effect of breed and location on feed intake

Feed intake was generally higher for Kuroiler chickens compared to Local chickens (Figure 5.1a and Figure 5.1b), and the differences were significant ($P< 0.05$) from week four up to week seven and later at week eleven (Table 5.1). Chickens reared in Gulu district had a higher feed intake than those in Kiryandongo ($P<0.05$), at week twelve, thirteen and from the sixteenth up to twentieth week of age (Table 5.1 and 5.2).

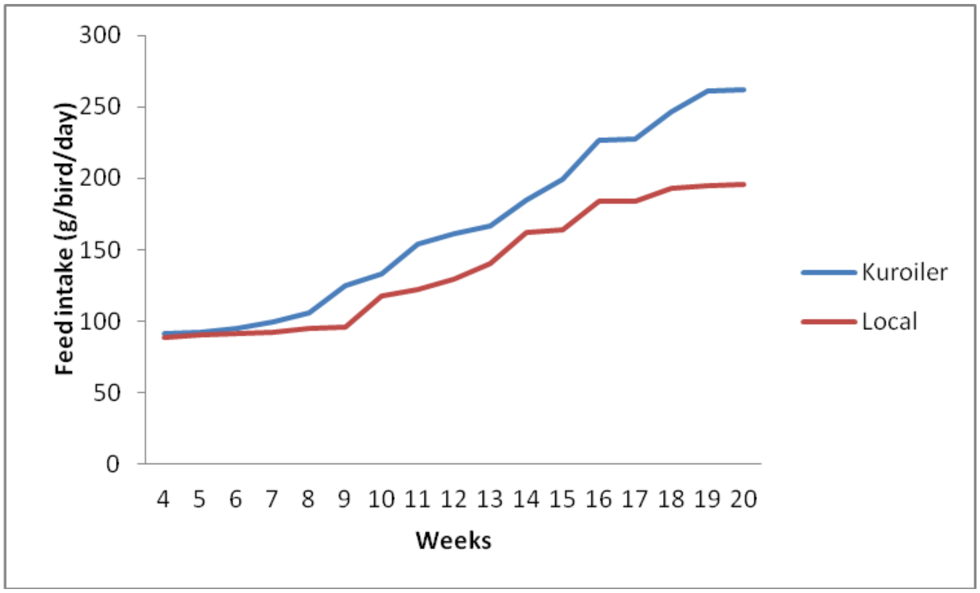

Fig. 5.1a: Feed intake of Kuroiler and Local chickens

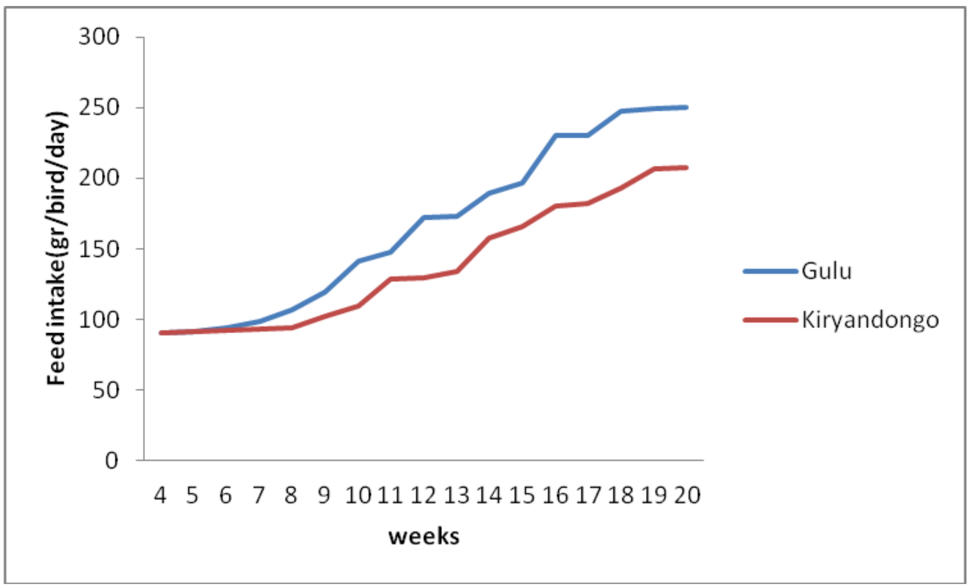

Fig. 5.1b: Feed intake of chickens in Kiryandongo and Gulu districts

5.3.2 Effect of breed, management system, location and sex on live weight of chickens

This part of the study was conducted to determine the factors that affect growth performance of two chickens breeds in Northern Uganda. Of the four factors studied, namely: breed, management system, location and sex, only breed significantly affected body weight of chickens at all ages from hatching to the end of the study (20 weeks). Kuroiler chicks were significantly heavier ($P< 0.001$) than Local chicks at day old by 4.7 g (Table 5.3), and this margin rose to 31.1

g at 4 weeks, 219.5 g at 8 weeks, 393.03 g at 12 weeks, 597.9 g at 16 weeks and 772.9 g by 20 weeks (Table 5.3). The growth trend showed by the live weight charges of the chickens is also graphically presented in Figure 5.2

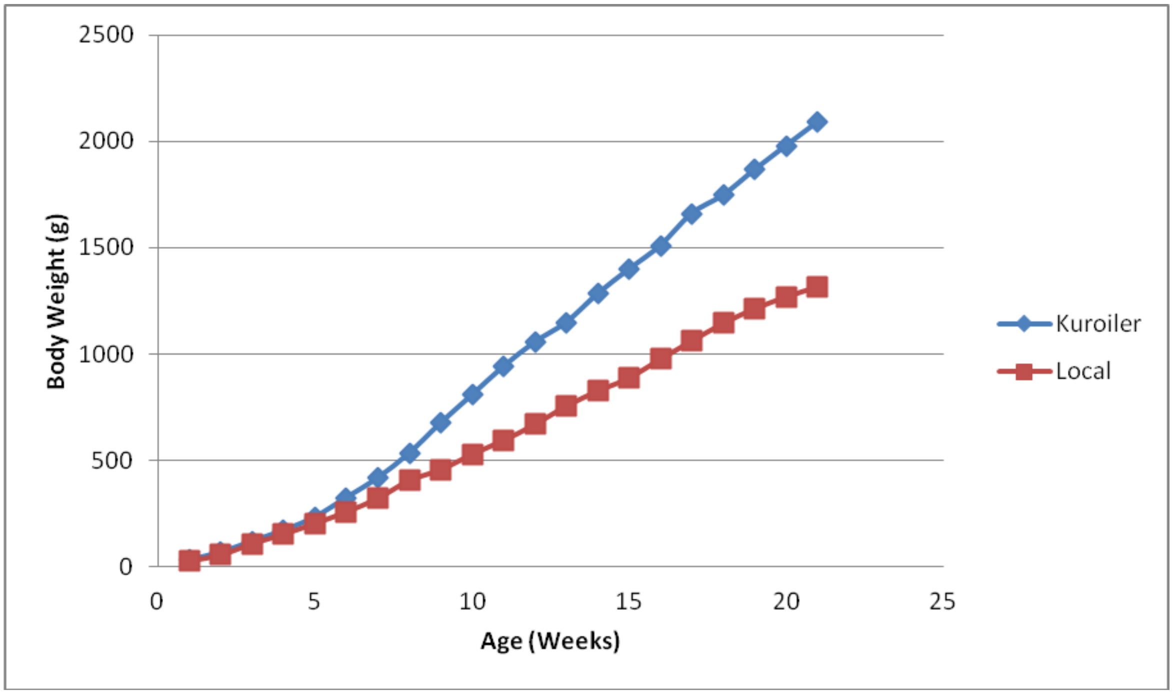

Fig. 5.2: Effect of breed on live weight of chickens at various ages

Management system effect on the chickens started being significant at 4 weeks (Table 5.3) and remained at all the subsequent ages till the end of the trial at 20 weeks. While the variation in weight at four weeks was only 46.7 g, it rose to 351.8 g at 10 weeks and then more than doubled to 701.9 g by the age of 20 weeks.

Table 5.1 Feed intake (g/bird) of chickens at various ages between 4 and 12 weeks reared under intensive management in two districts

Variable	Level	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Breed										
	Kuroiler	91.71[a]	92.50[a]	94.67[a]	99.59[a]	105.87	124.64	132.83	153.89[a]	161.52
	Local	89.04[b]	90.24[b]	90.98[b]	92.10[b]	94.63	96.25	117.76	121.80[b]	129.68
Location										
	Gulu	90.35	91.50	93.74	98.55	106.85	119.08	141.04	147.35	172.01[a]
	Kiryandongo	90.39	91.24	91.93	93.14	93.65	101.81	109.55	128.34	129.13[b]
LSD		1.527	1.417	3.543	6.597	16.506	29.009	28.55	29.333	34.73

[a,b] Means within variable and age group having different superscripts differ significantly ($P<0.05$)

Table 5.2 Feed intake (g/bird) of chickens at various ages between 13 and 20 weeks reared under intensive management in two districts

Variable	Level	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18	Week 19	Week 20
Breed									
	Kuroiler	166.57	184.42	199.23	226.70	227.75	246.98	261.02	262.42
	Local	140.68	162.11	163.57	183.91	184.12	193.30	194.59	195.39
Location									
	Gulu	172.69[a]	189.11	196.71	230.16[a]	230.14[a]	247.49[a]	249.34[a]	249.95[a]
	Kiryandongo	134.19[b]	157.42	166.08	180.46[b]	181.72[b]	192.90[b]	206.27[b]	207.86[b]
LSD		38.19	35.57	35.66	42.84	43.17	40.02	37.76	37.67

[a,b] Means within variable and age group having different superscripts differ significantly ($P<0.05$)

Table 5.3: Least square mean live weights (g) of chickens at various ages between hatching and 10 weeks reared under two management systems in two districts

Variable	Level	Week 0 (n=239)	Week 1 (n=239)	Week 2 (n=239)	Week 3 (n=239)	Week 4 (n=239)	Week 5 (n=236)	Week 6 (n=229)	Week 7 (n=227)	Week 8 (n=224)	Week 9 (n=218)	Week 10 (n=216)
Breed												
	Kuroiler	31.6^{a}	67.86^{a}	119.95^{a}	170.8^{a}	234.12^{a}	325.06^{a}	417.63^{a}	533.84^{a}	675.84^{a}	807.48^{a}	941.04^{a}
	Local	26.9^{b}	54.90^{b}	108.51^{b}	152.1^{b}	203.02^{b}	257.96^{b}	321.34^{b}	405.43^{b}	456.34^{b}	528.40^{b}	593.89^{b}
Management System												
	Intensive	29.43	60.61	114.67	161.42	241.94^{a}	345.59^{a}	452.39^{a}	592.35^{a}	710.67^{a}	830.70^{a}	943.37^{a}
	Extensive	29.23	61.37	113.79	161.47	195.21^{b}	237.43^{b}	286.58^{b}	346.91^{b}	422.59^{b}	505.18^{b}	591.55^{b}
Location												
	Gulu	29.55	62.90^{a}	117.62^{a}	167.13^{a}	226.45^{a}	305.35^{a}	373.02	468.65	565.17	698.55^{a}	805.19^{a}
	Kiryandongo	29.11	59.09^{b}	110.85^{b}	155.76^{b}	210.70^{b}	277.7^{b}	365.67	470.61	565.00	637.32^{b}	729.74^{b}
Sex												
	Male	29.58	62.46	120.83^{a}	171.93^{a}	232.60^{a}	312.62^{a}	395.20^{a}	512.42^{a}	616.77^{a}	731.16^{a}	838.17^{a}
	Female	29.20	60.22	110.78^{b}	155.97^{b}	211.29^{b}	280.26^{b}	355.88^{b}	446.91^{b}	539.38^{b}	632.03^{b}	727.03^{b}
LSD		0.711	2.250	4.508	8.105	11.63	17.42	24.219	29.591	34.298	39.023	42.115

^{a,b} Means within variable and level having different superscripts differ significantly ($P<0.05$)

Variable	Level	Week 0 (n=239)	Week 1 (n=239)	Week 2 (n=239)	Week 3 (n=239)	Week 4 (n=239)	Week 5 (n=236)	Week 6 (n=229)	Week 7 (n=227)	Week 8 (n=224)	Week 9 (n=218)	Week 10 (n=216)
Breed and system												
	Extensive x Kuroiler	32.01	68.16^{a}	119.20^{a}	170.22^{a}	204.10^{a}	258.03^{a}	321.98^{a}	396.90^{a}	511.09^{a}	621.11^{a}	745.58^{a}
	Extensive x local	26.45	54.55^{b}	108.33^{b}	152.63^{b}	186.20^{b}	215.87^{b}	251.25^{b}	296.92^{b}	33.92^{b}	386.39^{b}	433.80^{b}
	Intensive x Kuroiler	31.51	67.53^{ac}	120.65^{ac}	171.28^{ac}	264.01^{c}	391.86^{c}	513.35^{c}	670.76^{c}	840.35^{c}	994.47^{c}	1138.00^{c}
	Intensive x local	27.35	53.70^{bd}	108.70^{bd}	151.57^{bd}	219.8 ^{ad}	299.31^{d}	391.43^{d}	513.95^{d}	586.84^{d}	665.89^{ad}	747.47^{ad}
LSD		0.7	2.3	4.7	8.44	11.9	17.87	24.41	30.36	35.10	41.10	44.98
Breed and Location												
	Gulu x Kuroiler	32.22	69.08^{a}	124.00^{a}	180.74^{a}	252.80^{a}	362.22^{a}	453.89^{a}	576.40^{a}	707.19^{a}	880.07^{a}	1008.96^{a}
	Gulu x Local	26.88	56.70^{b}	111.26^{b}	153.6^{b}	200.69^{b}	251.01^{b}	298.63^{b}	370.33^{b}	433.53^{b}	539.36^{b}	632.00^{b}
	Kiryandongo x Kuroiler	31.31	66.63^{ac}	115.93^{bc}	166.93^{bc}	216.03^{bc}	289.41^{c}	389.19^{c}	500.87^{c}	658.60^{ac}	750.89^{c}	893.58^{c}
	Kiryandongo x Local	26.91	51.55^{bd}	105.76^{bd}	150.60^{bcd}	205.38^{bcd}	265.93^{bd}	351.43^{cd}	453.26^{cd}	495.14^{bd}	547.01^{bd}	594^{bd}
LSD		0.7	2.25	4.6	8.2	12.05	21.95	31.9	43.29	51.71	59.29	64.80
Breed and Sex												
	Female x Kuroiler	31.89	67.14^{a}	116.25^{a}	162.80^{a}	223.32^{a}	308.50^{a}	402.48^{a}	507.80^{a}	648.28^{a}	762.18^{a}	887.75^{a}
	Female x Local	26.46	52.98^{b}	104.78^{b}	148.20^{b}	197.67^{b}	250.20^{b}	315.73^{b}	398.76^{b}	448.11^{b}	525.36^{b}	596.40^{b}
	Male x Kuroiler	31.51	69.19^{ac}	126.92^{c}	185.87^{c}	255.21^{c}	357.87^{c}	458.10^{c}	597.94^{c}	749.20^{c}	918.25^{c}	1073.12^{c}
	Male x Local	27.73	56.31^{d}	115.70^{ad}	159.60^{abd}	213.37^{abd}	274.95^{bd}	342.92^{bd}	437.58^{bd}	496.66^{bd}	576.67^{bd}	639.54^{bd}
LSD		0.7	2.2	4.5	8.14	13.12	22.47	32.41	43.68	51.26	58.69	63.45

^{a,b,c,d} Means within variable and level having different superscripts differ significantly ($P<0.05$)

Table 5.4.: Least square mean live weights (g) of chickens at various ages between 11 and 20 weeks reared under two management systems in two districts

Variable	Level	Week 11 (n=211)	Week 12 (n=206)	Week 13 (n=202)	Week 14 (n=201)	Week 15 (n=200)	Week 16 (n=195)	Week 17 (n=195)	Week 18 (n=195)	Week 19 (n=195)	Week 20 (n=195)
Breed	Kuroiler	1056.03^{a}	1148.5^{a}	1282.79^{a}	1398.34^{a}	1509.92^{a}	1660.29^{a}	1746.5^{a}	1865.97^{a}	1979.2^{a}	2089.42^{a}
	Local	669.08^{b}	755.47^{b}	826.22^{b}	888.04^{b}	976.60^{b}	1062.39^{b}	1144.71^{b}	1213.85^{b}	1269.47^{b}	1316.45^{b}
Management System											
	Intensive	1078.18^{a}	1187.13^{a}	1308.85^{a}	1408.22^{a}	1540.89^{a}	1683.67^{a}	1789.31^{a}	1891.25^{a}	1958.02^{a}	2018.22^{a}
	Extensive	646.93^{b}	716.84^{b}	800.16^{b}	877.15^{b}	945.63^{b}	1039.00^{b}	1101.90^{b}	1188.57^{b}	1290.65^{b}	1387.65^{b}
Location											
	Gulu	936.64^{a}	1038.18^{a}	1134.53^{a}	1227.10^{a}	1362.50^{a}	1506.53^{a}	1609.08^{a}	1723.59^{a}	1822.14^{a}	1920.11^{a}
	Kiryandongo	788.47^{b}	865.78^{b}	974.48^{b}	1059.28^{b}	1124.02^{b}	1216.15^{b}	1282.13^{b}	1356.23^{b}	1426.53^{b}	1485.76^{b}
Sex											
	Male	951.76^{a}	1049.84^{a}	1158.89^{a}	1251.77^{a}	1380.44^{a}	1508.37^{a}	1605.14^{a}	1720.14^{a}	1797.52^{a}	1878.78^{a}
	Female	809.60^{b}	892.68^{b}	990.46^{b}	1070.63^{b}	1159.00^{b}	1268.32^{b}	1318.51^{b}	1427.80^{b}	1518.51^{b}	1595.62^{b}
LSD		50.051	58.948	61.267	62.99	68.62	73.52	79.65	80.64	84.64	84.67

^{a,b} Means within variable and level having different superscripts differ significantly (P<0.05)

Variable	Level	Wk 11 (n=211)	Wk 12 (n=206)	Week 13 (n=202)	Week 14 (n=201)	Week 15 (n=200)	Week 16 (n=195)	Week 17 (n=195)	Week 18 (n=195)	Week 19 (n=195)	Week 20 (n=195)
Breed and system											
	Extensive x Kuroiler	814.00^{a}	885.98^{a}	1008.93^{a}	1121.25^{a}	1206.55^{a}	1340.44^{a}	1412.30^{a}	1539.39^{a}	1696.27^{a}	1829.34^{a}
	Extensive x local	478.51^{b}	539.12^{b}	590.68^{b}	634.21^{b}	689.32^{b}	734.83^{b}	788.43^{b}	834.29^{b}	881.29^{b}	941.86^{b}
	Intensive x Kuroiler	1304.08^{c}	1416.45^{c}	1567.22^{c}	1686.50^{c}	1832.00^{c}	1999.57^{c}	2102.57^{c}	2217.14^{c}	2288.59^{c}	2378.56^{c}
	Intensive x local	851.03^{ad}	956.34^{ad}	1049.13^{ad}	1130.52^{ad}	12.47.76^{ad}	1370.32^{ad}	1478.91^{ad}	1568.58^{ad}	1630.93^{ad}	166170^{ad}
LSD		56.01	65.70	67.70	70.89	71.75	89.34	97.67	102.99	107.14	110.3
Breed and Location											
	Gulu x KK	1184.17^{a}	1295.16^{a}	1405.44^{a}	1520.55^{a}	1670^{a}	1878.83^{a}	1989.07^{a}	2153.03^{a}	2280.64^{a}	2410.54^{a}
	Gulu x LL	722.08^{b}	836.44^{b}	930.31^{b}	1007.21^{b}	1126.16^{b}	1247.57^{b}	1350.82^{b}	1416.91^{b}	1483.64^{b}	1542.64^{b}
	Kiryandongo x KK	961.45^{c}	1044.16^{c}	1223.62^{c}	1341.04^{c}	1419.34^{c}	1532.70^{c}	1599.04^{c}	1669.36^{c}	1755.65^{c}	1840.02^{c}
	Kiryandongo x LL	665.58^{bd}	747.19^{bd}	812.39^{bd}	874.24^{bd}	943.96^{d}	1010.54^{d}	1083.24^{d}	1161.72^{d}	1208.76^{d}	1236.18^{d}
LSD		78.66	89.33	95.78	100.06	111.05	120.19	128.77	131.63	129.47	125.3
Breed and Sex											
	Female x KK	989.43^{a}	1073.75^{a}	1217.86^{a}	1318.04	1415.65^{a}	1551.31^{a}	1626.22^{a}	1728.31^{a}	1828.22^{a}	1931.72^{a}
	Female x LL	675.34^{b}	772.64^{b}	852.52^{b}	924.85	1018.32^{b}	1110.56^{b}	1195.98^{b}	1258.88^{b}	1329.08^{b}	1368.10^{b}
	Male x KK	1236.02^{c}	1351.46^{c}	1494.98^{c}	1638.30	1798.80^{c}	1973.97^{c}	2086.56^{c}	2234.46^{c}	2355.50^{c}	2471.92^{c}
	Male x LL	722.00^{bd}	816.85^{bd}	894.05^{bd}	958.42^{bd}	1050.74^{bd}	1143.82^{bd}	1234.00^{bd}	1323.25^{bd}	1355.91^{bd}	1404.05^{bd}
LSD		78.55	89.19	94.30	97.49	109.12	120.2	121.6	133.4	132.70	131.29

^{a,b,c,d} Means within variable and level having different superscripts differ significantly ($P<0.05$)

The effect of location on t body weight of the chickens was significant at certain periods and not at others. Before the age of nine weeks, there was no difference in weight of the chickens (Table 5.3), but after that, till the 20th week, chickens reared in Gulu district were significantly heavier (P<0.05) than those reared in Kiryandongo district. At 10 weeks, chickens in Gulu weighed 805.1 g, translating into a superiority of 75.5 g over those reared in Kiryandongo district. This margin widened to 434.3 g at the 20th weeks of age (Fig. 5.3).

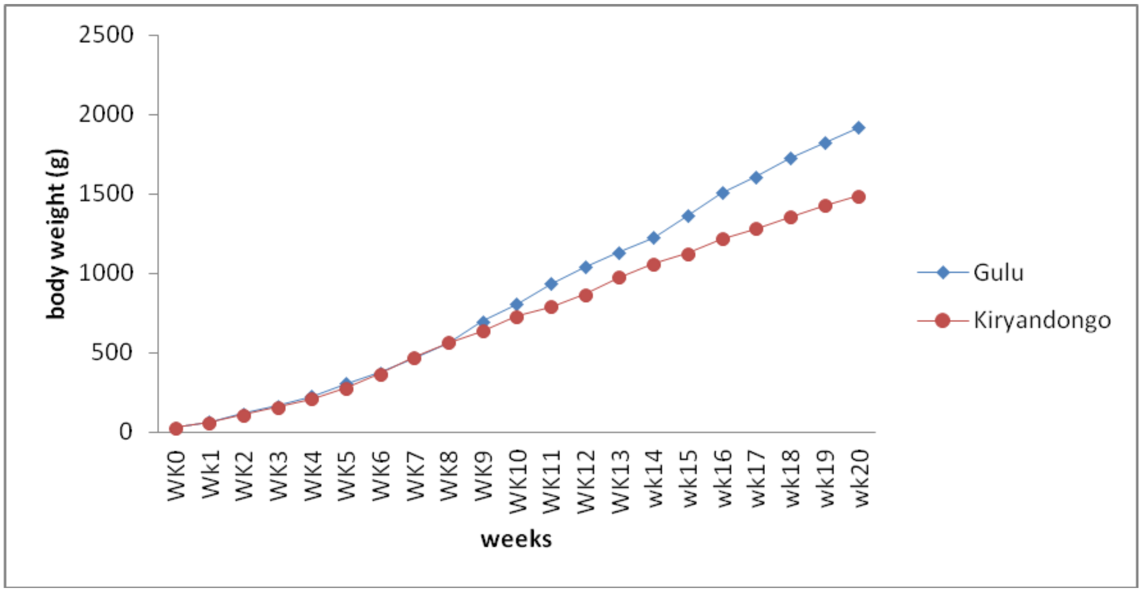

Fig. 5.3: Effect of location on live weight of chickens at various ages

Male chickens had larger weights than females at all stages of the experiment (Table 5.3 and 5.4), however, the variation started being significant (P < 0.05) at two weeks of age when the difference was 10 g. Males were then heavier than females by 21.3 g at the fourth week, 77.3 g at eight weeks, 157.1 g at 12 weeks, 240 g at 16 weeks and 283.1 g at the age of 20 weeks. The relationship of male and female chicken growth is presented graphically in Figure 5.4.

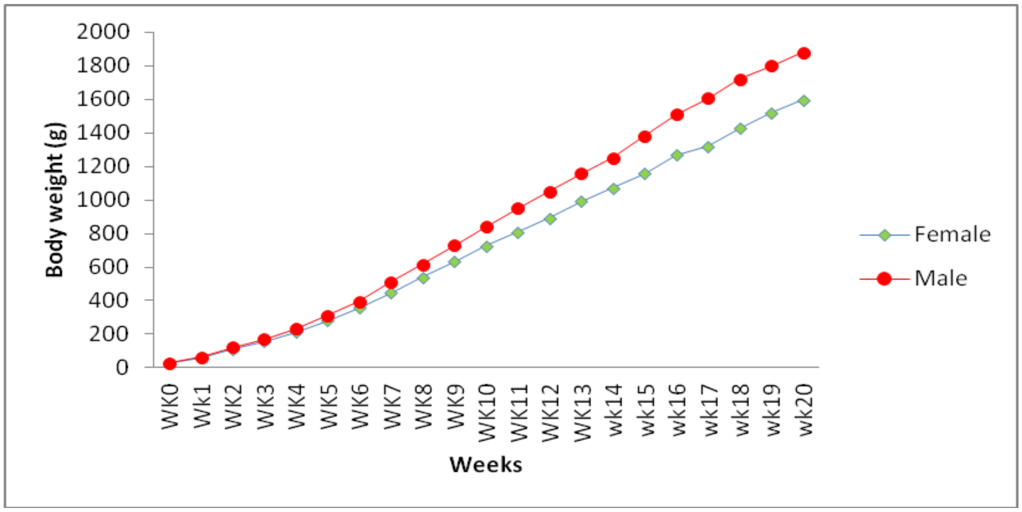

Fig. 5.4: Effect of sex on live weight of chickens at various ages

Chickens reared intensively were heavier than their counterparts that were extensively managed counterparts starting at the fourth week till maturity at week 20 (Fig. 5.5, Table 5.3 and Table 5.4). At the fourth week when the brooded chicks were partitioned into two, the mean weight of those put under intensive and those put under extensive management were similar (161.4 g). After only one week, a significant difference ($P < 0.001$) of 46.7 g was registered. This superiority rose to 351.8 g at the 10th week of age, 595.2 g at the 15th week of age, and 630.5 g at 20 weeks of age.

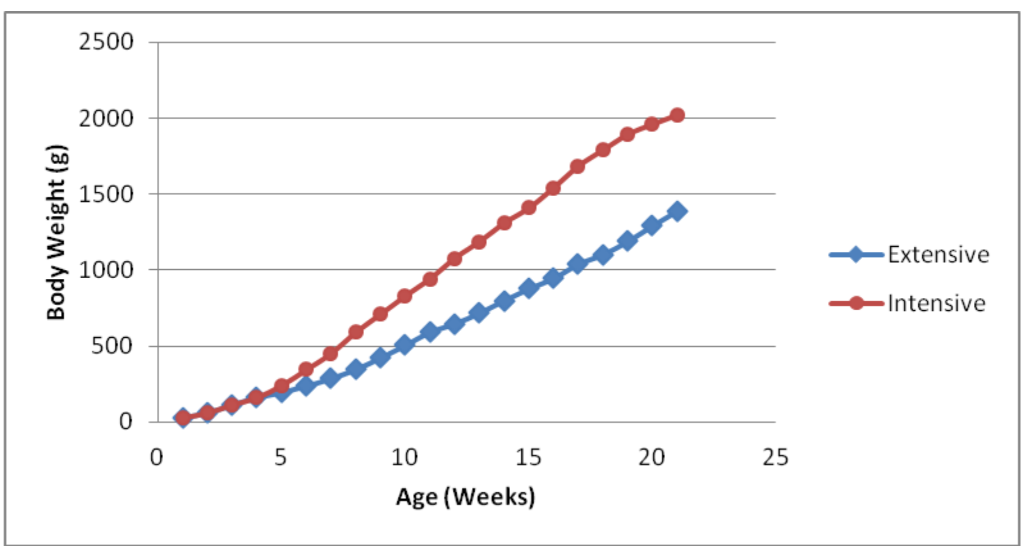

Fig. 5.5: Effect of management system on live weight of chickens at various ages

5.3.3 Effect of breed and location on feed conversion ratio of chickens

The Kuroiler chickens were significantly more efficient in feed conversion at all phases of growth compared to local chickens (Table 5.5). The difference was observed from eight up to twenty month of age. Gulu and Kiryandongo chickens at all ages from one up to twenty weeks, were not significantly different($P>0.05$).

5.3.4 Effect of breed, management system, location and sex on growth rate of the chickens

Over the 20 week study period, the growth rate of the chickens was significantly ($P<0.001$) affected by breed, management system, location, and sex of the chickens (Table 5.6). Kuroiler chickens grew faster than local chickens by an average of 5.38 g/d. Chickens reared intensively grew faster than those reared under extensive/free range by 4.60 g/d. Chickens reared in Gulu district grew faster than those reared in Kiryandongo district by 2.89 g/d, while male chickens grew faster than female chickens by 2.02 g/d over the 20 weeks of the study. The effects of the four factors were also very significant for the first ten (0-10) weeks of the study, and this continued over the subsequent ten (10-20) weeks (Table 5.6). The growth rate of chickens was significantly affected ($P < 0.05$) by all the four factors studied between 0-4, 8-12, and 12-16 weeks. For the period from 4^{th} to 8^{th} weeks the location effect was not significant ($P>0.05$) and so was the effects of management system and sex during in the 16-20 week period.

5.3.5 Mortality rate of chickens between various ages reared under two management systems in two districts of Uganda

Management system showed to have an influence on loss of chickens, the mortality rate was higher in extensive system than intensive over 20 weeks of the study period (Fig.5.6). There were no significant ($P>0.05$) differences observed on breed and location on the mortality rate of chickens (Table 5.7) during the study period.

Table 5.5 FCR of chickens at various ages between 4 and 20 weeks reared under intensive management system in two districts

Variable	Level	Week 4	Week 8	Week 12	Week 16	Week 20
Breed						
	Kuroiler	7.23	4.89[b]	7.38[b]	11.80	15.26[b]
	Local	7.09	8.60[a]	10.90[a]	14.18	21.95[a]
Location						
	Gulu	6.82	6.76	8.88	13.00	18.38
	Kiryandongo	7.50	6.73	9.04	12.98	18.82
LSD		2.30	1.12	2.25	3.90	2.26

[a,b] Means within variable and level having different superscripts differ significantly ($P<0.05$)

Table 5.6: Growth rate (g/d) of chickens between various ages reared under two management systems in two districts of Uganda

Variable	Level	0-4 wks	5-8 wks	9-12 wks	12-16 wks	16-20 wks	0-10 wks	10-20 wks	0-20 wks
Breed									
	Kuroiler	7.34[a]	16.03[a]	17.35[a]	17.86[a]	15.27[a]	13.30[a]	16.47[a]	14.88[a]
	Local	6.40[b]	9.25[b]	10.75[b]	11.54[b]	9.63[b]	8.26[b]	10.74[b]	9.50[b]
Management System									
	Intensive	7.70[a]	17.05[a]	17.43[a]	17.96[a]	12.18	13.36[a]	15.62[a]	14.49[a]
	Extensive	6.05[b]	8.22[b]	10.67[b]	11.44[b]	12.72	8.20[b]	11.59[b]	9.89[b]
Location									
	Gulu	7.10[a]	12.23	16.91[a]	16.95[a]	15.02[a]	11.13[a]	16.14[a]	13.64[a]
	Kiryandongo	6.64[b]	13.04	11.19[b]	12.45[b]	9.88[b]	10.43[b]	11.07[b]	10.75[b]
Sex									
	Male	7.20[a]	13.65[a]	15.44[a]	16.35[a]	13.22	11.56[a]	14.84[a]	13.20[a]
	Female	6.5[b]	11.63[b]	12.63[b]	13.06[b]	11.68	9.99[b]	12.37[b]	11.18[b]
LSD		0.410	1.009	1.415	1.714	1.833	0.618	1.022	0.604

[a,b] Means within variable and age group having different superscripts differ significantly ($P<0.05$)

Table 5.7: Mortality rate (%) of chickens between various ages reared under two management systems in two districts of Uganda

weeks	system		Breed		District		sex	
	χ^2	P value	χ^2	P value	χ^2	P value	χ^2	P value
4-8	12.5	0.13	8.0	0.43	8.0	0.43	8.0	0.43
8-12	8.0	0.33	9.77	0.20	7.1	0.41	8.0	0.33
12-16	7.27	0.20	5.09	0.40	5.09	0.40	5.8	0.32
16-20	2.0	0.36	2.28	0.31	2.0	0.36	2.28	0.31
0-20	12.8	0.30	11.2	0.42	11.2	0.42	12.8	0.30
0-8	12.5	0.13	8.0	0.43	8.0	0.43	8.0	0.43
8-16	10.0	0.26	10.0	0.26	8.0	0.43	10.0	0.26

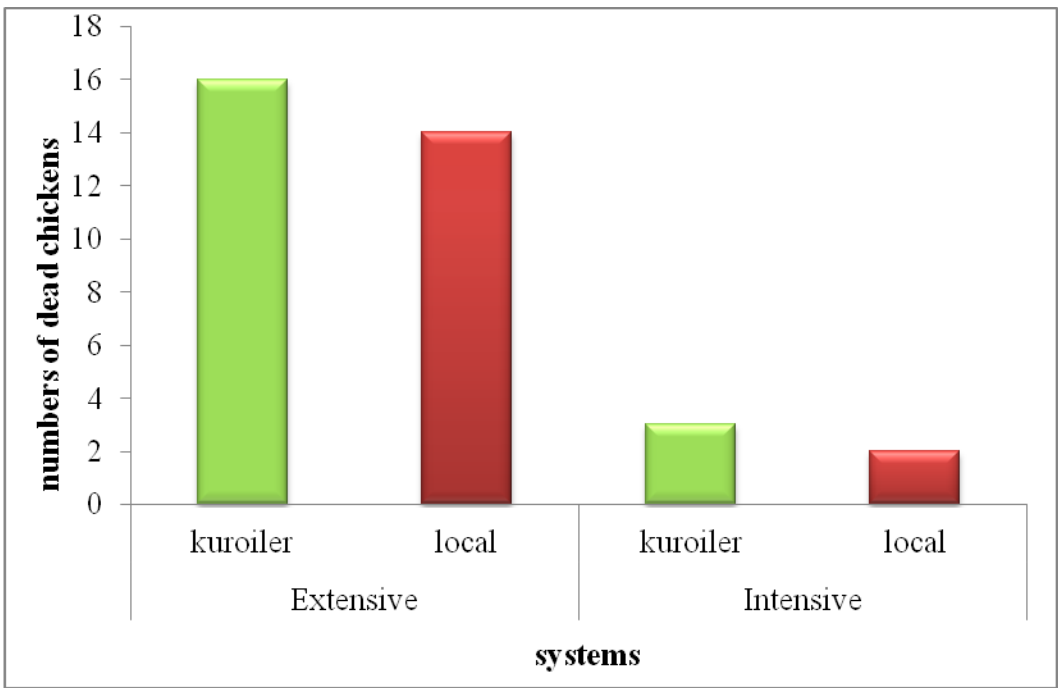

Fig. 5.6: Effect of management system on mortality rate of chickens

5.4 Discussion

5.4.1 Effects of breed and location on feed intake

The feed intake was generally different between the two breeds with Kuroiler having higher intake. Significant breed effect on feed intake among chickens raised in various systems have been reported elsewhere (Nemavhola and Ndlovu, 2000; Tadelle et al., 2003; Reta et al., 2012). Feed intake can be affected by many factors, but the main one is the environmental conditions such as the weather including the temperature of the region (Ferket and Gernat, 2006). This explains why the feed intake was different between Gulu and Kiryandongo during the study period. Being that Gulu is generally cooler than Kiryandongo (Appendix 2 and 3), which is located in the hotter cattle corridor.

5.4.2 Effects of breed, management system, location and sex on live weight of chickens

Live weight of chickens can be affected by genotype, sex and the production system. In this study Kuroiler chickens were significantly heavier ($P<0.05$) than local chickens at all ages irrespective of management system. The key implication of these findings is that even under the free range system, it still makes economic senses to raise Kuroiler chickens, though they would not reach their full potential. Studies on Kuroiler performance in Uganda have reported that Kuroiler chickens can attain 1 kg (for hens) and 1.5 kg (for cocks) at the age of three months; and 3 kg (for hens) and 4 kg (for cocks) at six months (Harth, 2011) under intensive conditions. These weights cannot be attained by local chickens at this age. Mikulsk et al. (2011) observed a high weight difference ($P<0.01$) between a fast growing and slow growing chicken breed. Binda et al. (2012) also reported that body weight at various ages among the improved breed and local ecotypes of chickens differ significantly.

Management systems of chickens have varied effects on the live weights as in this study chicken reared under intensive system had higher live weights than those under the extensive system. The same results have been observed in local cocks reared under three management systems in Uganda. The study showed that cocks under intensive had larger live weights than those under the run (semi-intensive) and free range systems (Magala et al., 2012a). Dou et al. (2009) found similar results on performance, with chickens reared under intensive having higher live weight than those under extensive system. Birds reared under extensive systems perform poorly because they face many challenges such as insufficient feed, poor quality feeds, high ambient temperatures, high light intensity and also long distances walked while searching for feed. The latter makes birds to use a lot of energy and this would have otherwise contributed to growth (Fanatico et al., 2007; Goromela et al., 2008; Wang et al., 2009; Kingori et al., 2010; Magala et al., 2012a). The sex of chickens in this study influenced the live weight and that was also reported by Apuno et al. (2011) who found that cocks were significantly ($P<0.05$) heavier than hens in the Nigeria. Similarly Mwalusanya et al. (2001) in his study on local chickens of Tanzania reared under free range system found that cocks were heavier than hens with an average of 1948 g and 1348 g for cocks and hens, respectively. Chickens in Gulu district had higher body weight than those in Kiryandongo, this is because of the difference weather between the two locations. The situation of birds of the same breed performing differently in different locations of the same country was also reported by Apuno et al. (2011) who found that chickens had significantly different body weights in different localities Nigeria.

5.4.3 Effects of breed and location on feed conversion ratio of chickens

Feed conversion ratio (FCR) is a measure of how well a flock converts feed into live weight. The FCR of chickens mostly depends on the genotype. Improved breeds have better FCR than local chickens under the same management system. In the present study, Kuroiler chickens had better FCR than local chickens. Binda et al. (2012) reported that feed conversion ratio significantly differs ($P<0.01$) between exotic strains and the local ecotypes. In Bangladesh broiler chickens of Cobb 500 line attained the highest FCR compared to the rest of the test breeds (Dutta et al., 2012).

5.4.4 Effects of breed, management system, location and sex on growth rate of chickens

The effect of management system is consistent to that reported by Wang et al. (2009) and Dou et al. (2009) that the growth of slow-growing chickens in the extensive system was much lower than that of similar chickens in the intensive system in China. The same results have been reported by Magala et al. (2012a) on local chicken in Uganda that cocks reared in an intensive system grew faster than those in the extensive system. Chen et al. (2013) reported that the growth of broilers under extensive system is significantly lower than broiler kept in intensive system ($P<0.05$). Another study by Castellini et al. (2002) reported that broilers raised in an organic system showed a lower growth rate compared to those reared under the intensive system. Breeds of chickens have different genetic potential for growth and this explains why Kuroiler chickens grew faster than the local chickens. This has also been shown by Dana et al. (2011) who reported that the growth of chickens is moderately dependent on genetics of the chickens. Reta et al. (2012) got also different performance between two breeds of chicken in Ethiopia. In their study the RIR chickens showed faster rate of growth compared to the Fayoumi (Reta et al., 2012). The growth performance of chicken is mostly affect by the environment, which reflects the differences in location. In this study chickens in Gulu performed better than those in Kiryandongo. Mutayoba et al. (2012) showed that growth of local chickens in Tanzania significantly differed ($P< 0.05$) between locations. The sex of chickens is one of the factors which affect the in growth performance. Salim et al. (2011) reported that male chickens showed significantly higher ($P<0.05$) growth performance than females. Osei-Amponsah et al. (2012) indicated that male chickens have significantly ($P<0.05$) superior growth rate than females across all genotypes of local chickens in Ghana.

5.4.5 Mortality rate of chicken reared under intensive and extensive system in Kiryandongo and Gulu Districts

Management system influenced death of chickens. In this study, mortality rate was higher in extensive system than in intensive system over a period of 20 weeks of the study period. The same results have been reported by Abalaka et al. (2013) who found that the extensive system increased the rate of death of chickens than other management system in Nigeria. Genetic make up of chickens makes some to survive better than others. Grobbelaar et al. (2010) reported that mortality rate significantly differs among indigenous chickens of South Africa. Demeke (2003) found that local breeds of Ethiopia survive better than exotic breeds introduced in rural area under free range. However, Halima et al. (2006) in his study found that Rhode Island Red survive better than the local breed under intensive system. This is because confinement of indigenous chickens results in high stress levels and associated high infection pressure from pathogens causing high morbidity and mortality. Awobajo et al. (2007) found that mortality rate significantly ($P<0.001$) differed between two breeds of broiler from brooding to maturity stage. These findings are different from the results of this study, in which Kuroiler and Local chickens showed no difference on the survive rate. Geographic location can influence the survival rate of chickens. Aberra et al. (2013) and Alem (2014) reported that chickens in midland of Ethiopia survive better than chickens in other agro-ecological zones. But in this study location had no effect on the mortality of chickens during the entire period.

CHAPTER SIX

EVALUATION OF MEAT CHARACTERISTICS OF KUROILER AND LOCAL CHICKENS REARED UNDER EXTENSIVE AND INTENSIVE MANAGEMENT SYSTEMS

6.1 Introduction

Chicken meat is the most preferred meat by consumers, and its global production ranks second with 106 million tones, with the first world meat trade making 13.3 million tons in 2013. This shows how its consumption is still rising dramatically (Chemnitz, 2014). Quality of meat is judged by its tenderness, flavour, color and taste. The quality is influenced by the breed, production system, age at slaughter and the nutritional regime (Sogunle et al., 2010; Sanka and Mbaga, 2014). Management systems of chickens are a key factor which determines meat characteristics. Chickens under extensive system cover a great distance in search of feeds making their meat less tender and less juicy compared to those kept under deep liter and run system (Wattanachant et al., 2004; Magala et al., 2012a). Provision of Supplementary feeds minimizes the distance covered by chicken and improves growth and meat quality.

Local chicken is more preferred by consumers compared to other chicken breeds because of the chewy texture, color and flavor of their meat. Also, consumers prefer them because they contain less drug residue as they are rarely treated using veterinary drugs (Wattanachant et al., 2004; Saowakon et al., 2008; Magala et al., 2012a). Kuroiler chickens are a new breed improved to survive under condition of rural areas just as local chickens (Harth, 2011). However, there is a gap in knowledge about the meat characteristics of Kuroiler compared to that of local chickens reared under intensive and extensive management systems. This made the objective of this part of the wider study.

6.2 Materials and methods

At the age of 20 weeks, one cock from each replicate was selected and fasted for 18 hours before being slaughtered.

6.2.1 Dressing percentage and carcass yield

After slaughtering and evisceration the weights of the hot carcass, organs (intestines, liver, gizzard, heart, proventriculus and the testes) and the head were recorded. The hot carcass, organs and head yield was expressed as percentage of live body weight. Dressing percentage was computed as the ratio between hot carcass weight (without organs, intestines and head) and live body weight. The eviscerated carcasses were chilled at 4^oC for twenty four hours. The cold carcass weight was recorded. Carcass yield was computed as the ratio between the cold carcass (without head) and live body weight. The cold carcass was partitioned into breast, wings, back, neck, thighs and drumsticks. The weight of breast, wings, back, neck, thighs and drumsticks were expressed as percentages of the cold carcass weight.

6.2.2 Carcass pH

The pH of the carcass was recorded on whole intact raw breast muscle (*pectoralis major*) one hour after slaughter (initial pH) as well as after chilling the carcasses for twenty four hours at 1-4^oC (ultimate pH) as described by Qi et al. (2009). A portable pH meter was used.

6.2.3 Drip loss

Samples of muscles from the breast, thigh and drumstick were weighed and suspended in a plastic bag using a string and place in a refrigerator at 1-4^oC (Omojola and Adesahinwa 2007). After forty eight hours, the muscles were weighed again. Drip loss was expressed as the percentage weight loss during refrigeration.

6.2.4 Cooking loss

Samples used for determination of the cooking loss were taken from the breast, thigh and drumstick muscles sealed individually in plastic bags (30 microns thickness) and cooked in a thermostatically controlled water bath at 75^0C for 45 minutes (Rizz et al. 2007). After cooking, the samples were put under running cold water to cool for fifteen minutes. The samples were then dried and weighed. The weight loss during cooking was expressed as the cooking loss percentage

6.2.5 Data analysis

Data analysis was performed using Statistical Analysis Systems, Portable Version 9.1.3 (SAS, 2004). Slaughter parameters were assessed using General Linear Models, with breed and management system of chickens as fixed effects. The model used was:

$$Y_{ijklmn} = \mu + b_i + m_j + e_{ijk} \sim N(0, \sigma^2)$$

where, y is an observation of the trait of an individual chicken of breed *i* reared under management system *j*,: μ = overall mean, b_i = effect of breed (i = 2), m_j = management system effect (j = 2), e_{ijk} is the random effect on the trait, independently and identically distributed with mean = 0 and variance = σ^2.

6.3 Results

6.3.1 Slaughter characteristics of Kuroiler and local cocks raised under two management systems

Dressing percentage and relative organ weights of Kuroiler and local cocks raised under extensive and intensive management system are presented in Tables 6.1. The dressing percentage and relative organ weights of both breed reared under the two management system were similar (P>0.05), but Kuroiler breed tended to have higher dressing percentage than the local breed.

6.3.2 Carcass yield and carcass composition of Kuroiler and local cocks raised under two management systems

Carcass yield and proportion of meats cuts Kuroiler and local cocks reared under intensive and extensive management system are presented in Table 6.2. Although the percentages of breast, thigh, drumsticks, back andfeet did not differ between the two breeds, Kuroiler cocks showed the highest carcass yield (P<0.05), while local cocks showed to have the highest relative wing and neck yield (P<0.05).

Kuroiler cocks muscles and bones were significantly (P<0.05) heavier than those of local cocks (Table 6.3). Management system had significant effect on the weights of breast, lean and the ratio of learn:bone. Cocks under intensive management system had significantly (P<0.05) heavier breast muscles and higher lean: bone ratio.

6.3.3 Chemical and physical characteristics of Kuroiler and local cocks raised under two management systems

The initial pH, the cooking loss and drip loss of carcass muscles did not differ between breeds and management systems (P>0.05) as it is shown in Table 6.4. Chicken reared under extensive management system showed the lowest pH after 24 hours of chilling than those under intensive (P<0.05).

Table 6.1: Comparison of Dressing (%) and non carcass components of chickens belonging to two breeds and reared under two management systems in Uganda

Variable	Level	Dressing (%)	Organ weight (expressed as percentage of live weight)									
			Head	Heart	Liver	Intestines	Gizzard	Proventriculus	Crop	Lungs	Kidney	Testes
Breed												
	Kuroiler	66.75	4.41	0.55	1.41	5.55	2.02	0.30	0.43	0.64	0.09	0.85
	Local	63.02	4.77	0.56	1.69	5.97	1.81	0.38	0.62	0.67	0.13	0.60
Management System												
	Intensive	65.34	4.73	0.63	1.42	5.45	2.15	0.28	0.47	0.60	0.11	0.81
	Extensive	64.42	4.45	0.48	1.68	6.05	1.68	0.40	0.59	0.71	0.11	0.64
LSD		9.464	1.072	0.165	0.254	1.438	0.837	0.129	0.129	0.218	0.040	0.216

[a,b] Means within a variable having similar superscripts in the same column do not differ significantly (P>0.05)

Table 6.2: Effect of breed and management system on relative carcass portions of cock's carcasses

Variable	Level	Cold carcass (g)	Carcass portions (expressed as percentage of cold carcass)						
			Breast	Thigh	Drumstick	Wing	Back	Neck	Feet
Breed									
	Kuroiler	2072.00[a]	22.96	19.95	18.40	11.10[b]	21.63	6.80[b]	5.98
	Local	1158.74[b]	23.78	19.72	18.22	14.06[a]	22.93	8.96[a]	7.22
Management System									
	Intensive	1718.40	24.81	20.38	18.49	12.34	22.81	8.17	6.65
	Extensive	1512.33	21.99	19.29	17.77	12.82	21.74	7.59	6.55
LSD		373.5	3.11	2.13	2.39	1.76	3.81	1.76	1.745

[a,b] Means within a variable having different superscripts in the same column differ significantly (P<0.05)

Table 6.3: Effect of breed and management system on relative learn and born of cock's portion carcasses

		Muscles with bone (g)			Muscles only (g)			Total Lean and bone		
Variable	**Level**	**Breast**	**Drumstick**	**Thigh**	**Breast**	**Drumstick**	**Thigh**	**lean(g)**	**bone(g)**	**Lean:bone**
Breed										
	Kuroiler	479.66^a	372.33^a	414.00^a	302.66^a	217.66^a	304.00^a	824.33^a	491.66^a	1.87
	Local	268.11^b	209.37^b	225.40^b	138.37^b	124.33^b	169.22^b	422.92^b	279.96^b	1.53
Management System										
	Intensive	418.44	310.37	347.07	256.03^a	194.66	266.22	716.92	358.96	1.91^a
	Extensive	329.33	271.33	292.33	185.00^b	147.33	198.00	530.33	362.66	1.45^b
LSD		84.693	60.048	68.237	50.24	46.227	84.195	156.43	66.66	0.29

^{a,b} Means within a variable having different superscripts differ significantly (P<0.05)

Table 6.4: Comparison of chemical and physical properties of muscles of two breeds of chickens reared under two management systems in Uganda

		Chemical properties		Physical properties					
		Initial pH	Ultimate pH	Drip Loss (%)			Cooking Loss (%)		
Variable	**Level**			**Breast**	**Thigh**	**Drumstick**	**Breast**	**Thigh**	**Drumstick**
Breed									
	Kuroiler	6.10	5.54	3.74	5.26	4.94	26.42	29.79	28.11
	Local	6.05	5.49	4.48	5.21	5.34	21.36	26.23	27.18
Management System									
	Intensive	6.04	5.82^a	4.37	5.27	5.28	26.54	29.12	28.82
	Extensive	6.10	5.22^b	3.85	5.21	5.01	21.54	26.89	26.82
LSD		0.174	0.191	0.934	1.117	1.292	4.159	4.974	4.242

^{a,b} Means within a variable having different superscripts in the same column differ significantly (P<0.05)

6.4 Discussion

6.4.1 Slaughter characteristics of Kuroiler and local cocks raised under two management systems

Slaughtering characteristics of chicken meat can differ between breed and management system. Studies elsewhere indicated that dressing percentage, heart weight, liver weight and abdominal fat weight were significantly (P<0.01) different in Anka and Rugao breeds in China (Musa et al. 2006). In this study, there were no differences observed between breeds or management systems (P>0.05). The same results have been reported by Jaturasitha et al. (2008) that the dressing percentages of two local breeds and two improved breeds are not significantly different. Similarly, Olawumi et al. (2012) showed that the dressing percentages of different strains of broiler chicken do not differ significantly (P>0.05). Management system of birds is one of the factors which influence the performance of chickens and their meat characteristics. However, Magala et al. (2012b) found no difference (P>0.05) on dressing percentages of local cocks reared under extensive and intensive systems but those under semi-intensive system differed (P<0.05). Połtowicz and Doktor (2011) reported that the management system had no significant effect on dressing percentage.

6.4.2 Carcass yield and carcass composition of Kuroiler and local cocks raised under two management systems

Results showed significant differences in carcass weights of the two breeds, but the management system did not affect the carcass yield of the cocks. The same results on the breed was observe on different strains of broiler which showed significant (P<0.05) difference in terms of carcass weight (Karima and Fathy, 2005). Ojedapo et al. (2008) also obtained the same results on carcass weight of three commercial broiler breeds reared under intensive management system. Similarly, Nakarin et al. (2014) reported significant difference between three chicken breeds in Thailand. Franco et al. (2012) reported that carcass weights clearly differ between two genotypes due to the lower growth rate of one of the breed. The different genetic potential for growth performance of chicken breeds leads to different potential for deposition of muscles and this result into different live weights and carcass weights. Zhao et al. (2009) founds that broiler breeds have higher carcass, breast, and thigh yields than indigenous chickens. However, Jaturasitha et al. (2008) reported no significance difference (P>0.05) in carcass yield of four indigenous chickens. Also, Dou et al. (2009) reported no difference in eviscerated carcass, breast and thigh percentages among three raising systems. Other findings showed that outdoor rearing has no effect on carcass yield of broiler chicken in China (Chen et al., 2013). No difference between intensive and semi-intensive systems on breast, thigh and drumstick meat of local chicken was also reported in Tanzania (Sanka and Mbaga, 2014). Lean and bone weights on the breast, drumstick and thigh portion of the cock's carcasses for Kuroiler and local chicken were found to be significantly different in this study. These results are related to those of Jaturasitha et al. (2008) who found that breast muscles of four different breeds were significantly different.

6.4.3 Chemical and physical characteristics of Kuroiler and local cocks raised under two management systems

Genetic potential such as the genetic type, the breed, the line or the strain on meat quality traits in poultry affects several characteristics of chicken meat quality (Tougan et al., 2013). In this study Kuroiler and local cocks did not show any difference in form of physical and chemical properties. After slaughter the glycogen in the muscle is converted into lactic acid causing a fall in pH from an initial value, and this explain the low pH of breast muscle after 24 hours of chilling. Chicken from the extensive system had muscles with higher glycogen reserves and that made it to have a lower ultimate pH (Smith and Northcutt, 2009). Low pH implies a long shelf life because it increase the lag phase time of psychrotrophic bacteria that are known to spoil meat. The rate of pH can also be reduced by the glycolytic enzyme just after death (Allen et al., 1997; Fanatico et al., 2007; Magala et al., 2012b). These results are consistent to those of Jaturasitha et al. (2008) who found no significant difference between the pH of four chicken breeds. However, Musa et al. (2006) reported significant differences in the pH values between breeds. For water holding capacity, no differences were noted between breeds. Díaz et al. (2010) also reported a significant ($P<0.05$) difference on ultimate pH of capon cocks of different breeds.

This study showed a significant difference ($P<0.05$) in pH of meat from cocks. This is consistent with the results of Magala et al. (2012b) who found that pH of cocks reared under intensive and extensive management differed. The cooking loss and the drip loss did not differ significantly among the local chicken meat raised under the three management system in Uganda. Similar findings have been reported by Sanka and Mbaga (2014) that chicken rearing system does not affect the pH of the meat. The same results have been reported by Wang et al. (2009) who found that the pH values of the muscle are largely unaffected ($P>0.05$) by the raising system of the chickens. Chen et al. (2013) showed that there is no significant difference on cooking and drip loss of broiler chicken reared under extensive management system.

CHAPTER SEVEN
GENERAL DISCUSSION, CONCLUSION AND RECOMMENDATIONS

7.1 General discussion

The majority of homesteads in both districts were headed by males, in agreement with previous studies done in eastern (Kugonza et al., 2008) and western Uganda (Mujuni et al., 2012). However, in the current study a larger number of female headed households were observed in Gulu than in Kiryandongo and this can be explain by the civil war which was recently in the region, and left most of the families with orphans and widows.

Chickens in both districts reach sexual maturity at six months. The same observation has been made in other studies in Uganda, indicating that local chickens reach sexual maturity on average between five and seven months of age. Local chickens northern Uganda had three egg laying cycles per year, just like chickens in central (Kyarisiima et al., 2004) and eastern Uganda (Kugonza et al., 2008; Natukunda et al., 2011). In the Accra plains of Ghana local chickens were also found to lay between 3 and 4 cycles per year (Aboe et al., 2006). The local chickens lay thirteen eggs on average per clutch. Farmers in Kiryandongo and Gulu generally kept local chickens and they did not practice cross breeding for flock genetic improvement. Farmers in both districts reported to do selection of their breeding stock. Big body size was a trait of great interest for farmers and was applied on both sires and dam. In addition, height and plumage color for males were also considered. Hens with high egg production and better hatching and mothering ability were also selected for breeding.

Most of the farmers provided night shelter for their chickens. This has also been observed for other famers in Kumi and Kamuli Districts of Uganda (Kugonza et al 2008; Natukunda et al. 2011). Some farmers in Gulu preferred to leave their chickens on the tree for overnight. Though, this should be discouraged as it exposes the birds to vagaries of nature and theft. Chicks were reported to be the age group that suffers the highest mortality rate probably because of being young they have low immunity to disease pathogens and since most farmers of local chickens do not vaccinate as do farmers of exotics layer/broiler types, the unvaccinated chicks easily succumb. Newcastle disease which has been reported by most contemporary studies in Uganda

(Kyarisiima et al., 2004; Kugonza et al., 2008 and Natukunda et al., 2011) was the most common disease mentioned by farmers to be the cause of chicken loss in both districts.

Breed, management system, location and sex affected the live weight gain and the growth rate of chickens, from the onset of the experiment to the end. Breeds influenced the growth of birds from day old up to the end of the study, with Kuroiler chickens being heavier than local chickens. Management system affected the growth of chickens, with intensive management resulting into higher growth performance of chickens compared to extensive management. This observation was also made by Magala et al. (2012a) and Dou et al. (2009). Chicken located in Gulu districts showed better growth rate than those in Kiryandongo while male chickens in this study were heavier than females. The feed intake was significantly higher for Kuroiler chickens than that of local chickens under intensive management system. This has been reported in other studies (Reta et al. 2012; Nemavhola and Ndlovu 2000; Tadelle et al. 2003). Similarly the FCR was better for Kuroiler chicken than local chickens. Kuroiler chickens under extensive management showed a better growth performance than local chickens in intensive management. That simply indicates that the productivity of smallholder farmer could increase by rearing Kuroiler chickens on free range when they don't have possibilities of acquiring commercial feeds.

Kuroiler cocks had higher dressing percentage than local chickens, though the difference was not significant ($P>0.05$). Jaturasitha et al. (2008) reported that the dressing percentages of local breeds and improved breeds are not significant different. Olawumi et al. (2012) showed that the dressing percentages of different strains of broiler birds are not significantly different ($P>0.05$). In this study, Kuroiler cocks had higher carcass yield than locals. The differences in carcass yield of different breeds have also been reported in other studies (Karima and Fathy, 2005; Ojedapo et al., 2008). Local cocks had higher wing and neck relative yield. Kuroiler cock muscles and bones from breast, drumsticks and thighs parts were significantly heavier ($P<0.05$) than those of local chickens. The differences on chemical and physical properties of Kuroiler and local cocks were only observed on the ultimate pH of cocks under different management systems. Cocks under extensive system showed the lowest ultimate pH than those under intensive management. Meat of Kuroiler and local cocks showed no differences on physico-chemical properties. Diaz *et al*. (2010) also reported the same results in the study on chemical composition and physico-chemical properties of different breeds of chickens. This result shows that Kuroiler chicken meat could easily be accepted by consumer and the productivity of small holder famer will improve since Kuroiler chickens are more expensive than local chickens at the market level.

7.2 Conclusion

Chickens are very important for farmers of Kiryandongo and Gulu districts, and most of the farmers do practice selection of their birds and they do not prefer cross breeding of the local chickens with exotics breeds. Growth of chickens is influenced by breed, management system, location and the sex of the birds. Kuroiler chicken showed better growth performance than local chickens from day old up to the end of the study. Intensive management system showed good performance with respect to the growth performance of chickens than extensive management system. Male chickens grew faster than female chickens. Chickens raised in Gulu had higher growth performance than those in Kiryandongo. Kuroiler cocks have higher carcass yield than local chickens and muscles of Kuroiler and local cocks have similar chemical and physical properties.

7.3 Recommendations

In general, this study sought to understand the growth performance of Kuroiler chickens compared to local chickens of Nothern Uganda. In order to contribute improved chicken productivity, the following recommendations are made:

1. Chickens productivity could be enhanced by improving the genotypes of their flock and also by reducing the inbreeding mostly occurred because of the long duration of keeping a cock in the flock. The prevention of predators and diseases by vaccination will reduce flock losses and increase flock productivity.
2. Kuroiler chickens are recommended to be reared because they showed ability to improve productivity of farmers since these chickens have better growth performance than local chickens under intensive and extensive management system.
3. A study on reproduction performance of Kuroiler chickens under different management system and their crosses with local chickens is also recommended for further evaluation.

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Qn. No.

APPENDIX 1: SURVEY QUESTIONNAIRE

Characterisation of local chicken production in Northern Uganda

Note: The enumerator should assure the respondent of the confidentiality of the information provided

A **Location**

1 Date of interview ……………

2 Village…………………………………….

3 Parish ………………………

4 Sub-County…………………….

5 District ………………………

6 GPS ………………………………..

B **General information on the Household Head**

7 Name of household head ……………..………………….. Phone Contact:……….

8 Position of respondent in the household

- [ ] Household head
- [ ] Spouse
- [ ] Child in a home
- [ ] Other form of dependent (specify) ………………………

9. Sex

Male	
Female	

10 Age (years)……………

11 Marital status of household head

- [ ] Married
- [ ] Single
- [ ] Divorced
- [ ] Widowed

12 Number of people in the household

Children ≤ 15yrs

Males	
Females	

Adults ≥15yrs

Males	
Females	

13 Highest level of education attained (e.g. P.6)………………

14 Major farming activity (Rank)

- [ ] Food crop production
- [ ] Livestock production
- [ ] Cash crop production

15 Rank the livestock species kept in your home

Rank	Name of species

16 Land holding (acres)

Grazing land	Crops

17 Type of land tenure system used

- [ ] Communal
- [ ] Leasehold
- [ ] Private/Freehold
- [ ] Public land
- [ ] Customary/ clan

C **<u>Information on indigenous chicken production</u>**

18 Type of chicken production system practiced

- [ ] Free range (scavenging) only
- [ ] Free range (scavenging + Seasonal supplementation
- [ ] Semi scavenging (free range + Regular supplementation)
- [ ] Intensive system

19 How long have you been rearing local chickens? (years)………………….

20 Who owns chicken in this home? (tick whichever is applicable)

- [ ] Mother
- [ ] Father
- [ ] Children
- [ ] Other relatives
- [ ] Joint family ownership

21. Mode of acquiring chickens

- [ ] Purchased them
- [ ] Given as a gift
- [ ] Exchanged for labour
- [ ] Others (specify)…………

22 How did you get the knowledge to start rearing chicken?

- [ ] Learning from my parents
- [ ] From my own initiative
- [ ] From colleagues and neighbors
- [ ] Formal training
- [ ] Others (Specify)…………………

23 Flock composition.

Composition	Numbers
Cocks	
Hens	
Pullets	
Cockerels	
Chicks	
Total	

24 Age (months) when males start mounting

………………………………………………

25. Age (months) at which females start laying.

………………………………………………

26 Egg laying cycles your hens have in a year 27. Eggs the hens lay per cycle (clutch size)

………………………………………………. …………………………………………

28 Average number of eggs you give to your hens for natural incubation

……………………………………………….

29 Average number of chicks you get at a single hatching per cycle

……………………………………………….

30 How many of the hatched chicks survive up to weaning? …………………………………………..

31 How do you hatch eggs? [ ] Naturally [ ] Artificially

32 If natural method, which one of these below do you use?

- [ ] Acholi traditional nest
- [ ] Brooding box
- [ ] Other …………………………….(specify)

33 What unique observations have you made regarding your laying hens?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

D **Breeding management**

34 Which breed of chicken do you have?

- [ ] Local
- [ ] Exotic (specify) ……………….…………
- [ ] Crossbred (specify) ……………………..

35 Which kind of local chicken do you keep (give name and describe)

……………………………………………………………………………………………………

……………………………………………………………………………………………………

36 Do you carry out selection for your breeding stock?

Yes [ ] No [ ]

37 If yes what attributes do you consider when selecting a breeding cock:

……………………………………………………………………………………………………

……………………………………………………………………………………………………

38 ……………………………………………………………………………………………………

For how long do you keep a breeding cock in the flock?...

39 What attributes do you consider when selecting a breeding hen:

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

40 Do you carry out cross-breeding among chickens in your flock?

Yes ☐ No ☐

41 If yes has it been of benefit to you?

Yes ☐ No ☐

42 How is this cross breeding done?

☐ Random mating.

☐ Organized (controlled mating)

43 Which constraints do you face when you cross breed chickens?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

44 Suggest ways on how these constraints can be addressed.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

E **<u>Housing</u>**

45 In which facility do your birds shelter overnight?

☐ Complete enclosure

☐ Rest on trees

☐ On the veranda

46 If enclosure what is the dimension of the structure?

……………………………………………………………………………………………

47 If trees how many trees do your chickens stay in?

……

48 What management practices do you often undertake to maintain the housing facility in a good condition?

………………………………………………………………………………………………………..

……

F **<u>Poultry products and their utilization</u>**

49 How do you utilize products from the chickens you rear? (give rank in the table below)

Mode of utilization	Sell to get money	Home consumption	Cultural functions	Exchange for labour	Hatching
Eggs					
Chicken					Xxxxxxxx

50 How do you dispose of the chicken wastes?

☐ Used as manure.

☐ Not put to use in any way.

G **<u>Production costs, profitability and marketing of poultry products</u>**

51 How much money do you spend on management of your flock in a month on average?

……

52 If sold what is the average price of :

An egg…………………………

Per tray…………………………..

Mature cock……………………

Mature hen………………………..

53 How much money do you earn from rearing local chicken in a year on average?

……

……

54 How do you market your products?

☐ Sell to middlemen

☐ Sell directly to consumers.

H **<u>Mortality and Disease management</u>**

55 Which chicken group has the highest mortality rates?

- [ ] Chicks
- [ ] Cocks
- [ ] Hens
- [ ] Pullets and cockerels

56. What are the causes of mortality (rank)

……………………………………………

……………………………………………

……………………………………………

……………………………………………

57 Name the major three diseases

………………………………………………..

………………………………………………..

………………………………………………..

………………………………………………..

58. During which periods of the year are the mortality rates highest?

- [ ] Dry Season
- [ ] Rainy Season

59 What measures do you undertake to avoid many deaths in case of disease outbreak?

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

60 Mention the treatment that is given to the birds with diseases

……………………………………………………………………………………

……………………………………………………………………………………

I **Extension and veterinary services**

61 Do you get any technical assistance or extension services in management of your flock from a government worker or any other service provider?

Yes [ ] No [ ]

62 If yes, how often?

- [ ] Very Often
- [ ] Rarely

63 If no why?

……………………………………………………………………………………

……………………………………………………………………………………

64 What are the different sources of extension information in chicken management?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

65 Do you belong to any organization/group that supports chicken rearing?

☐ YES

☐ NO

66 If Yes, what is the name of the organisation?

……………………………………………………………………………………………………

……………………………………………………………………………………………………

67 What benefit do you get as a member?

……………………………………………………………………………………………………

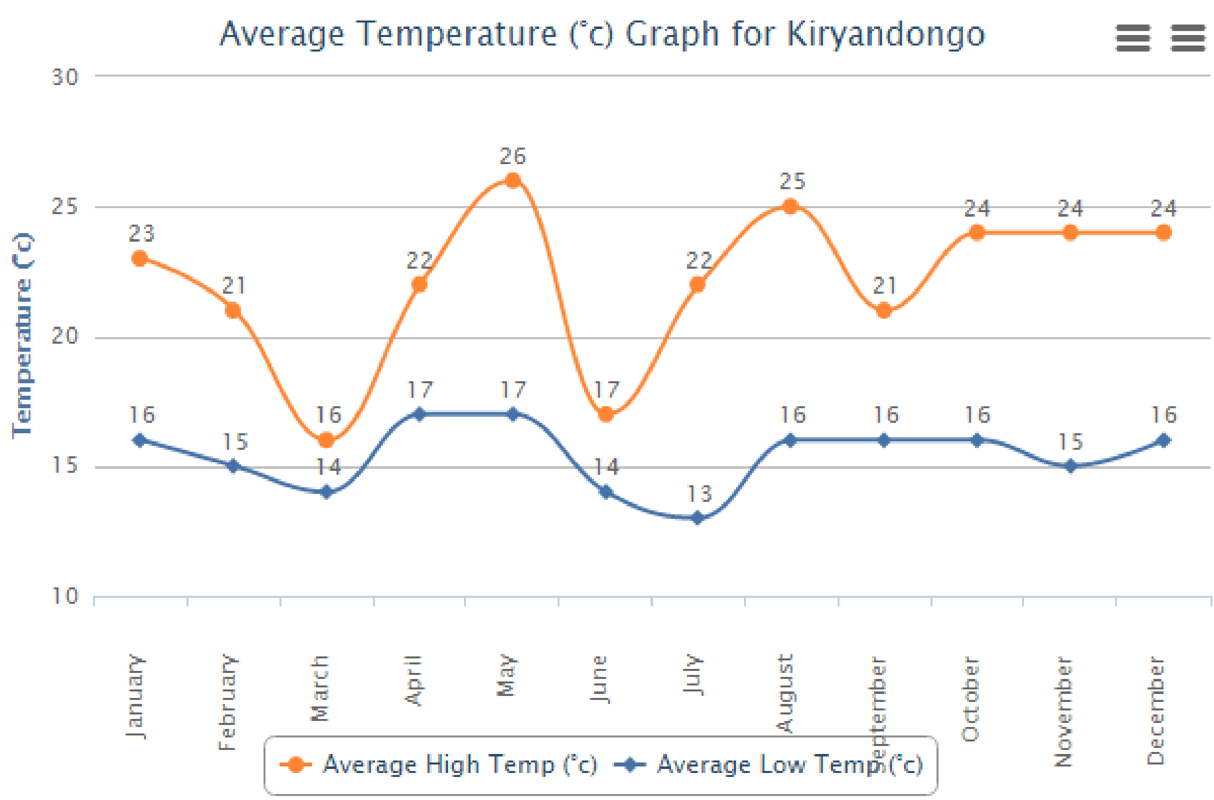
……………………………………………………………………………………………………

……………………………………………………………………………………………………

END

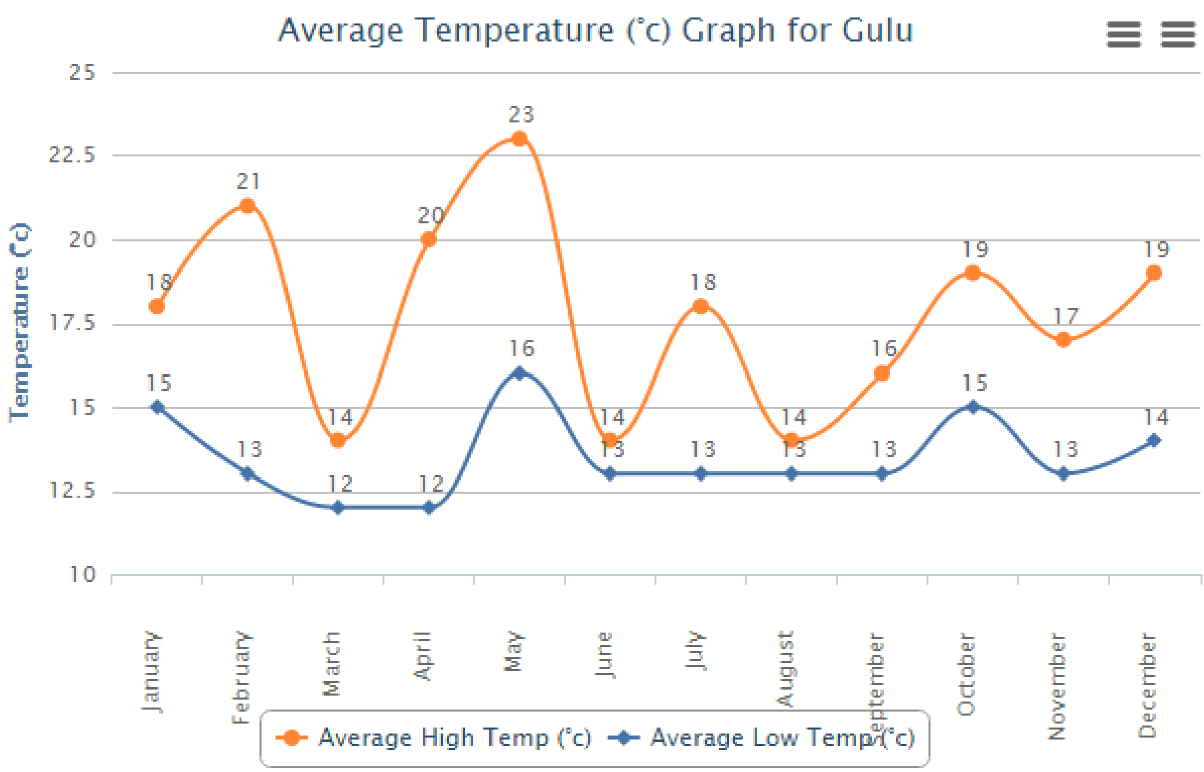
THANK YOU VERY MUCH

APPENDIX 2: Average temperature of Kiryandongo District



Source: http://www.worldweatheronline.com/Kiryandongo-weather-averages/Hoima/UG.aspx

APPENDIX 3: Average temperature of Gulu District



Source: http://www.worldweatheronline.com/Gulu-weather-averages/Gulu/UG.aspx