

**EFFECT OF DIFFERENT MANAGEMENT SYSTEMS ON
HAEMATOLOGICAL PARAMETERS IN LAYER CHICKENS**

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**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE
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ABSTRACT

A study was conducted at the Department of Animal Science and Production, Sokoine University of Agriculture. The aim was to study the effect of different management systems on haematological parameters in layer chickens. Three management systems which are battery cage, deep litter and semi-intensive were involved. Ninety layer chickens, Rhode Island Red, eight weeks old were used. Thirty chickens were placed in each of the three systems. Seven chickens from each management system were selected randomly for blood collection. Blood was collected in every two weeks for two months. Blood was used to analyse for hematological parameters. It was observed that, RBC ($\times 10^6/\mu\text{l}$), PCV (%), Hb (g %) increased as the age of chicken was increasing. ESR (mm), MCH (pg) and MCHC (%) decreased as age of chickens was increasing. All mean values for the RBC ($\times 10^6/\mu\text{l}$), and WBC ($\times 10^4/\mu\text{l}$) count, PCV (%), Hb (g %), ESR (mm), MCH (pg) and MCHC (%) did not differ ($P>0.05$) significantly among the management systems. No significant effect of management system on hematological parameters was observed. The differences in the values of hematological parameters among the management systems observed to be probably due to changes brought about by age and individual bird variation. Concluding that RBC ($\times 10^6/\mu\text{l}$), PCV (%), and Hb (g %), had a direct relationship with age while ESR (mm), MCH (pg) and MCHC (%) were indirectly related. Since no significant effect was observed in the haematological parameters for the chickens under the three management systems, then other factors such as risk of diseases, sanitation, costs should be considered in deciding which system to be used. Deep litter system is advocated to be used by the poultry keeper because of its less cost and less risk of predators, and climatic extreme changes.

DECLARATION

I, Jumanne Magnus Nyaulingo, do hereby declare to the Senate of Sokoine University of Agriculture that this is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

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The above declaration is confirmed

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Date

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LIST OF ABBREVIATIONS AND SYMBOLS

ANOVA	Analysis of Variance
BC	Battery Cage
CCs	Conventional Cages
CP	Crude Protein
CF	Crude Fibre
DL	Deep Litter
DASP	Department of Animal Science and Production
EDTA	Ethylene Diamine Tetraacetic Acid
ESR	Erythrocyte Sedimentation Rate
EU	European Union
FAO	Food and Agriculture Organization
FCs	Furnished Cages
G	gram
>	Greater than
<	Less than
Hb	Hemoglobin
HCl	Hydrochloric acid
WBC	White Blood Cell
MS	Management System
MCH	Mean Corpuscular Hemoglobin
MCHC	Mean Corpuscular Hemoglobin Concentration
m	meter
M ²	Meter squared
µl	Microlitre

ml	Milliliter
Mm	Millimeter
NRBC	Nucleated Red Blood Cells
PCV	Packed Cell Volume
%	Percentage
Pg	Picogram
±	Plus or minus
RBC	Red Blood Cell
RIR	Rhode Island Red
SAS	Statistical Analysis System
SE	Standard Error
SI	Semi- Intensive
SUA	Sokoine University of Agriculture
Tsh	Tanzania shillings
UPC	Utility Poultry Club
Wt	Weight

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

During the 13th up to 18th centuries chickens were mainly kept as farmyard scavengers. They were more important to the peasants and, in areas where money was a problem, were used to pay land rent. However in the 19th century, chicken farming was gradually transformed into a specialized enterprise (Elson *et al.*, 2011). During this period breed societies appeared and poultry clubs were formed all over Britain. This stimulated the establishment of breed standards and poultry stock improvement. Some of these clubs, for example the Sussex Club, put more effort on maintaining breed characteristics. Others, for example the Utility Poultry Club (UPC), did trials to improve performance aimed at achieving high fecundity and stamina (Charles, 2002).

In the intensive system, deep litter and battery cages are the management systems used by livestock keepers. Housing is an important aspect in layer chickens husbandry. Deciding on the housing system for chicken depend on market of different types of birds and the experience the farmer has on the system of housing (Tauson, 2005).

Deep litter, battery cage and semi-intensive system are current layer production systems adopted by farmers in Tanzania. In Tanzania, mostly in village, local chickens are left to scavenge during the day and are provided with simple housing at night, with supplementary feeds and minimal health care (Mwalusanya *et al.*, 2001).

High chick loss due to diseases, predators and poor nutrition, lack of capital and knowledge are among the challenges facing farmers when raising layer chickens in Tanzania (Ogali, 2012).

Lack of housing has been one of a major problem of layer chicken production to smallholder poultry keepers (Simeamelak *et al.*, 2011). Poor housing of chickens results into heat stress effects such as low production, suppressed reproduction, reduced feed intake (which might be reflected on the haematological parameters) and reduced egg production (Njoya *et al.*, 1994). Therefore improving housing system will help to minimize heat stress in chickens.

Chickens are important farm animal species in almost all countries in the world. They are an important source of animal protein and can be kept in situations with limited feed and housing resources. Chickens produce eggs and meat which are next to milk as a contributor to the output from livestock sector in recent years (Rajendran *et al.*, 2003). Chickens are waste converters; they convert a scavenged feed resource base into animal protein if kept under semi- intensive and extensive system. People raise chickens all around the world for maximizing the production (Eekeren *et al.*, 2006).

The word hematological comes from the word hematology which is the study of blood and its components such as blood plasma, and blood cells like Red blood cells, White blood cells, and blood platelets. Haematological parameters are the parameters such as, Red blood cell count ($\times 10^6/\mu\text{l}$), White blood cell count ($\times 10^4/\mu\text{l}$), Packed Cell Volume (%), Erythrocyte Sedimentation Rate (mm), Hemoglobin Concentration (g %), Mean

Corpuscular Hemoglobin Concentration (%), and Mean Corpuscular Hemoglobin (pg) (Islam *et al.*, 2004).

Hematological parameters make assessment of the body's ability to fight against diseases and try to predict the outcome of the infection (Mbassa, 1991). They are also useful for the assessment of the body's nutritional status and physiological status (Mbassa, 1991).

For proper management of layer chicken, it is desirable to know the normal physiological values under normal situation (Dutta *et al.*, 1994). Jain, (1993) reported that the examination of blood is performed for various reasons as screening procedure to determine the health status of the chickens and other animals. For example, high PCV (%) and high Hb (g %) are indicators of high feed conversion efficiency (Miruka and Rawnsley, 1997). Diurnal fluctuations or daily physical and metabolic activities change have an effect on the haematological parameters of the chickens.

1.2 Problem Statement and Justification

Haematological parameters of chicken are influenced by age, sex, breed, geographical location, nutritional status, exercise and pathogenic stress (Islam *et al.*, 2004; Sharmin *et al.*, 2004; Singh *et al.*, 1998) as well as management systems. Chicken keepers in Tanzania have been keeping their chicken without knowing the haematological status of their chickens.

Haematological studies are very important in diagnosing the structural and functional status of the animal's body (Elagib *et al.*, 2011). The hematological parameters are used as clinical indicators of the health, nutritional and physiological status of the animal.

There is no adequate and recent information in Tanzania about the effects of the different management systems of the layer chickens on hematological parameters of layer chickens. There is little known about the relationship between management system and haematological parameters of the layer chickens (Shini, 2003). Various studies have been done on the effect of age, sex, nutrition and breed on haematological parameters of broiler chickens and other avian species in some countries of Africa like Nigeria, Sudan, and Egypt and neglecting the effect of different management systems on the haematological parameters of layer chickens. Therefore this study is aimed at providing information on the effect of the management systems on the haematological parameters hence advising farmers the better system to choose.

1.3 Objectives of the Study

1.3.1 General objective

To study the effect of different management systems on the hematological parameters of the layer chickens.

1.3.2 Specific objectives

- i. To assess the effect of deep litter, battery cage and semi-intensive system on hematological parameters of growing layer chickens.
- ii. To compare the hematological parameters among the three management systems and find out the better layer chicken management system basing on the haematological parameters.

1.4 Research Question

Is there any effect of management systems on the haematological parameters of layer chickens?

CHAPTER TWO

2.0 LITERATURE REVIEW

Technological changes in the world have been an important stimulus to the poultry management system (Sogunle *et al.*, 2008). Intensive, semi- intensive and extensive/scavenging are the major poultry management systems worldwide (Kitalyi, 1998), including Tanzania.

2.1 Different Management Systems for Layer Chicken

2.1.1 Semi- intensive system

Semi- intensive system is among the rearing systems of poultry in which birds are housed at night but allowed to roam freely during day-time in a restricted area (Barbosafilho *et al.*, 2005). Semi- intensive system/ backyard is still the most popular and viable production system for rural household with little inputs (Mlozi *et al.*, 2003). In semi- intensive system chickens are supplemented with either feed commercially formulated feed or home made and *ad libitum* clean water is given with disease control measures executed (Mwakapuja, 2009).

It is also used in urban and peri- urban areas because of the high demand for eggs and meat (FAO. 2009). It is among the up to date alternative system for raising the living standards of the rural households by supplying additional income and supplement protein intake in rural and tribe folks (Niranjan *et al.*, 2008).

The environmental factors which are represented by the factors such as temperature, humidity and radiation have an effect directly on the birds reared in the semi- intensive system, since they affect the metabolism and general performance of birds such as egg

and meat production (Barbosafilho *et al.*, 2005). The affected metabolism reduces the synthesis of the blood cells in the chickens.

Scott and Balnave 1988; Kan *et al.*, 2011 reported that stress has an effect on the body weight and the total white blood cells. Laying hens exposed to hot environment showed decreased body weight and total white blood cells as compared to those kept under the shade. Therefore ambient temperature and radiation should be optimized to prevent such effects. Shaded areas might be a solution in the control of ambient conditions in the semi-intensive rearing system (Barbosafilho *et al.*, 2005).

Chickens kept in semi- intensive system are at high risk of being infected with diseases and ecto-parasites due to contamination with the soil dust and vegetations when they roam around during day- time (Rodenburg *et al.*, 2005; Muchadeyi *et al.*, 2004). An infestation with red mites can lead to reduced weight gain, anemia, and even increased mortality (Kilpinen *et al.*, 2005). The red mites which cause anaemia in chickens reduce the Red blood cells.

2.1.2 Deep litter system

Absorption of moisture resulting from poultry droppings and water from the drinkers and the insulation of heat and cold in the deep litter system of poultry keeping is done by the litter materials spread on the floor of the poultry house (Azmat *et al.*, 2009).

A good litter material is the one with high moisture absorbing ability, microbial free, non toxic to poultry, available and of low cost (Musa *et al.*, 2012). When choosing the type of litter materials to use, it is very important to make sure that the litter material is free from dust concentration, as dust causes respiratory problems (Gustafson *et al.*, 2006). Poultry

kept under deep litter system are at high risk of perforation and ulcerative erosion of the gizzard wall due to sand and other metallic particles found in the litter materials as compared to those kept in battery cage system (Musa *et al.*, 2011).

In deep litter system, the building should be well ventilated, with elevated perches in order for the birds to have rest and perform physical exercise, with nine birds per m² and moderate heat to ensure uniform distribution of birds in the floor space (Thiele *et al.*, 2008). Asbestos roofing materials are good as compared to metal sheets because they reduce temperature effect on birds (Awoniyi, 2003).

Emission rates of ammonia resulted from chickens' faeces are higher in deep litter system as compared to semi- intensive and battery cage system (Groot Koerkamp *et al.*, 1998). Wathes *et al.* (2004) reported that long time exposure to ammonia increases susceptibility to respiratory pathogens in chickens and may lead to impaired performance of laying hens.

The feeding and stocking density of layer chickens are very important factors which have an influence on body weight, egg production and on the haematological parameters of chickens (Singh *et al.*, 2008).

2.1.3 Battery cage system

Battery cage system commercially started around 1950's and from that time it has become a predominant system for the laying hens and provides livestock keeper with an efficient means of egg collection, proper waste disposal, reduction of feed loss and keeping the environmental temperature constant and easy monitoring of individual bird (Ekunwe *et al.*, 2007; Abrahamsson *et al.*, 1996; Vanhorne, 1996 and Mboko *et al.*, 2010). Most hens

reared for egg production in the industrialized countries are kept under the battery cage system (Sogunle *et al.*, 2008). Dereuk *et al.* (2008) reported that conventional cage housing system for laying hens will be abolished in European Union as of 1st January 2012, following EU directive (1999/74/EC) and instead, the furnished cage and non-cage system which provide more birds' movement will be used. The reason for abolishing conventional cage is to keep animal right of making them free to move in a wide area than in a small restricted area.

Banning the conventional cage housing system in Europe will have advantages and disadvantages to poultry keepers. It will be possible to only those who have enough land to practice furnished cage system which need more space for chickens to move in a wide area.

The EU directive describes the Conventional Cages (CCs) as the unenriched cage system, small and barren area which provides little or no opportunity for behaviours such as nesting, perching, foraging and wing flapping, where as furnished cages (FCs) sometimes called enriched cages are the ones with nest boxes, perches, areas for foraging, and greater height (Elson *et al.*, 2006).

Battery cage system is more suitable to large scale egg production (Elson *et al.*, 2011). The cage system of the layer chicken rearing system is most economical and makes easy house cleaning and reduces problems related to sanitation (Ahmet *et al.*, 2010).

Egg quality in cage system depends on the number of birds per unit area, size of the group, wire size and quality, and slope of the floor (Mirjana, *et al.*, 2012). If the birds in

battery cage system are overcrowded, there is high possibility of bone fracture of the birds and consequently reduced performance in terms of egg production (Pohle *et al.*, 2009).

Pistekova *et al.* (2006) reported that, in battery cage system laying hens lack physical and psychological space and therefore it is difficult for the bird to move from one place to another.

Economically, battery cages are most efficient because poultry keeper can keep large numbers of birds in strict confinement with highly mechanized feed and water systems, with manure and eggs collected automatically (Cooper and Albentosa, 2003). Battery cage system improves performance of chickens in terms of egg production, feed intake and food conversion as compared to deep litter system (Banga- Mboko *et al.*, 2010; Tauson *et al.*, 1999).

Battery cages whereby everything is done automatically are commonly found in the developed world. In Tanzania battery cage system is mostly used in urban areas where there is a scarcity of land. The cages designed are not well mechanized in Tanzania as, where by feeding, drinking, egg collection and manure collection systems are of manual type in which feeding and drinking troughs are placed in the cages, eggs and manure are collected manually.

Battery cage system has side effects on the birds' welfare as it affects the morphological, physiological, psychologically and behavioral changes due to stress caused by restriction of not allowing them to move from one area to another for foraging and exercise (Rogers, 1995).

2.2 Hematological Parameters

Hematological changes are used to determine various status of the body and determine stress due to nutrition, health and environment, (Islam *et al.*, 2004). Mmereole (2004) suggested that such hematological parameters bearing on the productivity of animals should be incorporated in the formulation of selection indices for optimum production especially in poultry. Haematology in animals can detect the nutritional status, differences in food supply among the population, disease and immune suppression caused by various stresses (Vanwyk *et al.*, 1998; Cooper, 2002).

The haematological parameters of health birds are influenced by many factors which include physiological, physical and environmental conditions, fasting, water, feed restriction and nutrient conditions (Alodan *et al.*, 1999), environmental factors (Vecerek *et al.*, 2002; Graczyk *et al.*, 2003), fasting (Lamosova *et al.*, 2004), nutritional contents (Odunsi *et al.*, 1999; Kurtoglu *et al.*, 2005), water and feed restriction (Galip, 1999; Al-Rawashdeh, *et al.*, 2000; Iheukwumere and Herbert, 2003), age (Furlan *et al.*, 1999; Naziefy, 1997; Seiser *et al.*, 2000; Talebi *et al.*, 2005), continuous supplementations of vitamin E (Tras *et al.*, 2000), administration of drugs (Khan *et al.*, 1994; Zaman *et al.*, 1995), Breed (Mush *et al.*, 1999) and anti-aflatoxin premixes (Oguz *et al.*, 2000).

2.2.1 Red blood cells count

Red blood cells (erythrocyte) count is the number of red blood cells per cubic millimeter of blood. It is measured by using microscope and a ruled chamber called Neuber hemacytometer and the number of RBC is in millions per cubic millimeters (Hamouda *et al.*, 2012).

The red blood cells are among the cellular part of the blood which are biconcave in shape and transport oxygen and carbon dioxide from one part of the body to another (Guyton *et al.*, 2006). They are synthesized in the bone marrow (Ganong, 2003). Depressed bone marrow development results in decreased production of the red blood cells and the red blood cells count (Coles, 1986).

In a normal situation nucleated red blood cells (NRBC) are seen in the blood of fetus, avian species and neonates, their amount in cold blood are for the health of the animal (Schaefer *et al.*, 2000). Factors such as lipids, proteins, carbohydrates, minerals, and vitamins are among the chemical composition contained in the erythrocytes. The abnormal synthesis of erythrocytes like Polycythemia results from those factors that are most important for red blood cell production (Jain, 1986).

A significant difference in the number of red blood cell exist between the individuals of the same breed due to factors such as sex, age, physical activity, nutritional status, laying cycle, altitude, stress and management (Sjaastad *et al.*, 2003; Coles, 1986).

In excitable animals, it is difficult to get a correct picture of erythrocytes density from examination of a blood sample. Handling the animal and drawing blood sample activate the sympathetic nervous system to a varying degree, causing mobilization of stored erythrocytes. It takes an hour for the erythrocyte number in the circulating blood to attain the normal state after the animal has been frightened (Sjaastad *et al.*, 2003).

2.2.2 Packed cell volume

Centrifugation of the heparinized blood sample separates blood cells from the plasma, and the red blood cells are found packed at the bottom of the centrifuge tube, while the

leucocytes, blood platelets appearing as a thin grayish layer above the erythrocytes. This separation of red blood cells and other cell component is due to differences in mass density (Sjaastad *et al.*, 2003).

Packed cell volume PCV (%) is one of the indicators of high feed conversion efficiency in chickens (Mmereole, 2004). Mhonzya, (2002) reported that hemoglobin and packed cell volume levels are normally higher in a well nourished than poorly fed animal. PCV (%) is erroneously decreased in the blood sample with excessive EDTA or marked hemolysis. Anaemia exists when the PCV (%) falls below the normal range for the species in question (Jain, 1986).

Coles (1986) reported that destruction of avian red blood cells due to blood parasite (*Plasmodium* and *Aegyptionella*), aflatoxicosis or toxic chemicals from ingested plants (member of mustard family) whether birds are kept under semi-intensive system or free range, diseases, nutritional deficiencies (iron and folic acid) result in decreased Packed Cell Volume and therefore such decrease in PCV (%) from the normal range is an indication of anaemia in birds.

Packed Cell Volume decreases when chickens are exposed to heat stress (Yahav *et al.*, 1997; Aengwanich *et al.*, 2003; Aengwanich *et al.*, 2004). Packed Cell Volume has been accepted as an indicator for heat stress in chickens (Aengwanich, 2007).

2.2.3 Erythrocyte sedimentation rate

If the uncoagulated blood is kept in Erythrocyte Sedimentation Rate (ESR) westergreen tubes and left for sometimes without being disturbed, the blood cells settle at the bottom of the ESR standard tubes and pale yellow plasma is observed on top of it. This is due to

the differences in mass density, the tendency of the red blood cells to cluster together (rouleaux effect) and composition changes in plasma which increases aggregation of red blood cells in the diseased animals as well as nutritional deficiency in proteins and vitamins especially vitamin B group (Sjaastad *et al.*, 2003). If there is an abnormal RBCs such as sickle cell, clustering together (rouleaux effect) of RBCs is hindered and hence ESR is decreased (Jandl, 1996).

Jain (1986) reported that ESR is influenced by the length and temperature of blood storage and the result of sedimentation rate is used to correct for the PCV(%) because as the sedimentation increases, the packed cell volume decreases and vice versa.

2.2.4 Hemoglobin Concentration

Hemoglobin synthesis starts in the proerythroblasts and goes on in the reticulocyte of red blood cells. The hemoglobin combines with oxygen in the lungs and releases oxygen in the areas with low oxygen tension, (Guyton *et al.*, 2006).

Nutrients such as protein, iron, copper, vitamin B₁₂, B₆ and folic acids are very important in the synthesis of hemoglobin in animals, and their deficiency causes nutritional anaemia (Sjaastad *et al.*, 2003). Hemoglobin concentration together with packed cell volume and red blood cell count determine the red blood cell indices which are MCH (pg) and MCHC (%) (Elagib *et al.*, 2011).

Hemoglobin molecule consists of protoporphyrin, native globin and ferrous iron. It is a protein with a molecular weight of 64 458 and the iron content is 0.33 %, or 3.35 mg/g of hemoglobin (Jain, 1986). Hemoglobin concentration and oxygen affinity are the most

important factors, responsible for ensuring the availability of oxygen content in blood against hypoxic condition (Liu *et al.*, 2009)

Hemoglobin and myoglobin (an iron and oxygen binding protein found in the muscle tissue of vertebrates) are important parameters which indicate meat quality. They affect the color of meat and can cause unsuitable discoloration when they exudate from muscle tissue or extravasate from the circulatory system of the chickens (Kranen *et al.*, 1999). Biu *et al.* (2009) explained that there is a decrease in the hemoglobin content in chickens fed high dose of aqueous leaf extract of Neem (*Azadirachta indica*) plant administered intraperitoneally. High rate of tannin in Neem plant leaf extract reduces hemoglobin content by neutralizing the absorption of iron in the blood (Shori, 2012).

2.2.5 Mean corpuscular values

Mean Corpuscular Values (MCH and MCHC) are utilized to classify anaemias morphologically. Morphological classification has little reference to the cause of anaemia instead it represents an estimation of alterations in size and hemoglobin concentration of individual red blood cells (Coles, 1986). The mean corpuscular haemoglobin, or "mean cell haemoglobin" (MCH), is the mean mass of hemoglobin per red blood cell in a given sample of blood. It is reported as part of a standard complete blood count (Van *et al.*, 2001). The Mean Corpuscular Hemoglobin Concentration (MCHC) is a measure of the concentration of hemoglobin in a given volume of packed red blood cells. It was reported as part of a standard complete blood count (Van *et al.*, 2001).

2.2.6 White blood cells count

White blood cells are among the blood cells synthesized in the stem cell of the bone marrow. They are sometimes called leucocytes. There are five types of leucocytes, which

are neutrophils, eosinophils, basophils, monocytes and lymphocytes. The first three are classified as granulocytes and the last two are classified as agranulocytes (Sjaastad, 2003).

White blood cells are transported to areas of serious infection and inflammation, thereby providing a rapid and potent defense against infectious agents (Guyton *et al.*, 2003). The granulocytes and monocytes (agranulocytes) have a special ability to “seek out and destroy” a foreign invader, (Guyton *et al.*, 2003). White blood cell counts are affected when the layer chickens are subjected to excessive heat stress (Mashaly *et al.*, 2004). White blood cells carry out their function by producing antibodies, which deactivate the foreign substances known as antigens. An antigen is an agent or particle which stimulate the production of specific antibodies, cell-mediated immunity, or both (Ferguson, 1985). The antibodies are serum or cell-bound proteins produced to an antigen and able to react specifically to that antigen. Some white blood cells (monocytes) have the ability to engulf the foreign particles by phagocytosis (Ferguson, 1985).

White blood cells count (WBCc) is a bed rock in the estimation of malaria parasite density in malaria field trials, interventions and patient management. White blood cells are indirectly and relatively used in microscopy to estimate the density of malaria parasite infections (Gyasi, 2012).

Conclusively, all three management systems (Battery cage, Deep litter and Semi-intensive) have advantages and disadvantages. The choice of the system to use depends much on the financial position of the chicken keeper. In Tanzania most farmers in urban areas have been using deep litter system in keeping chickens for commercial basis because of land restriction, low costs, and less risk of chicken loss due to predators and

theft. Semi- intensive system and free range system is mostly used in villages (Mwalusanya *et al.*, 2001). Knowing the haematological status of layer chickens, helps the farmer to assess the health status of chickens and take immediate action upon an abnormality (Elagib *et al.*, 2011).

Table 1: Normal blood values for chickens (*Galus galus domesticus*)

Blood parameter	Range	Average
RBCs (x 10 ⁶ / µl)	2.5 - 3.5	3.0
Hemoglobin (g %)	7.0 - 13.0	9.0
PCV (%)	22.0 -35.0	30.0
MCH (Pg)	33.0 – 47.0	41.0
MCHC (%)	26.0 -35.0	29.0
ESR (mm)	3.0 -12.0	7.0
White blood cells (x10 ⁴ / µl)	1.2 -3.0	2.1

Source; Jain, N.C (1986)

CHAPTER THREE

3.0 MATERIALS AND METHODS

The study to assess the effect of the management system i.e. deep litter, battery cage and semi-intensive system on hematological parameters of growing layer chickens was carried out at Sokoine University of Agriculture.

3.1 Study Area

The study was carried out at the poultry unit of the Department of Animal Science and Production (DASP), Sokoine University of Agriculture (SUA) from July 2012 to September 2012. SUA is situated at latitude of 06°- 07° S and longitude of 37°-39° E. It is located west of Dar es Salaam at an altitude of about 526m above sea level. The temperature ranges from 21.3 °C to 34.0 °C. The relative humidity is about 81% and the annual mean rainfall is about 846mm.

3.2 Study Design

A cross sectional study design which allows data to be collected at one point in time and makes possible to determine relationship between different variables in focus at a time of survey was used (Bernard, 1996). In this study, a total of ninety (90) layer chickens of eight weeks old, medium-heavy egg type, Rhode Island Red (RIR) breed, were procured from the poultry farm unit of the Department of Animal Science and Production, Sokoine University of Agriculture. Thus the animals were in an environment that was not new. All birds were in good condition. Only ninety layer chickens were kept because of financial constraints, otherwise I could keep more than this number of chickens.

The birds were divided into three treatment groups, each group with thirty birds. The treatment was three different management systems. The first treatment group was kept in the battery cage system, second treatment group was the deep litter system and the third treatment group was the semi- intensive system. Birds in all three management systems were kept for eight weeks from 8-16 weeks. The duration of the study was enough to note the effect of management systems on hematological parameters in layer chickens because of high growth rate of well fed layer chickens.

3.2.1 Battery cage system

Thick wire gauze material was used in this system. Two layer chickens were kept in a cage of 0.6 m length by 0.4 m wide and 0.42 m height at the front and 0.36m at the back (Fig. 1). The light exposure was 10 hours light/ day for the whole period of the study (Roll *et al.* 2008). Growers' mash containing about 16% crude protein, (CP), energy 2928.7 kcal/kg, 7.8% crude fibre, (C F) 3.5 % crude fibre (either extract) was formulated and fed to the pullet. Feed and water troughs were placed in the cage. Mineral concentrate composed of 1.2% calcium and 0.2 % phosphorus was formulated and fed to the pullet as was suggested by Malago *et al.* (2009). Formulated feed composition and nutrient contents for the chickens feed are as shown in Appendix 1 and 2 respectively. Clean drinking water was given *ad libitum* daily. All birds were weighed at an interval of 2 weeks to monitor their growth. A total of two million three hundred nineteen thousand and two hundred and forty Tanzania shillings (Tsh. 2 319 240/=) were incurred in this management system for buying chickens, feeds, drugs and for labour charge.

3.2.2 Deep litter system

In this system, 30 layer chickens were kept. The stocking density was eight birds per m² as was suggested by Thiele *et al.* (2008) as shown in Fig. 2. Rice husks were used as a

litter material at the depth of 6 cm so as to allow efficient absorption of moisture (Asaniyan *et al.*, 2007). The light exposure was 10 hours light/ day for the whole period of the study as was suggested by Roll *et al.* (2008). Perches were placed in the house for pullets' resting and physical exercise purposes (Thiele *et al.*, 2008). Growers mash containing about 16% crude protein, (CP), energy 2928.7 kcal/kg, 7.8% crude fibre (C F) 3.5 % crude fibre was formulated and fed to the pullets. Supplemented vegetable materials were fed.

Mineral concentrate containing 1.2% calcium and 0.2 % phosphorus was formulated and fed to the pullet at the amount of 130 grams per bird per day but the amount to feed increased a bit as the birds were growing. Clean drinking water was given *ad libitum* daily. All birds were weighed at an interval of 2 weeks to monitor their growth. A total one million eight hundred and ninety three thousand Tanzania shillings (Tsh. 1 893 000/=) were incurred in this management system for buying chickens, feeds, drugs, litter materials and for labour charge.

3.2.3 Semi- intensive system

In this system, a fence structure of an area of 121 m² (11m length x 11m width) was Constructed (Fig. 3) in such a way that the birds roamed around within it during day-time for scavenging and housed at night. The stocking density in the fence was 4 m² per bird (Thiele *et al.*, 2008), while in the house were eight birds per m² as in the deep litter system. The formulated diets was provided throughout the experimental period as a supplementary diet bearing in mind that birds get other feeds when scavenging. Clean water was given to birds in *ad libitum* daily.

All birds were weighed at an interval of 2 weeks to monitor their growth. A total of two million one hundred thirty thousand and two hundred Tanzania shillings (Tsh.2 130 200/=) were incurred in this management system for buying chickens, feeds, drugs, constructing fence and for labour charge.



Plate 1: Battery cage system



Plate 2: Deep litter system



Plate 3: Semi- intensive system

3.3 Sample Collection

Seven growers were picked randomly from each treatment group for blood sample collection. Only seven growers were picked from each group because of the financial constraints, otherwise I could have more samples. Blood sample was collected before keeping (Control) and at every two weeks for two months. Three milliliters of blood were aseptically collected using a sterile needle and syringe of 5 milliliters from the wing vein of chickens. Immediately after collection, blood was transferred to the vacutainer tubes containing anticoagulant (EDTA) to prevent it from clotting.

3.4 Sample Processing

The collected blood samples were measured at the Department of Veterinary Physiology, Biochemistry, Pharmacology and Toxicology laboratory and Department of Veterinary Anatomy laboratory, both in the Faculty of Veterinary Medicine, Sokoine University of Agriculture, Morogoro, Tanzania, in order to get the haematological values.

3.4.1 Red blood cell count

In determining the red blood cells count, 20 mls of the blood sample were drawn using a diluting pipette, and mixed with 5mls of a diluent (Natt and Herricks solution). The contents were mixed up by carefully shaking horizontally for a few minutes. One third of the sample was drawn out to make sure that the actual count is made from the blood content from the bulb. The actual 20mls of blood sample were drawn in clean dry counting chamber of hemacytometer by making sure that the space between the ruled area and the cover glass is filled without overflowing. The filled counting chamber of hemacytometer was left for 3 minutes for the cells to settle in the chamber. Using a light microscope x 40 objective, red blood cells were manually counted in chambers of hemacytometer labeled R as shown in Plate 4.

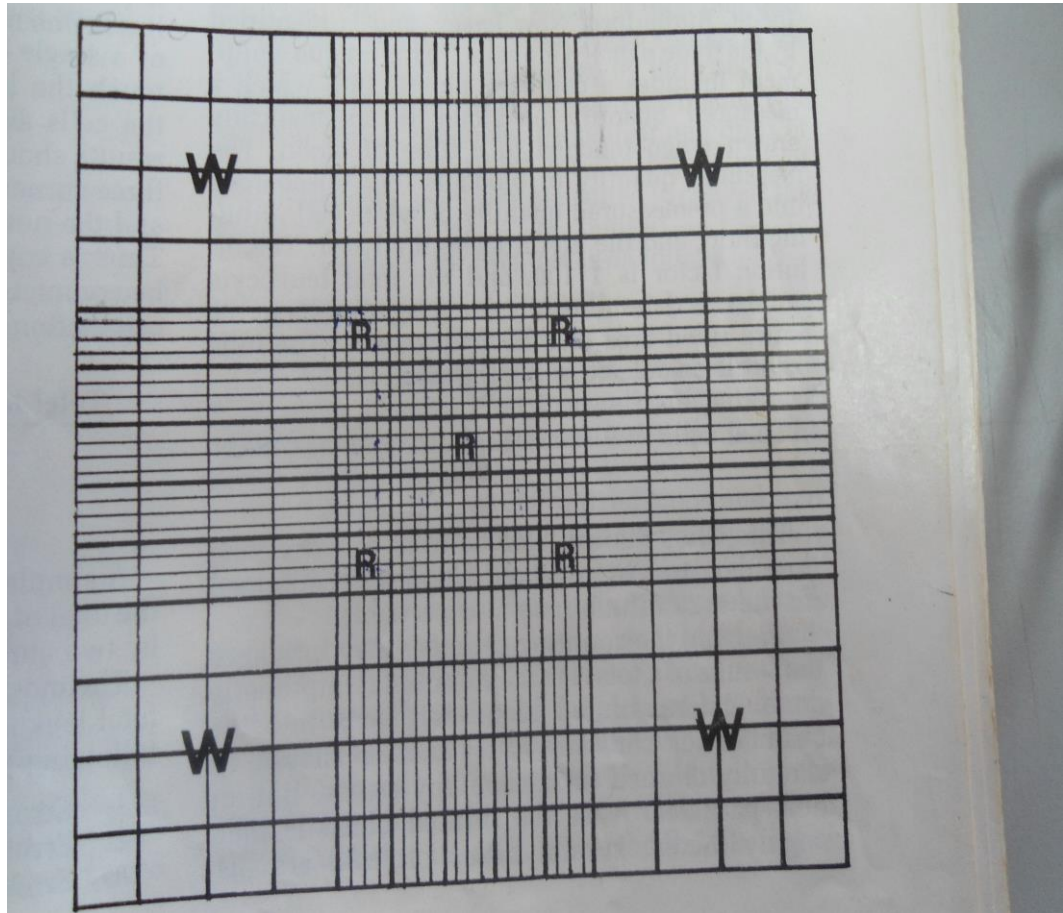


Plate 4: Chambers of hemacytometer

3.4.2 Packed Cell Volume (PCV)

To obtain the Packed Cell Volume, a well mixed blood sample in the vacutainer was filled in heparinized capillary tubes at three quarter level, and then sealed at one end by wax through dipping into wax materials (Plate 5).

The sealed capillary tubes were transferred onto the centrifuge machine and centrifuged at 12 000 revolutions per minute for 5 minutes. Thereafter the centrifuged capillary tubes (Plate 6) were taken out of the machine and the sedimented blood cells were read using the micro-haematocrit reader in percentages (Plate 7).



Plate 5: Heparinized capillary tubes filled with uncoagulated blood before centrifugation

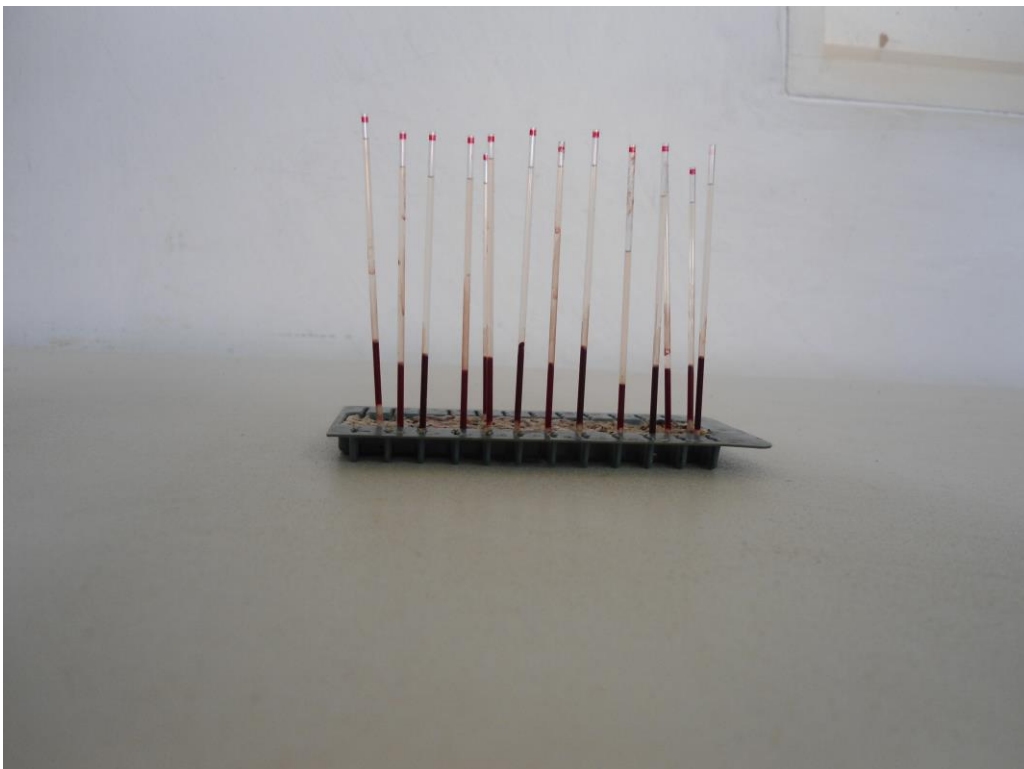


Plate 6: Heparinized capillary tubes filled with blood after centrifugation

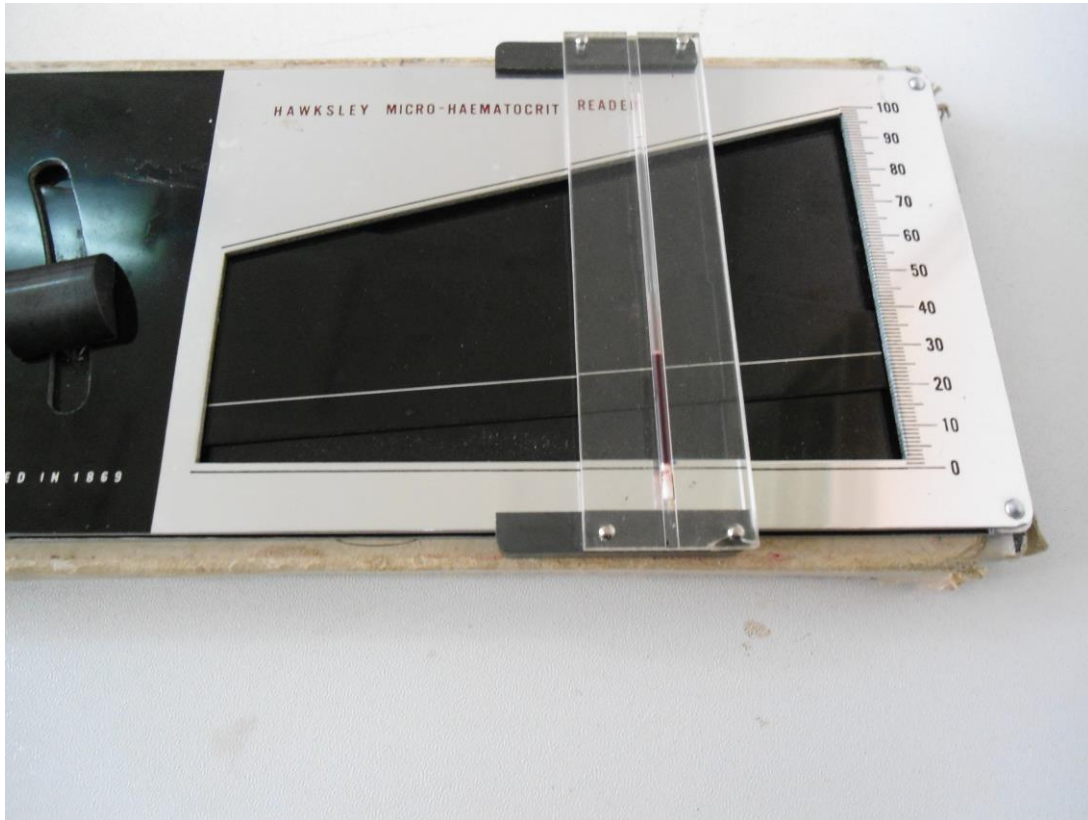


Plate 7: Centrifuged blood in the capillary tube on micro-haematocrit reader

3.4.3 Erythrocytes Sedimentation Rate (ESR)

The uncoagulated blood samples were taken and put into ESR westergreen tubes. ESR westergreen tubes containing the blood sample were placed in the sedimentation rack vertically at ninety degrees (Plate 8). The distances (mm) through which the erythrocytes have traveled (settled) (Plate 9) were read in mm after been left for 24 hours.



Plate 8: ESR westergreen tubes filled with blood before sedimentation

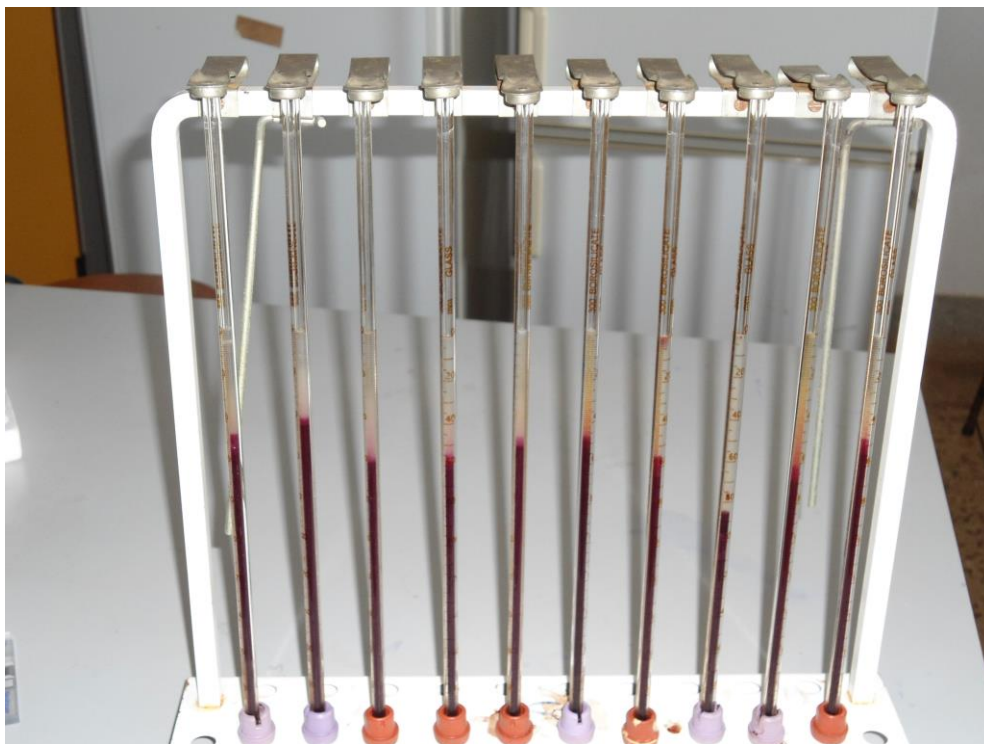


Plate 9: ESR westergreen tubes (one of the fig. 8 above) containing sedimented blood after being left standing for 24 hours.

3.4.4 Hemoglobin concentration

To have the hemoglobin concentration in the blood samples, the sahli haemometer method was used as suggested by coles (1986). The graduated sahli tube was filled with 10% HCl solution up to the 2-graduated mark on the scale and blood was sucked using capillary pipette up to the 20- μ l mark. Excess blood was removed by cleaning the tip of the pipette using filter paper. Then, blood was blown from the pipette into the 10% HCl in the graduated sahli tube keeping the tip in the HCl solution. Blowing and sucking using pipette was done several times to make sure all the blood has been removed from the pipette. The colour change, dark brown, of the mixture was observed. A drop of 10% HCl at a time was added into the mixture until a colour, which is similar to that of the standard solution was obtained. Finally the graduated sahli tube was removed and read in g %.

3.4.5 Mean corpuscle hemoglobin (MCH) and Mean corpuscle hemoglobin concentration (MCHC)

Mean corpuscle hemoglobin (MCH) and Mean corpuscle hemoglobin concentration (MCHC) were obtained from the red blood cell count, packed cell volume and hemoglobin concentration through the following formula;

- $MCH = \text{hemoglobin concentration} \times 10 / \text{total number of the erythrocytes}$.
- $MCHC = \text{hemoglobin concentration} \times 100 / \text{PCV}$.

3.4.6 White blood cell count

To obtain the total white blood cell, 0.05 Milliliters of blood was pipetted into a small test tube containing 0.95mls of the diluent. The mixture was mixed by shaking slowly. The diluent used was Natt and Herricks solution, the same solution used in RBCs but what differed were volumes of diluent solution and blood sample.

The mixture was filled into clean dry counting chambers of hemacytometer. Using light microscope x 40 objective, White Blood Cells were manually counted in chambers of hemacytometer labeled W in Plate 4.

3.5 Data Analysis

The data obtained were statistically analyzed. Descriptive statistics and one way analysis of variation (ANOVA) were used using Statistical Analysis System (SAS) of 2004.

CHAPTER FOUR

4.0 RESULTS

4.1 Red Blood Cell (RBC) Count

Data on red blood cell count mean ($\times 10^6/\mu\text{l}$) \pm SE in chickens raised under different management systems are presented in Table 2. The result presented showed that as the chickens grew older, RBC values increased in all three management systems. Ranged from 2.36 ± 2.10 to 2.68 ± 1.26 for the battery cage, 2.21 ± 2.10 to 2.75 ± 1.26 for the deep litter system and from 2.40 ± 2.10 to 2.52 ± 1.2 for the semi- intensive system. Deep litter system showed high value (2.75 ± 1.26) of RBC compared to other two Management systems (Table 2), though the increase was not significant ($P>0.05$) in all the three management systems.

4.2 Packed Cell Volume (PCV)

The PCV (%) values in chickens kept under different management systems are presented in Fig. 1. As observed in Fig.1, it was noted that the PCV values in all the three Management systems were increasing as the chickens grew older. PCV (%) values in chickens reared under battery cage and deep litter system indicated linear increase trends. PCV (%) values in chickens kept under semi intensive system showed slight decreased PCV (%) value at week10 and increased from week 12 to week16. Deep litter system showed high PCV (%) value compared to battery cage and semi-intensive system as shown in Fig. 1. There were no significant differences ($P>0.05$) among the PCV values in chickens kept in all the three management systems.

Table 2: Red Blood Cell (RBC) count mean ($\times 10^6/\mu\text{l}$) \pm SE in chickens raised under different management systems

MS	Experimental duration (weeks)				
	8 weeks (Control)	10 weeks	12 weeks	14 weeks	16 weeks
BC	2.36 \pm 2.10	2.38 \pm 1.33	2.47 \pm 2.01	2.59 \pm 1.26	2.68 \pm 1.26
DL	2.21 \pm 2.10	2.39 \pm 1.33	2.50 \pm 2.01	2.67 \pm 1.26	2.75 \pm 1.26
SI	2.40 \pm 2.10	2.44 \pm 1.33	2.47 \pm 2.01	2.55 \pm 1.26	2.52 \pm 1.26

Key: MS=Management System BC= Battery Cage DL= Deep litter
SI= Semi-Intensive

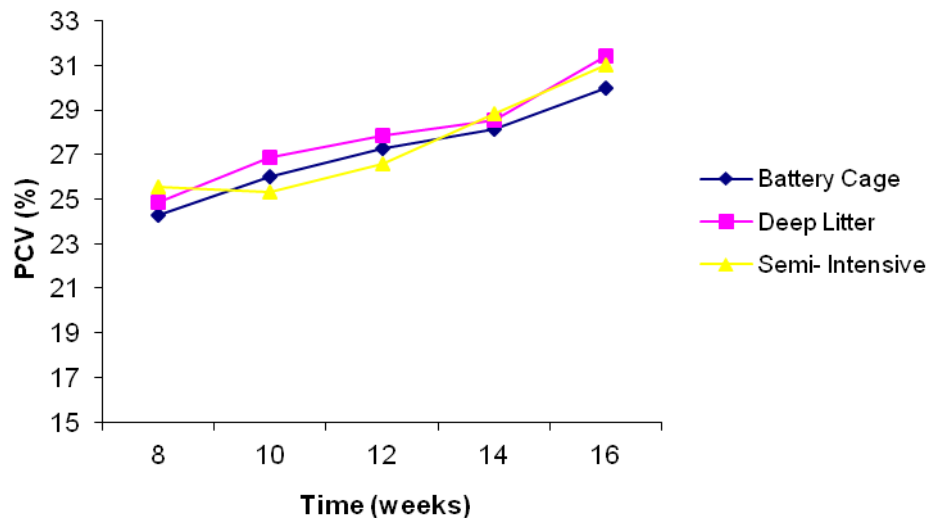


Figure 1: Packed cell volume (%) of chickens reared under different Management systems.

4.3 Erythrocyte Sedimentation Rate

The ESR (mm) mean \pm SE values in chickens kept under different management systems are as presented in Table 3. Table 3 shows the ESR (mm) means recorded from the 8th week (the beginning of the experiment) to the 16th weeks (end of the experiment) for the three management systems. The ESR (mm) Values obtained at the start of the experiment in all management systems were higher than the values obtained at the end of the study.

The ESR (mm) values in all three Management systems were decreasing as the ages of the chickens were increasing (Table 3). Statistically there were no significant differences ($P > 0.05$) in ESR (mm) values among the three Management systems.

4.4 Hemoglobin Concentration

Fig. 2 shows the hemoglobin (Hb) concentration (g %) in chickens kept under different management systems. Hb (g %) values in all management systems increased with age of chickens. Chickens in deep litter system had higher Hb (g %) values compared to chickens in Battery Cage and Semi- intensive system.

Table 3: Erythrocyte sedimentation rate mean (mm) \pm SE in chickens raised under different management systems

MS	Experimental duration (weeks)				
	8 weeks (Control)	10 weeks	12 weeks	14 weeks	16 weeks
BC	3.36\pm0.17	2.93 \pm 0.20	2.73 \pm 0.25	2.69 \pm 0.14	2.37 \pm 0.13
DL	3.01\pm0.17	3.00 \pm 0.20	2.73 \pm 0.25	2.53 \pm 0.14	2.39 \pm 0.13
SI	3.12\pm0.17	2.97 \pm 0.20	2.96 \pm 0.25	2.64 \pm 0.14	2.43 \pm 0.13

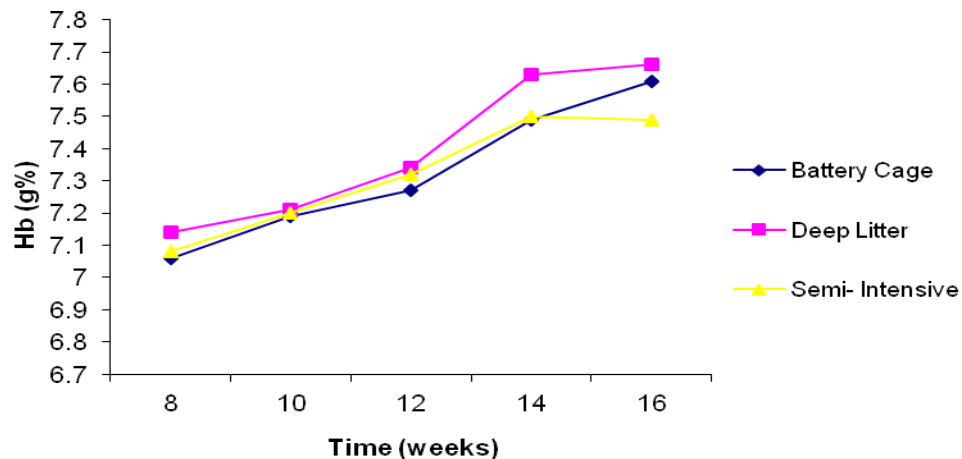


Figure 2: Hemoglobin concentration (g %) in layer chickens kept under different Management Systems.

4.5 Mean Corpuscle Hemoglobin

Mean Corpuscle Hemoglobin (MCH) (Pg) in the layer chickens kept under different management systems are presented in Fig. 3. In deep litter system, MCH (Pg) values decreased from 8th weeks, to 16th weeks. MCH (Pg) values in battery cage remained more or less the same in week 8 and 10 of the experiment. From week 14 of the experiment, there was insignificant variation in the levels of MCH (Pg) in chickens under all management systems. Generally MCH (Pg) values decreased as the chickens advanced in ages (Fig. 3). MCH (Pg) mean values did not differ significantly ($P>0.05$) among the Management systems. The differences observed were normal physiological change brought by age.

4.6 Mean Corpuscle Hemoglobin Concentration

Fig. 4 presents the Mean Corpuscle Hemoglobin Concentration (MCHC) (%) in layer chickens reared under different management systems. MCHC (%) values under battery cage system showed insignificant decrease from week 8 to week 16. MCHC (%) means of the chickens kept under deep litter system decreased at week 10 and week 12, and then increased slightly at week 14 and at week 16 increased again. MCHC (%) in chickens kept under semi-intensive system increased at week 10 and week 12 and decreased at week 14 and 16 as shown in Fig. 4 below.

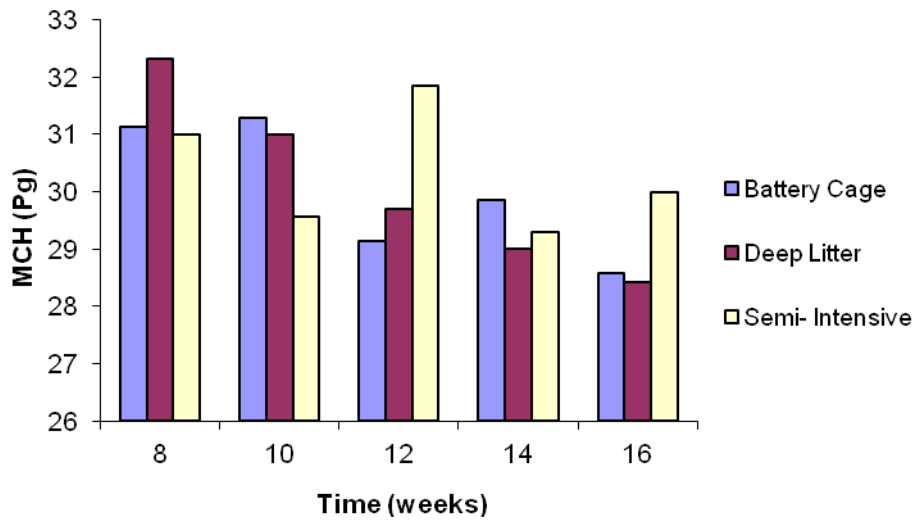


Figure 3: Mean corpuscle hemoglobin (pg) in chickens kept under different Management Systems

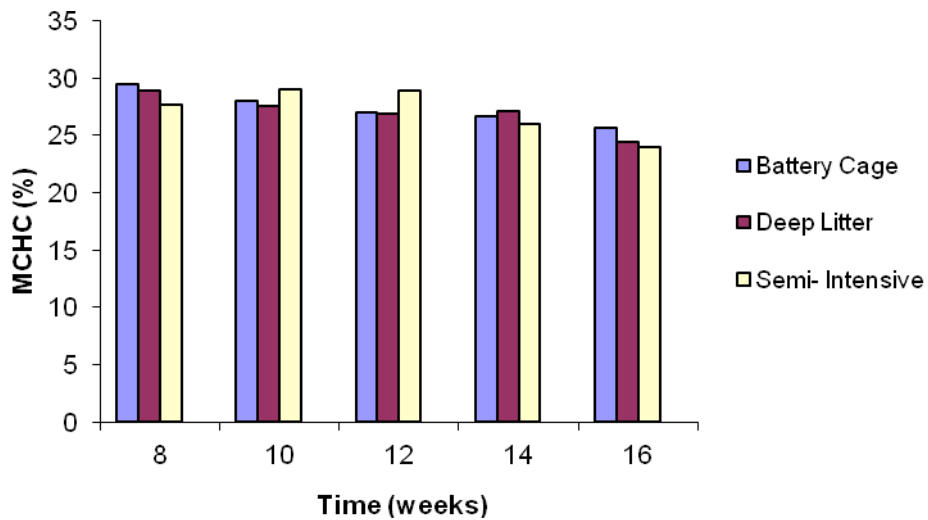


Figure 4: Mean corpuscle hemoglobin concentration (%) in chickens reared under different Management Systems

4.7 White Blood Cell Count

White blood Cell count means ($\times 10^4/\mu\text{l}$) \pm SE in chickens reared under the different management systems are presented in Table 4. White blood cell count means in chickens reared under battery cage system indicated slight increase at week 14 and 16. In deep litter system and semi-intensive system, white blood cell count remained more or less the same. The values did not differ significantly ($P > 0.05$) among the systems. No challenge either due to the system. The change was a normal physiological change brought about by age.

4.8 Body Weight

Body weight (Wt) gains (g) \pm SE in chickens reared under different management systems are shown in Table 5. Body weight gain in chickens kept under battery cage and deep litter system increased from week 10 to 14 and decreased at week 16 of age.

Body weight gain in chickens kept under semi-intensive system increased in week 10 to 12 and decreased at week 14 and 16. Body weight gains were higher in chickens reared in Battery cage compared to deep litter and semi-intensive system. Body weight gains in chickens kept under semi-intensive systems were lower compared to other systems. Body weight gains at week 16 were lowest in chickens kept in all management systems as shown in Table 5. There were no significant differences ($P > 0.05$) in body weight gain in chickens among the three management systems.

Table 4: White blood cell count mean ($\times 10^4/\mu\text{l}$) \pm SE in chickens reared under different management systems.

MS	Experimental duration (weeks)				
	8 weeks (Control)	10 weeks	12 weeks	14 weeks	16 weeks
BC	2.56 \pm 1.41	2.50 \pm 2.90	2.40 \pm 3.51	3.12 \pm 2.23	3.21 \pm 3.38
DL	2.57 \pm 1.41	2.84 \pm 2.90	3.25 \pm 3.51	2.75 \pm 2.23	3.08 \pm 3.38
SI	2.60 \pm 1.41	2.88 \pm 2.90	3.18 \pm 3.51	2.90 \pm 2.23	2.73 \pm 3.38

Key: MS=Management System BC= Battery Cage DL= Deep litter
SI= Semi-Intensive

Table 5: Body weight gain (g) \pm SE in chickens kept under different management systems

MS	Experimental duration (Weeks)			
	10 weeks	12 weeks	14 weeks	16 weeks
BC	173 \pm 12.02	204 \pm 31.33	212 \pm 23.10	143 \pm 8.14
DL	163 \pm 12.02	181 \pm 31.33	220 \pm 23.10	148 \pm 8.14
SI	109 \pm 12.02	175 \pm 31.33	137 \pm 23.10	38 \pm 8.14

CHAPTER FIVE

5.0 DISCUSSION

The study to assess the effect of deep litter, battery cage and semi-intensive system on hematological parameters of growing layer chickens was done. Various values of the hematological parameters were determined in each management system.

5.1 General body condition

The birds were in good body condition from the beginning of the study up to the end of the study.

5.2 Body weight

Body weight gain in chickens and animals helps to assess the trend of growth. It is an indicator of whether the chickens are growing or not. Body weight gains were higher in chickens reared in battery cage compared to deep litter and semi-intensive system. High feed conversion in chickens kept under battery cage system is one of contributed factor in high body weight gain in chicken.

Body weight gains in chickens kept under semi-intensive systems were lower compared to the chickens reared in other management systems. This concurs with the findings reported by Castellini *et al.* (2002) and Olaniyi *et al.* (2012) who found that out door rearing system had less body weight gains as compared to conventional system because chickens spend more energy during scavenging looking for extra feed. Body weight gains at 16 weeks were lowest in chickens kept in all management systems as shown in Table 5. This is a normal physiological state of reduced in body weight gain as birds get older.

There were no significant differences in body weight gain in chickens kept under all the three management systems. This supports the findings obtained in the study by Sekeroglu *et al.* (2010). The body weight gain shown in Table 5, indicated that chickens had good growing trend and health.

5.3 Haematological Parameters

5.3.1 Red blood cell count

The present study confirms that the Red blood cell count in layer chickens increases as the age of the chickens increases (Table 2). The increase of Red blood cell with age was because of the dietary effect. Young chickens consumed less amount of feeds as compared to grown chickens as result more Red blood cells were produced as the amount of diet taken increased (Sjaastad *et al.*, 2003; Coles, 1986). Normal Red blood cells production required a diet that contained sufficient amounts of protein, iron, copper, vitamin B₂, B₆, B₁₂ and folic acid.

Red blood cell count in chickens kept under battery cage and deep litter systems were increasing from week 8 to 16. In semi-intensive system, red blood cell count values increased from week 8 to 14 and slightly decreased at week16. This was consistent with the findings of Islam *et al.* (2004) and Kundu *et al.* (1993) who reported lowest RBC ($\times 10^6/\mu\text{l}$) in day-old chicks and higher in 3 months old birds. Although no significant differences ($P>0.05$) observed in RBC ($\times 10^6/\mu\text{l}$) means of all the three management system, deep litter systems indicated high mean value (2.75 ± 1.26) of RBC ($\times 10^6/\mu\text{l}$), followed by battery cage (2.68 ± 1.26) system and lastly semi- intensive system (2.52 ± 1.26) as shown in Table 2.

The supplemented vegetable materials in deep litter system probably is one of the cause of higher RBC ($\times 10^6/\mu\text{l}$) value in deep litter system than in other management systems. The high RBC ($\times 10^6/\mu\text{l}$) values in deep litter system has been also reported by Sogunle *et al.* (2008) who worked to find out the performance, carcass characteristics and haematological parameters of chickens reared in cage and floor . No effect of battery cage, deep litter and semi- intensive system on the red blood cell count observed because the RBC ($\times 10^6/\mu\text{l}$) count values in all the three management systems were within the physiological range of 2.5-3.5 ($\times 10^6/\mu\text{l}$) as stated by Jain (1986). The differences in RBC ($\times 10^6/\mu\text{l}$) count in all the three management systems were not due to systems but were brought about by differences in age. This supports the finding reported by Sogunle *et al.* (2006); Kaneko, (1989), who worked and found no effect of management systems on Red blood cell counts.

5.3.2 Packed cell volume

The increased Packed Cell Volume (PCV) with advancement of age was observed. This was because of the increase in the number of RBCs ($\times 10^6/\mu\text{l}$) as the age increased. The increase or decrease in the number of Red blood cells had an effect on the packed cell volume and was from the Red blood cells where the packed cell volume was derived. The current study concurs with values obtained in a study by Tabinda *et al.* (2012) who did comparative research on growth performance, meat quality and haematological parameters of Fayoumi, Rhode Island Red and their reciprocal cross breed chickens. In the present study, chickens reared under deep litter system showed slight increase in the packed cell volume (%) than chickens kept under other management system as shown in Fig. 1. This slight increase in PCV (%) was due to increase in the number of Red blood cells in deep litter system because of the feed (vegetable material) supplement given.

Packed Cell Volume in chickens reared in all the three management systems indicated statistical similarities ($P>0.05$).

Packed Cell Volume values obtained were within the physiological range of 22-35 (%) as was stated by Jain, (1986) suggesting that there is no effect on PCV (%) due to different management system. This supports the findings obtained by Olaniyi *et al.* (2012) who did research on effect on performance and blood profile of two strains of chickens kept in free range and deep litter system. Packed Cell Volume being in normal physiological range indicated that chickens were free from heat stress.

5.3.3 Erythrocyte sedimentation rate

The findings of this research revealed that the erythrocyte sedimentation rate (ESR) chicken kept under different management decreased as the age of the chickens increased (Table 3).

The same findings were obtained by Islam *et al.*, (2004); Kundu *et al.* (1993) and Tabinda *et al.* (2012). Erythrocyte sedimentation rate values indicated slight decrease from the normal physiological range of between 3 and 12 mm as was suggested by Jain (1986). The non significant decrease erythrocyte sedimentation rate mean values was also experienced by Islam *et al.* (2004) who did research on haematological Parameters of Fayoumi, Assil and Local chickens reared in Sylhet Region in Bangladesh.

5.3.4 Hemoglobin

Hemoglobin (Hb) concentration (g %) in chicken kept under different management system was assessed. Hemoglobin concentration (g %) in all the three management system increased as the chickens were growing from the eight week to sixteen week.

The increase of the hemoglobin concentration as chicken grew was because of the increased in the number of Red blood cells brought about by the increase of feed intake as the chickens got older. The iron mineral contained in the diet played an important part in the synthesis of hemoglobin in the red blood cells.

This positive change of hemoglobin concentration with the age of the chickens concurs with results obtained in a study by Islam *et al.* (2004); Kundu *et al.* (1993) and Tabinda *et al.* (2012). Hemoglobin concentration values in all the three management systems were not significantly ($P>0.05$) different. Deep litter system showed higher hemoglobin value compared to battery cage and semi- intensive system. This was because of the increased amount of Red blood cells due vegetation supplement in the deep litter system. The results are consistent with the findings obtained in the study by Addass *et al.* (2012) who studied effect of age, sex and management system on some haematological parameters of intensively and semi-intensively kept chicken in Mubi, Adamawa State, Nigeria. In their study, no significant differences in Hb (g %) mean values in chickens kept under management systems observed. Hemoglobin concentration obtained in this study complies with the normal physiological range of chickens (*Galus galus domesticus*) which ranges from 7 to 13 as was reported by Jain, (1986). Hb (g %) values being in normal physiological range, indicated no significant effect of different Management systems on the Hb concentration as was stated by Obinna *et al.* (2011) and Pavlik *et al.* (2011). The slight differences in Hb (g %) values among the management system were brought about by individual variations and age of chickens.

5.3.5 Mean corpuscle hemoglobin

The trend of recorded result in Fig. 3 shows that the mean corpuscle haemoglobin (MCH) decreased with the advancement of the age especially in chickens kept in deep litter

system. At younger age the mean corpuscle hemoglobin observed to be higher than the mean value at older age. The higher mean corpuscle hemoglobin at early age in this study complies with the values obtained in a study by Islam, (2004); Mmereole (2009); Kundu *et al.* (1993) and Tabinda *et al.* (2012) who reported the mean corpuscle hemoglobin values of Fayoumi and crossbreed chicken being inversely related with age.

There were no significant ($P>0.05$) differences in mean corpuscle hemoglobin values in chickens reared under all the three management systems, as was reported by Addass *et al.* (2012). Semi-intensive system indicated high mean corpuscle hemoglobin values compared to the other management systems (battery Cage and deep litter). Mean corpuscle hemoglobin values in all three management systems slightly decreased from the normal physiological range of chickens, 33 - 47 (pg)) as was reported by Jain (1986). The slight decrease of MCH in chickens reared under different management systems had no significant effect.

5.3.6 Mean corpuscle hemoglobin concentration

The Mean Corpuscular Hemoglobin Concentration (MCHC %) measures the concentration of hemoglobin in a given volume of packed red blood cells. From the result obtained in this study, mean corpuscle hemoglobin concentration (%) in all three management was observed to be inversely proportional to the age of the chickens. Mean corpuscle hemoglobin concentration decreased as the age of birds increased and increased when the age decreased (Fig. 4). The same findings were obtained by Mmereole (2009). Mean Corpuscle Hemoglobin Concentration did not show significant ($P>0.05$) differences in chickens kept under different management systems. Mean corpuscle hemoglobin concentration values in chickens kept under the three management systems were in the normal physiological range of chickens, 26-35% as was reported by Jain, (1986).

This indicated that there was no effect of management systems on MCHC (%). This opposes the findings reported by Addass *et al.* (2012) who reported significant effect of management systems on mean corpuscle hemoglobin concentration. The difference between the observation in current study and that of Addass *et al.* (2012) may be because of geographical location and the nutritional composition used in the study.

5.3.7 White blood cell count

The real values of white blood cells in the chicken's body are their quick response to the area where there is serious infection and inflammation and provide rapid and potent defense against infectious agents.

White blood cell counts mean ($\times 10^4/\mu\text{l}$) \pm SE in chickens kept in different management systems are present in Table 4. White blood cell count values in chickens reared under battery cage system indicated slight increase at week 14 and 16 of age.

White blood cell count in chickens reared under deep litter system and semi-intensive system, remained more or less the same. WBCs ($\times 10^4/\mu\text{l}$) values were in normal physiological range of 1.2 to 3.0 ($\times 10^4/\mu\text{l}$) as was reported by Jain, (1986). The WBC ($\times 10^4/\mu\text{l}$) counts values were not significantly different ($P > 0.05$) among the three management systems. No challenge either due to the system, the change was a normal physiological change brought about by age and individual variations. The study concurs with the findings reported by Fouad *et al.* (2008); Mench *et al.* (1986) and Sogunle *et al.* (2008); Pavlik *et al.* (2011); Addass *et al.* (2012); Molee *et al.* (2011) and Olaniyi *et al.* (2012) who reported insignificant effect on white blood cell count of chickens kept under different management systems.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study revealed that, no significant effect of different management systems were observed for RBC ($\times 10^6/\mu\text{l}$) and WBC ($\times 10^4/\mu\text{l}$) count, PCV (%), ESR (mm), Hb (g %), MCH (pg) and MCHC (%). The values of RBC ($\times 10^6/\mu\text{l}$), PCV (g %) and Hb (g %) had a direct relationship with age while ESR (mm), MCH (pg) and MCHC (%) were indirectly related. The differences observed in the haematological parameters in different management systems were normal physiological changes brought about probably by age and individual variations within the birds.

Since no significant effect was observed in the haematological parameters for the chickens under the three management systems, then other factors such as risk of the diseases, sanitation, costs should be used to determine the system to use.

The total cost incurred in the battery cage, deep litter and semi- intensive system was Tsh. two million three hundred nineteen thousand and two hundred and forty (Tsh.2 319 240/=), one million eight hundred and ninety three thousand (Tsh. 1 893 000/=) and two million one hundred thirty thousand and two hundred (Tsh.2 130 200/=) respectively. These costs were not significantly different, but deep litter system is advocated to be used by the poultry keeper because of its less cost and less risk of predators, and climatic extreme changes.

6.2 Recommendations

From this study the following are the recommendations;

- (i) More work/study has to be done in breeds such as broilers and local chickens.
- (ii) Regular weight taking is to be done as this helps in assessing the growing trends of chickens and ensures the birds' good health at all the time.
- (iii) Proper feeding of high quality feed should be done. Studies on feeding/feeds quality versus management systems are required.
- (iv) Disease, parasite control and management of chickens kept under different management systems should be taken into consideration.

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APPENDICES**Appendix 1: Ingredient composition of the experimental diet Grower's mash.**

Ingredient	Percent in diet of chicken feeds
Maize	41.0
Maize bran	12.0
Rice bran	20.0
Sunflower seed cake	10.0
Cotton seed cake	7.0
Fish meal	5.5
Layers premix	0.5
Limestone	1.0
Salt	0.5
Bone meal	1.0
Methionine	0.5
Lysine	1.0

Appendix 2: Analytical chemical composition of the experimental diet (Grower's mash).

Nutrient content	Amount
Crude protein (%)	16
Metabolizable energy (kcal/kg)	2928.7
Crude fibre (%)	7.8
Crude fat (%)	3.5
Calcium (%)	1.2
Phosphorus (%)	0.2