Thesis Ref. No _________

THE EFFECT OF STOCKING DENSITY ON PERFORMANCE OF GROWER CHICKEN OF HORRO CHICKEN BREED UNDER INTENSIVE POULTRY PRODUCTION SYSTEM

MSc Thesis

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June, 2017

Bishoftu, Ethiopia

THE EFFECT OF STOCKING DENSITY ON PERFORMANCE OF GROWER CHICKEN OF HORRO CHICKEN BREED UNDER INTENSIVE POULTRY PRODUCTION SYSTEM

A Thesis Submitted to College of Veterinary Medicine and Agriculture of Addis Ababa University in Partial Fulfillment of the Requirement for Degree of Masters of Science in Animal Production

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June, 2017

Bishoftu, Ethiopia

ADDIS ABABA UNIVERSITY

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DEPARTMENT OF ANIMAL PRODUCTION STUDIES

As MSc research advisors, we here by certify that we have read and evaluated this Thesis prepared under our guidance by Gosaye Mekonen Dabi title: **The effect of stocking density on performance of grower chicken of Horro chicken breed under intensive poultry production system** we recommend that it can be submitted as fulfilling partial requirement of the MSc thesis.

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DEDICATION

This thesis is dedicated to my beloved family. Their unreserved financial and moral support for my academic success is highly memorable.

BIOGRAPHICAL SKETCH

Gosaye Mekonen was born on January 16/05/1981 E.C, in South West Shewa, Ethiopia. He attended his elementary education in Gibiso, secondary and preparatory education in Leman secondary and preparatory school. After completion of his preparatory school education, he joined Haramaya University in 2001 E.C and graduated with BSc degree in Animal science in 2003 E.C.

Soon after his graduation, he was employed by Bishoftu Poly Technic College as lecturer, and then he joined School of Graduate Studies (SGS) of Addis Ababa University to pursue MSc studies in Animal Production.

STATEMENT OF THE AUTHOR

First, I declare that this Thesis is my bonfire work and that all sources of materials used for this Thesis have been duly acknowledged. It has been submitted in partial fulfillment of the requirements for MSc degree at Addis Ababa University and is deposited at the University Library to be made available to borrowers under rules of the Library. I solemnly declare that this Thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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Date of Submission: ---------------------------------------

ACKNOWLEDGEMENTS

I wish to express my sincere thanks to all individuals who have contributed to the successful completion of this work. First and foremost I would like to thanks to my almighty God for his help in giving me courage to cope with complicated situations. My deepest respect and appreciation goes to my advisor Prof. Harpal Singh for his conceptual orientation and framework. His constructive, criticism and comments from the initial conception to the end of this work is highly appreciated. I express my deepest and sincere gratitude to my advisor Dr. Wondmeneh Esatu for his encouragement, constructive comments, guidance and supervision throughout my study period. I would like to thanks Debere Zeit Agricultural Research Center (DZARC) for offering the opportunity to work in the ongoing Horro breed research program.

I would like to give my gratitude thanks to beloved friends in campus as well as outside DZARC Poultry case team staff member Mr. Dawit Adisu for his advice and moral support. In addition to this, Bishoftu Poly Technic College staff members especially, Turnash Guluma, Etagegn Eshetu and Teriku Mesfin, I would like to say thanks for their promotion, advice and moral support. My thanks also go to Mrs. Chaltu Chala for her precious advices, constrictive comments and unreserved help in typing the manuscript.

Finally, I extend my heartfelt respect and deepest love to my beloved family mainly my wife Wrs. Hawi Nadew (Beshadu) and my brother (KM) for their moral support and consistent encouragement for my studies. I would say you have an immense contribution in my life and I always remember you for your keen support and interest in my life.

LIST OF ABBREVIATIONS

BW	Body Weight
FBW	Final Body Weight
BWG	Body Weight Gain
IBW	Initial Body Weight
CRD	Completely Randomized Design
DZARC	Debre Zeit Agricultural Research Center
EARO	Ethiopian Agricultural Research Organization
FAO	Food and Agriculture Organization
FCR	Feed Conversion Ratio
FI	Feed Intake
FR	Feed Refused
ND	Newcastle Disease
TFC	Total Feed Consumed
TNBD	Total Number of Birds Dead
TNBF	Total Number of Birds in Flock

TABLE OF CONTENTS

Contents **Pages**

Table of Contents (*Continued*)

LIST OF TABLES

Table **Pages**

ABSTRACT

*A study was conducted to evaluate the effect of stocking density on feed intake, body weight, body weight gain, feed conversion ratio, mortality and behavior of unsexed Horro breed chicken under intensive poultry production system. The experiment was carried out at Debre Zeit Agriculture Research Center. Data were recorded daily for feed consumed, feed refused and morality but body weights were recorded biweekly. Data were analyzed using procedures of SAS software. Eight week old 120 unsexed chickens were randomly divided into three groups of 8, 10 and 12 with four replications. The birds were reared from 8 to 20 weeks of age under stocking densities of 8 birds/m^2 (D1), 10 birds/m^2 (D2) and 12 birds/m^2 (D3). Feed intake was significantly ($p \leq 0.01$) higher under D1 (918.05*g*) followed by D2 (879.34*g*) and D3 (793.44*g*). Body Weight, body weight gain and feed conversion ratio were significantly ($p \leq 0.01$) higher under D2 (10 birds/m^2). Body weight recorded higher under D2, D1 and D3 with value of* 1074.85*g,* 1012.22*g and* 957.24*g respectively. Body weight gain was* 124.49*g,* 110.16*g and* 102.78*g under D2, D1 and D3 respectively. Feed conversion ratio was lowest for D2 (*2.07*), followed by D1 (*2.13*) and D3 (*2.30*). The higher mortality were observed to be associated with high stocking density (D1 (5.83%) followed by D2 (9.16%) and D3 (11.66%)). The observations on behavioral aspects indicated that cannibalism, locomotion and molting were increasingly affected with increased stocking density, while leg deformation was not affected.*

Keywords: *Body weight, Body weight gain, Feed conversion ratio, Feed intake and Mortality, Stoking density.*

1. INTRODUCTION

In Ethiopia, the agricultural sector is a corner stone system known to possess desirable characteristics such of the economic and social life of the people (Tadelle *et al*., 2000). At national level in Ethiopia, from total 60.51 million chicken population, 57.072 million (94.33%) estimated chickens are indigenous while 1.4 million (2.47%) are exotic breed and 1.9 million (3.21%) hybrid chickens maintained under intensive and same intensive management system (CSA, 2016).

Poultry production in Ethiopia shows a clear distinction between traditional, low input systems and modern, more intensive systems with a relatively improved housing, feeding, breeding, marketing and processing (Alemu, 1995). The traditional system of poultry production, which has come to be known as "balanced farming", is characterized by its low input and a corresponding low output (Tadelle *et al.*, 2000). In Ethiopia, the egg laying performance of indigenous chickens is reported to be low under farmers' management conditions. However, under improved conditions, a maximum of 100 eggs per chicken per year has been reported (Abebe, 1992; Negussie and Ogle, 1999). The major constraints that limit poultry productivity are diseases, poor feeding and management practices, and the low genetic potential of indigenous chicken (Alemu, 1997; Tadesse *et al.*, 2005).

Under intensive poultry production system, stocking density that is floor space per chicken is a very important welfare factor which directly and indirectly influences and determines the level of growth of chicken body weight (Škrbi *et al*., 2009b). Profitability can be realized by efficient management of floor space. Poultry producers tend to increase the number of birds per unit of space in order to reduce housing, equipment, and labor costs per unit of space. According to Estevez, (2007) the negative consequences of high stocking density include reduced final body, feed intake and feed conversion ratio, and greater incidences of foot-pad dermatitis, scratches, bruising, poorer feathering and condemnations.

Commercial poultry producers are often tempted to increase the number of breeding stock per pen as a method to reduce housing, equipment, and labor cost per pen. However, the literature indicates that high stocking densities can have a deleterious effect on the economics and welfare of poultry production (Estevez, 2007). Hall, (2001) observed a higher mortality, greater incidence of leg problems, and disturbed resting behavior in birds kept at high stocking densities. Chickens at high density grow more slowly, produce fewer eggs, and have higher mortality (Deaton *et al.*, 1989). Feed consumption was significantly reduced among birds reared at high stocking density. On the other hand, eggs produced by birds kept at high stocking density were heavier than those produced by birds kept at low stocking density (Cravener, 1992).

Poultry welfare issues are considered controversial because it is generally assumed that any improvements in the area of poultry welfare will have a negative impact on farm profitability. The issue of stocking density lies at the heart of this controversy because limiting space allowances in production systems can have a major negative economic impact for industry as revenues per unit of space increase linearly with density (Feddes *et al.*, 2002). Higher profits, however, may compromise poultry health and welfare if densities are taken too far. In broilers, high densities have been associated with a decline in feed intake, body weight and conversion, flock uniformity, leg health, and increased frequencies of gait scores, carcass bruising and scratching, disturbances or exacerbated mortality related to heat stress (Feddes *et al.*, 2002; Dozier *et al.*, 2005b, 2006).

The negative consequences of stocking density and the quest for profitability necessitate the evaluation of optimum density allowances for various species of poultry, especially family chickens. Family poultry encompasses the wide variety of small-scale poultry production systems found in rural and peri-urban areas of developing countries (FAO, 2014). Family chickens are usually kept in places of varying sizes in owner’s homes with some chickens being widely spaced while others are crowded. These varying stocking densities could affect performance of family chickens. There is no management guideline for this Horro breed chicken. Therefore, this study was carried out to investigate the effect of stocking densities on growth performance of unsexed Horro breed chickens during 8 to 20 weeks of age under intensive poultry production.

Therefore, general objective of this study was to assess the effect of stocking density on growth performance of chicks of dual purpose unsexed Horro breed chicken reared under intensive poultry production. Specific objectives of study was to determine,

- The effect of stocking density on the feed intake, body weight, body weight gain and feed conversion ratio of the chicken
- The effect of stocking density on the mortality and behavior of birds of the chicken.

2. LITERATURE REVIEW

2.1. Poultry Production Systems in Ethiopia

The word poultry production is synonymous with chicken production under the present Ethiopian conditions (EARO, 1999). Indigenous poultry contribute almost 94.33% of the national egg and poultry meat production (CSA, 2016). The poultry sector in Ethiopia can be characterized into three major production systems based on some selected parameters such as breed, flock size, housing, feeding, health, technology and bio-security. These are large scale commercial poultry production system, small-scale commercial poultry production system and village or backyard poultry production system (Bush, 2006).

According to Bush, (2006) large-scale commercial production system is highly intensive production system involves an average of greater or equal to 10,000 birds kept under indoor conditions with a medium to high bio-security level. This system heavily depends on imported exotic breeds that require intensive inputs such as feed, housing, health, and modern management systems. It is estimated that this sector accounts for 2.47% of the national poultry population (CSA, 2016). This system is characterized by higher level of productivity where poultry production is entirely market oriented to meet the large poultry demand in major cities. The existence of somehow better bio security practices has reduced chick mortality rates to merely 5%.

Small-scale intensive production system is characterized by medium level of feed, water and veterinary service inputs and minimal to low bio-security. Most small-scale poultry farms obtain their feed and foundation stock from large-scale commercial farms (Nzietchueng, 2008). There are few studies about diseases affecting poultry in this production system. Kinung'hi *et al.* (2004) mentioned coccidiosis as a cause of mortality, reduced weight gain and egg production and market value of affected birds.

Village/indigenous production system characterized by little or no inputs for housing, feeding (scavenging is the only source of diet) and health care with minimal level of bio-security, high off take rates and high level of mortality. As such, it does not involve investment beyond the cost of the foundation stock, a few handfuls of local grains and possibly simple night shades, mostly night time in the family dwellings. Mostly, indigenous chickens are kept although some hybrids and exotic breeds may be kept under this system (Dawit *et al.*, 2008; Addis and Malede, 2014).

2.2. Poultry Welfare

Poultry welfare in the poultry industry is an ongoing topic of interest by the consumers of poultry products (Thompson, *et al*., 2007). These consumers are concerned about how poultry are handled before, during, and after processing. For many years, there has been much emphasis on the management of table egg laying birds (hens) because they were reared in cages that provided limited amount of space for behavioral expressions (Mench, 2008).

Stress is any condition that interrupts the homeostasis of the body (Tablante *et al.*, 2000). Stress is also described as any condition that generates a nonspecific response of the body to any demand made upon it (Pattison, 1992; Moberg and Mench, 2000). Stress is initiated by stressors and stressors come in diverse forms such as extreme temperature variations, poor management practices (extreme beak trimming, contaminated premises, uneven feed distribution), and illness (Rosales, 1994). Although stress is said to be detrimental to the poultry industry, some activities from which birds derive pleasure also result in stress conditions. Nonetheless, it cannot be ruled out that prolonged stressful conditions of any form cause detrimental effects in its subjects (Moberg and Mench, 2000).

Deaths on farm may be due to many factors, caused for example by disease, injury, physiological system failure or unidentified causes, which shows that the welfare has been poor (Willeberg, 1991). Birds may also be culled for the same reasons, and in such cases, culling should be treated as a similar sign of poor welfare. Welfare is poorer if the incidence of production related diseases is higher in birds under consideration than in similarly aged birds which have not been exposed to the same management, housing or selection. In a group of birds, such as a flock, house, pen or any other population unit, the amount of poor welfare caused by disease is a function not only of its incidence but also of its severity and duration, as described by (Thompson *et al*., 2007).

2.3. Effect of Stocking Density on Different Performance traits of chicken

Stocking density has a major impact on animal production, as it affects productivity, animal welfare and farm profitability. This issue is of more importance to the poultry industry, which has been developed for high efficiency and productivity, and has been based on intensive systems of production utilizing large scale operations with large flock size under confinement and high stocking density (Sanotra *et al*., 2001).

Stocking density plays an important role in broiler production. The poultry industry always opts for higher density stocking because increasing space allowances in production systems can have a major negative economic impact for industry as revenue per unit of space increases linearly with density (Sanotra *et al*., 2001). In broilers, high densities have been associated with a decline in body weight, feed consumption and conversion, flock uniformity, leg health, and increased frequencies of gait scores, carcass bruising and scratching, disturbances or exacerbated mortality related to heat stress (Estevez *et al*., 1997; Sanotra *et al*., 2001).

The influence of stocking density (the number of birds calculated on a weight basis per meter square) of different poultry species on growth and productive performance has generated considerable interest in recent years (Abdel-Azeem, 2010). Stocking densities are kept high to maximize financial returns. It is considered as one of the most important environment factors because of the established effect on growth rate of broiler chickens. However, for the purpose of defining optimal stocking density, it is necessary to realize differences in effects depending on the broiler genotype, environment conditions, duration of production cycle (final body weight), season and management conditions (Pattison, 1992; Škrbić *et al*., 2009a).

In the broiler industry, the major concern is the effect of high stocking densities on the welfare of birds, especially during the final weeks of the growing period when body weight per unit area is high (Ravindran *et al*., 2006). However, abundant studies have shown that increase in stocking density is accompanied with decreases in health and performance. These include reduced growth, body weight, carcass quality and immune status as well as increased breast blisters, ammonia burns and heat stress mortality (Heckert *et al*., 2002; Dozier *et al*., 2006).

Stocking density has become a major issue in the debate on chicken welfare. Very high densities may impair the bird's welfare directly through physical restriction of the movement. Indirect effects through poor litter quality, high ammonia level and heat are also suggested to have a welfare impact (Pettit and Estevez, 2001). In most experiments on stocking density in broilers, the variation of density is achieved be varying number of birds at a given floor space. Hence density is confounded with group size. Also the ventilation rate at different stocking density is generally not adjusted to the number of birds in all treatment. This causes further complications (Ekstrand *et al*., 1997). The higher stocking densities caused stress on the birds compared with the lower stocking densities. Moreover, high stocking density has been reported to increase ammonia production, footpad lesions, litter moisture, locomotion, heat stress, and preening (Cravener *et al*., 1992).

2.3.1. Growth

One of the most important consequences of increasing density is the environmental change that occurs within the chicken house. An increase in density usually results in corresponding increases in temperature, humidity, CO_2, and ammonia levels. High ammonia levels (over 25 to 50 ppm) reduce growth and increase the incidence of air sac inflammation. High humidity and moist litter increase the incidence of breast blisters, hock burns, and foot pad dermatitis (among other effects). However, the magnitude of the effect of density depends on technical factors (e.g. quality of ventilation and cooling systems) as well as management factors (e.g. litter condition and light programs). This means that increasing the number of birds in a well-prepared house can cause fewer negative effects than an increase in a similar increment in an out-of-date building with poor technical conditions (Estevez, 1999; Nahashon *et al*., 2009).

Increasing stocking density of broilers is a management practice used for reducing costs associated with labor, housing, fuel and equipments. However, crowding of broilers can lead to reductions in performance (Shanawany, 1988). Maintaining a high stocking density is a common practice for the poultry industry because it allows for an increase in economic returns per unit of floor space. However, income per bird often decreases primarily due to reduction in growth rate, increased proportion of downgraded carcasses, and greater risk of health-related problems (Estevez, 1999).

There exist experiments with broiler densities varying from less than 10 to more than 80 kg/m^2 (14 to 19 birds per m^2) on litter and cage systems. The very high densities of over 80 kg/m^2 stem from caged broilers (Andrews *et al*., 1997). There is general tendency of reduced growth rate with increasing stocking density. The critical value, however, varies between the experiments. Thompson *et al*. (2007) increased the stocking density from 18.4 to 28.6 and 32.7 kg/m^2. The slaughter weight was significantly reduced at the highest density. But in later studies, there was no depression of growth rate when the stocking density was raised to about 30 and 32 kg/m^2 (Mench, 2008).

Stocking density in caged broilers is generally higher than on litter. Nevertheless growth rate under high densities in cages has been found to be similar to that of lower density in litter systems (Estevez, 1999). In most experiments with broilers under litter conditions there was a tendency of growth depression from about 30 kg/m^2 onwards (Gordon, 1992; Grashorn, 1993). It is interesting to note that the growth depression occurred in early growth phases, when physical density was not considered as a problem in the birds. The results may be explained by the procedures used in the experiments. The different densities have been tested under the same ventilation rate (Nahashon *et al*., 2009). Grashorn and Kutritz, (1991) showed that the negative effects of high density disappeared with increasing ventilation rate.

2.3.2. Feed intake and feed conversion ratio

Puron *et al*. (1995) reported that there is a linear reduction in feed intake of broiler chickens when stocking density increased from 10 to 20 birds/m^2. Also, Feddes *et al*. (2002) showed that feed intake decreased in broiler chickens when density increased from 14.3 to 23.8 bird/m^2. Furthermore, Al-Homidan and Robertson, (2007) indicated that increasing stocking density of Hybro broiler chicken from 10 to 15 bird/m^2 resulted in reduction of feed intake. In other study reported by Seker *et al*. (2009) showed that increasing stocking density of Japanese quails resulted in linear reduction in feed intake.

Rearing systems significantly affect feed intake and feed conversion ratio of the broilers (Santos *et al*., 2012). According to Estevez, (2007), high stocking density may cause low feed intake and poor carcass yield. Silas *et al.* (2014) found that quantitative feed restrictions had a significant effect on the growth performance leading to reduced feed intake and weight gain in the broilers.

There was a reduction of feed intake in response to increasing density even though the feeder space per bird was kept constant (Estevez, 2007), and in some cases the depression of feed intake was higher than the reduction of growth rate. This resulted in a better feed conversion when stocking density increased (Cravener *et al.*, 1992). In other experiments, however, there was no influence or even a worse feed conversion when stocking density was increased (Waldroup *et al.*, 1992; Skrbic *et al*., 2007). There is a unique relationship between temperature and humidity but these parameters of ventilation vary in the house with some fluctuations affecting feed intake of the broilers in different housing zones (Czarick and Fairchild, 2012).

High humidity exerts damaging effect on performance, wellbeing, growth rate and feed intake of broilers (Daghir, 1995; Mizubuti *et al*., 2000) causing heavy productive losses (Francesch *et al*., 2004) and adversely affecting the respiratory epithelium of the broilers (Kristensen *et al*., 2000) resulting into desquamation of respiratory epithelium. It is documented that 70% humidity is a good indicator for minimum ventilation leading to maximum broilers growth. However, low humidity causes dusty conditions, making the birds susceptible for respiratory diseases (Czarick and Fairchild, 2012).

Motivation to feed is perhaps the strongest motivation in broilers (Bokkers and Koene, 2004). If birds are not able to feed to the extent they are motivated this may lead to frustration and impaired welfare. Several authors found that feed intake decreased with increasing density (Beloor *et al*., 2010; Benyi, 2012; Mizubuti *et al*., 2000). However, other authors studies found either no response of feed intake to density (Sirri *et al*., 2007; Turkyilmaz, 2008), an increase in feed intake with increasing density (Zuowei *et al*., 2011), or peak values at intermediate densities (Feddes *et al*., 2002). Such contradictions between studies cannot be explained by a focus on different parts of the density scale, as contradictions were also found between studies focusing on similar density ranges. Evidence on food conversion ratios is similarly contradictory, with some studies indicating worse (i.e., higher) ratios at higher density (Zuowei *et al*., 2011), whilst others studies found no effect (Ventura *et al*., 2010; Sekeroglu *et al*., 2011).

Better efficiency of food utilization in higher stocking densities was established by Lewis *et al*. (1997), Edriss *et al*. (2003), whereas Andrews *et al.* (1990) established higher feed conversion in conditions of higher stocking density. El-Deek and Al-Harthi, (2004) established better feed conversion in all stages of broiler nutrition in higher stocking density, Thomas *et al.* (2004) only during starter phase, and at the end of trial, at the age of 35 days, differences were below the level of significance. Absence of the effect of stocking density on consumption of food per unit of gain of body mass was concluded also by Mortari *et al.* (2002) and Skrbic *et al*. (2007).

2.3.3. Body weight and body weight gain

Tayeb *et al*. (2011) found that there was no significant effect of stocking density on body weight of chickens at the end of the rearing period**.** These results are not in line with studies of Makowski *et al*. (2004), Feddes *et al*. (2002) and Reiter and Bessei, (2000) they have found a significant effect of densities on body weight. However, Turkyilmaz, (2008) reported that stocking density had no significant effect on live body weight. In general, trend of decrease of the level of growth with the increase of stocking density was established (Lewis *et al*., 1997, Škrbic, 2007), as consequence of heat stress (Yadgari *et al*., 2006), main factor of growth depression in cases of high stocking densities.

Bandyopadhyay *et al.* (2006) reported that the income per bird decreases due to poor growth rate and health problem in high stocking density. Wang *et al*. (2014); Simitzis *et al.* (2012) reported that high stocking density is associated with decreased weight gain in broilers. Mortari *et al.* (2002) reported that there was no effect of stocking density on feed consumption per unit gain of body mass in broilers. Dozier *et al.* (2005) reported that reduced floor space can reduce the growth rate and carcass quality. In addition to this, body weight gain and feed intake were affected by increasing the stocking density from 30 to 45 kg of BW/m^2. Similarly, Das and Lacin, (2014), reported that mean body weight of the group raised under normal stocking density was significantly higher as compared to the higher stocking density.

Bilgili and Hess, (1995) found final body weight was reduced by 13 and 20% respectively, as stocking densities increased from 40 to 50 birds/m^2. Similarly, Bilgili *et al*. (2009) reported that a 3.6% reduction in body weight at 49 days of age was obtained as the stocking density was increased from 10 to 13 birds/m^2. In another study, Puron *et al*. (1995) found a 2.3 and 3.5% reduction in body weight in 49 day old broiler.

In other study, the depression in body weight gain due to increased stocking density, was attributed to the reduction in feed consumption due to limited physical access to feeders as the stocking density was increased, leading to reduced feed consumption. Dozier *et al*.

(2005) reported that increasing the stocking density above 30 kg of body weight/m^2 of broiler adversely affected growth rate, feed consumption and feed conversion ratio calculated at 28 days of age. Final body weight gain and nutrients utilization were also negatively impacted by high stocking densities calculated at 35 days of age. Feddes *et al*. (2002) reported that as stocking density was increased from 14 to 18 birds/m^2 cumulative body weight was decreased by 3.2 and 3.6 % respectively with broiler weighing approximately 1.9 kg. Lower body weights values occurred also with decreasing stocking density from 14 to 11 birds/m^2. In addition, both weight gain decreased as the floor space allowance decreased to 0.046 m^2/ bird (21.5 birds/m^2).

There is a unique relationship between temperature and humidity but these parameters of ventilation vary in the house with some fluctuations affecting body weight of the broilers in different housing zones (Czarick and Fairchild., 2012). It has been reported that when birds are exposed to low ambient temperature maximum body weight could be achieved between 28 to 35 day (Simmons *et al*., 2003). However, high temperature has also been reported to have adverse effect on broiler growth performance e.g. body weight gain (Dozier *et al*., 2005).

2.3.4. Mortality

Shanawany, (1988) found increased mortality when stocking density was increased from 5 to 45 kg/m^2. Despite the increase of mortality and the decrease of growth rate in this experiment net profit per crop increased linearly with stocking density. The costs for chicks and the feed of the dead birds are made up by the lower costs per birds for buildings and equipment. In the other experiments with a high density (ranging from 14 to 54 kg/m^2) there was no significant effect of density on mortality (Cravener *et al.*, 1992; Grashorn, 1993).

Several previous reports described that there was a significant effect of stocking density on the production performance, feed consumption, feed conversion ratio and mortality of broilers. High stocking densities may even decrease mortality in the first weeks of rearing

(Heier *et al*., 2002; De Jong, 2010) which may be the effect of higher temperatures at chick level. However, mortality may increase with stocking density under exceptionally hot conditions (De Oliveira *et al*., 2000; Imaeda, 2000).

Recent research supports the lack of a density effect on mortality (Sekeroglu *et al*., 2011; Zuowei *et al*., 2011). High stocking densities may even decrease mortality in the first weeks of rearing (Heier *et al*., 2002; De Jong, 2010) which may be the effect of higher temperatures at chick level although this needs further study. However, mortality may increase with stocking density under exceptionally hot conditions (De Oliveira *et al*., 2000; Imaeda, 2000). Bilgili and Hess, (1995) found that examining densities of 0.8, 0.9 or 1.0 square foot per bird. They observed that mortality was significantly improved 3.6%, 2.1% and 2.0% respectively when birds were given more space. However, in another study, Feddes *et al.* (2002) demonstrated that stocking density had no effect on mortality. In our study, mortality was lower in high stocking density group (14-17 birds/m^2).

Majority of authors established no statistical dependence of this trait on stocking density, although it should not be overlooked that percentage of died broilers increases with the increase of stocking density, especially in stocking densities above 10 bird/m^2 (Thomas *et al*., 2004). In investigation of the effect of stocking density in production conditions of large farms, Hall, (2001) established significant increase of mortality with the increase of stocking density. It is possible that in conditions of high stocking density mass hysterical behavior of chickens occurs with harmful effects on their vitality, which is not occurring in experimental conditions.

2.3.5. Behaviors of birds

In high stocking density differences in behavior that are mostly associated with reduced movement due to barrier effects (Newberry and Hall, 1990) and increased frequency of disturbances have also been reported to have negative effects on bird performance as a result of increased bird density. Although most studies have not succeeded in linking physiological stress in birds to high densities, Heckert *et al*., (2002) reported a reduction in bursa weight in broilers, which may be interpreted as a sign of increased stress in birds.

There are conflicting experimental results on the effect of stocking density on behavior. Bessei, (1992) observed commercial broilers under densities of 10 and 20 birds per m^2 (19 and 35 kg/m^2 respectively) and 15, 20 and 25 birds/m^2 (30, 37.5 and 45kg/ m^2). There was no significant difference in loco motor activity, feeding, drinking, scratching or resting. Blokhuis and van derhaar, (1990) observed the behavior of broilers at different stocking densities: 2, 8, 14 and 20 birds per m^2 (4.3 to 42 kg/m^2), and Lewis and Hurnik (1990) worked on densities from 7.5 to 15 birds/m^2. In these experiments the loco motor activity and scratching declined with increasing density. This effect was confirmed by Reiter and Bessei, (1998). In this experiment group sizes of 5, 20, 40 and 60 birds have been combined with densities of 5, 10 and 20 birds per m^2. There was a significant decrease of locomotion and scratching between 5 and 20 birds per m^2. The data of 10 birds/m^2 density were intermediate. Feeding, drinking, and sitting were not influenced by density. There was a significant effect of group size on both, feeding activity and scratching. Scratching increased continuously with increasing group size.

The birds kept at the lower stocking density in each case showed more walking, running and calm behavior, spent less time concentrated in the areas around the feeders and drinkers and were more active, in the last week before slaughter than birds kept at the high densities. Increased activity near the feeders and drinkers but lower activity elsewhere at 30 kg/m^2 than at 25 kg/m^2 was also reported by Lewis and Hurnik, (1990). It appears that at 66 stocking densities above 25 kg/m^2 birds have to spend longer and move more close to feeders and drinkers in order to obtain enough food and water, but, especially in the latter stages of growth, their movements are also considerably restricted elsewhere and activity levels are lower. This great restriction of locomotion and other normal behavior is a direct indication of poorer welfare and is likely to result in greater leg problems.

Febrer *et al*. (2006) and Buijs *et al*. (2010) were mentioned that increased stocking density may restrict the possibility to perform litter directed behavior and locomotion. Hall, (2001) and Buijs *et al*. (2011b) studies are more equivocal on the increase of disturbances at higher density. Likewise, walking bouts were found to be shorter at higher density (Buijs *et al*., 2010), with birds covering less distance per unit of time (Leone and Estevez, 2008a; Leone and Estevez, 2008b), suggesting that it becomes increasingly hard to move around as density increases. Together with the findings of Bokkers *et al.* (2011) that broilers are compressed when kept at a stocking density of 16 birds/m^2 it can be suggested that more birds per unit area create a barrier effect that hampers dispersion of other birds throughout the space (Collins, 2008). It is important to note that increased disturbance and decreased walking bout lengths were found even in large scale commercial studies in which environmental influences overshadowed many other stocking density effects (Dawkins *et al*., 2004; Febrer *et al*., 2006).

Feather pecking, an abnormal behavior, which consists of pecking the feathers of other birds (van Hierden *et al*., 2002, Vestergaard *et al*. 1993, Savory 1995). The occurrence of cannibalism has been associated with a number of factors. Unsatisfactory housing conditions such as in a wire floor system (Baum 1995; Johnsen *et al*. 1998) or cages (Tablante *et al*., 2000) have been shown to promote its occurrence. Increasing group size and stocking density increases the frequency of aggressive pecks (Bilsing *et al*., 1992; Savory *et al*., 1999; Bilcik and Keeling 2000), resulting in greater feather picking and cannibalism (Appleby *et al*., 2002).

2.3.6. Pathologies

The interrelationships between stocking density and pathologies, such as chronic dermatitis, breast blisters and leg disorders have been reported in various experiments. It was found in most studies that the incidence or frequency of the disorders increased with increasing stocking density (Cravener *et al.*, 1992; Gordon, 1992). It seems that - as in the case of growth rate - the density only indirectly influences the development of pathologies. High stocking density has generally been regarded as leading to a greater risk of wet litter and high ammonia concentrations which have been reported as causes of breast blisters and dermatitis and hock burn was worse at 30-40 kg/m^2 than at 24 kg/m^2, (Gordon and Thorp, 1994).

However, although Czarick and Fairchild, (2012) found significant relationships between wet litter and ammonia in broiler houses on acute and chronic dermatitis, and general constitution disorders, they found no direct relationships between these disorders and stocking density within the high stocking density range of 20-35 birds /m^2. Frankenhuis *et al.* (1991) described the scabby hip syndrome as a result of the stepping over pen mates which is likely to occur under high densities. Claw clipping (Frankenhuis *et al.*, 1989) and toe 65 clipping (Harris *et al.*, 1989) reduced the incidence of scabby hips. This shows that scabby hips are the result of physical constraint or nervousness which leads the birds to step on the back of the pen mates. This syndrome, however, has only been reported in a few experiments using high densities. It is assumed that the high stocking density may elicit this syndrome in combination with other factors e.g. the presence of infectious agents. In dry conditions, increased stocking density can lead to increased levels of airborne dust and hence more respiratory disease challenge. However, at stocking densities of over 30 kg/m^2, increases in airborne dust caused by bird disturbance of litter reach a plateau (Gustafsson and Martensson, 1990; Johnson *et al*., 1991).

3. MATERIALS AND METHODS

3.1. Study Area

The experiment was carried out at Debre Zeit Agricultural Research Center (DZARC), located 47 km South East of Addis Ababa at an altitude of 1900 meters above sea level and at $8^{o}44'$ N latitude and 38^{o}, 38' E longitude. The average annual rainfall and average minimum and maximum temperatures of the area are 1100 mm, 8.9 ^{o}C and 28.3 ^{o}C, respectively (DZARC, 2003).

3.2. *Breed Description*

Horro breed is an indigenous type chicken named after the geographic region of origin located in the western part of Ethiopia near the Blue Nile gorge around Horro village. There are about 30,000 chickens restricted to this original environment (Dana *et al.,* 2010). The population has a wide range of morphologic and genetic diversity. Improved local Horro is an indigenous breed of dual-purpose type chicken. Dual-purpose is breeds that give reasonable numbers of meat and eggs (Iraqi *et al*., 2005; Mekki *et al*., 2005). The breeding program to improve the egg and growth traits of indigenous Horro chickens in Ethiopia was started in 2008 (Dana *et al*., 2011). Crossbreeding was used to develop dual purpose breed because, selection breeding can be difficult due to the negative genetic correlation between the egg and growth traits (Wondmeneh, 2015). These difficulties with negatively correlated traits could be overcome by using crossbreeding. The body weight of the base generation chickens was 701 (528) grams in males (females) and egg production in the base population was 34 eggs in 6 months after onset of egg laying (Dana *et al*., 2011). After 6 generations of selection, the egg production was increased to 76 eggs in 6 months after the onset of egg laying and the analysis revealed positive genetic changes over generations (Wondmeneh *et al*., 2014). In addition to this, Wondmeneh, (2015) reported that improved chickens produced 171 eggs per year than unimproved that only produced 66.5 eggs.

3.3. *Experimental Design*

A total of 286 layer day old chicks obtained from DZARC were reared up to 8 weeks of age in a house with floor space of 11.44 m^2 and then 120 unsexed grower birds selected randomly were reared from 8 up to 20 weeks of age under intensive management condition. A completely randomized design (CRD) was employed in this experiment. One hundred twenty (120) birds were randomly allocated to three stocking densities (treatments) of 8, 10 and 12 birds within each treatment having four replicates. Both sexes were reared together. Stocking density D_2 (10 birds/m^2) served as control. Stocking density selection was based on Bovan brown breed stocking density as per Bovan's management guide (ISA poultry.com) as stocking density had not been standardized for Horro breed. The layout of experiment is given in Table 1.

Table 1: Layout of experiment.

Replication	**Stocking Density (birds/m^2)**		
	D1	**D2**	**D3**
R1	8	10	12
R2	8	10	12
R3	8	10	12
R4	8	10	12

NB: D1: 8birds/m^2; D2:10birds/m^2; D3:12birds/m^2; R1: Replication One; R2: Replication Two; R3: Replication Three; R4: Replication Four.

3.4. Housing and Feeding Management of Experimental Birds

A wire mesh partitioned deep litter floor house covered with disinfected Teff straw material was used. Before the commencement of the actual experiment, the experimental pens, watering and feeding troughs were thoroughly cleaned, disinfected, and sprayed against external parasites. The experimental chicks were provided identical care and management and strict hygienic measures were undertaken during the experimental period. Hens were vaccinated against Marek's, Newcastle, Gumboro, Lasota, Fowl typhoid, and Fowl pox diseases. The area of each pen was 1 m^2 and provided with one tube feeder and a fountain waterer that were filled with feed and water all the time. The chicks were kept under deep litter management system in a house with windows for ventilation. Deep litter rearing arrangements was prepared two days prior to the arrival of chicks.

3.5. Formulation of the Grower Deits

The study flock was fed on recommended grower rations during 8 to 20 weeks of age. The feed was given equally for each pen or for each treatment as per requirements. Fresh and clean water was offered *ad libitum* throughout the study. The grower diets were formulated and produced at DZARC. Feed for the experimental birds was composed of protein source (meat meal, noug cake and soya bean), energy source (maize), essential amino acid (methionine, lysine), and vitamin premix and mineral (calcium, salt). Birds in each replicate were group fed. Feed intake was measured by giving pre-weighed feed allocated to each replicate group throughout the week and then weighing all the refusals at the end of the week. The formulation and nutrient composition of starter and grower feed used in the experiment are given in Table 2 and Table 3, respectively.

Table 2: Proportion of ingredients used for formulating the experimental diets.

	Rations
Ingredients (%)	**Grower**
Maize	55.25
Wheat middling	15
Noug seedcake	12
SBM	11
Meat and bone meal	3
Vitamin premix	0.5
Salt	0.4
Limestone	2.5
Methionine	0.2
Lysine	0.15
Total %	100

Table 3: Nutrient composition of starter and grower poultry rations.

	Rations
Nutrient	**Grower**
CP%	13.60
ME (kcal/kg DM)	2765
DM %	89.56
Ash (% DM)	9.20
EE (% DM)	7.14
CF (% DM)	7.05

NB: SBM: soybean meal; CP: Crude Protein; DM: Dry Matter.

3.6. Data Collection Procedure

Data on feed intake, body weight, body weight gain, feed conversion ratio, mortality and behavior of birds were recorded as follows.

3.6.1. Feed intake

Daily feed consumed in each pen was weighted starting from 8th week to the end of 20th week. Feed given to the birds and refusals were recorded weekly in each replicate using an electronic balance throughout the experimental period. The difference between feed given and left over feed was used to calculate feed intake (grams) as; Djakalia *et al.* (2011).

Feed Intake = Total Feed Consumed (TFC) (g) – Total feed Refused (FR) (g)

3.6.2. Body weight

Prior to the start of the experiment all chicks were individually weighed and randomly distributed to three groups of different stocking densities. Biweekly live body weights (at 2 weeks interval) were recorded starting from 8th week to 20th week. Before taking the weight, birds were fasted overnight and weighed empty crops on the following morning to obtain live body weight measurements.

3.6.3. Body weight gain

Body weight gain was determined at two weeks interval from 8 to20 weeks of age. Average biweekly body weight gain during 8 to 10 weeks, 10 to 12 weeks, 12 to 14 weeks, 14 to 16 weeks, 16 to 18 weeks and 18 to 20 weeks, were computed by taking the difference of the body weight at the final week from that of initial week body weight as follows;

Body Weight Gain = Final Body Weight (g) – Initial Body Weight (g)

3.6.4. Feed conversion ratio

Feed conversion ratio was determined by dividing total feed intake by body weight gain of birds during the specified period (Ratsaka *et al*., 2012).

Feed Conversion Ratio = Feed Intake / Body Weight Gain

3.6.5. Mortality

The rate of mortality in the flock were determined as the ratio between the number of birds dead and initial total number of birds in the flock multiplied by 100. (Ratsaka *et al*., 2012).

Mortality (%) = Total Number of Birds dead / Total number of Birds in Flock * 100

M =TNBD / TNBF * 100

3.6.6. Behavior of birds

The impact of stocking density on behavior of birds was studied by observing cannibalism, locomotion (movement of the birds), molting and leg deformity of the chickens.

3.7. Data Analysis

Data were analyzed using procedures of Statistical Analysis Systems (SAS, 2009) software. The analysis of variance was made using the following statistical model and the F test was applied for knowing the significance of overall effects stocking density.

$Y_{ij} = \mu + d_i + e_{ij}$

Where;

Y_{ij} = j^{th} observation under i^{th} stocking density

μ = Overall mean

d_i = the effect of i^{th} stocking density

e_{ij} = Error term assumed to be normally and independently distributed with mean 0 and variance σ_e^2, i.e. NID $(0, \sigma_e^2)$.

4. RESULTS

The average feed intake, body weight, body weight gain and feed conversion ratio of the experimental birds at the different stocking densities during 8 to 20 weeks of age were computed by taking the average of over all four replications and presented as follows.

4.1. Feed Intake

The biweekly average feed intake of unsexed Horro breed chickens from 8 to 20 weeks of age recorded under three stocking densities are presented in Table 4.

These results revealed that the feed intake under three stoking densities was significantly higher ($P \leq 0.01$) for hens under D1 (815.90±1.21g), compared to the others with the lowest intake recorded for D3 (717.56±0.59g). Biweekly average feed intakes were also increased from 8 to 20 weeks under all densities, because of the increased requirement of growing birds for growth.

Table 4: Means ± SE of biweekly feed intake (g) in unsexed Horro breed chicken during 8 to 20 weeks of age under three stocking densities.

Age of Birds (wks)	Feed intakes (g)			Sign.
	D1 Means ± SE	D2 Means ± SE	D3 Means ± SE	
8 – 10	815.90±1.21^{a}	801.72±0.79^{b}	717.56±0.59^{ab}	*
10 – 12	856.36±1.23^{a}	808.41±1.22^{b}	726.35±0.90^{c}	*
12 – 14	919.72±0.72^{a}	863.96±0.72^{b}	753.64±0.66^{c}	*
14 – 16	942.27±0.54^{a}	908.10 ±0.94^{b}	810.40±0.66^{c}	*
16 – 18	981.36±0.94^{a}	920.17±1.09^{b}	858.64±0.72^{c}	*
18 – 20	992.72±0.54^{a}	973.72±0.54^{b}	894.05±0.68^{c}	*
Over all	918.05±0.86^{a}	879.34±0.88^{b}	793.44±0.70^{c}	

*: Means with in rows different superscripted letters are statistically significant ($P<0.05$).

4.2. Body Weight

Biweekly average body weights at different stages of growth from 8 to 20 weeks of age are presented in Table 5. The results indicated that biweekly average body weight of unsexed Horro chicken at all stages of growth from 8 to20 weeks of age were higher under D2 followed by D1 and D3. The difference among the means under three stocking density were found to be statistically significant ($P \leq 0.01$) at all stages of growth. Under D1 low body weight recorded might be due to more activity of the birds in low stocking density.

Table 5: Means ± SE of biweekly body weight in Horro breed chicken during 8 to 20 weeks of age under three stocking densities.

Age of Birds (wks)	Body weights (g) D1 Means ± SE	D2 Means ± SE	D3 Means ± SE	Sign.
8 - 10	580.00 ± 14.18^{b}	632.06 ± 15.61^{a}	528.42 ± 14.85^{c}	*
10 - 12	810.95 ± 18.21^{b}	889.44 ± 24.37^{a}	762.36 ± 20.56^{c}	*
12 - 14	923.80 ± 25.20^{b}	1015.37 ± 34.28^{a}	871.18 ± 24.40^{c}	*
14 - 16	1153.33 ± 32.79^{b}	1201.55 ± 42.03^{a}	1099.16 ± 27.86^{c}	*
16 - 18	1247.38 ± 38.03^{b}	1297.07 ± 46.26^{a}	1194.74 ± 31.96^{c}	*
18 - 20	1357.86 ± 43.32^{b}	1413.62 ± 49.55^{a}	1287.63 ± 35.40^{c}	*
Over all	1012.22 ± 28.62^{b}	1074.85 ± 35.35^{a}	957.24 ± 25.83^{c}	*

*: Means with in rows different superscripted letters are statistically significant ($P < 0.05$).

4.3. Body Weight Gain

The biweekly average body weight gain of unsexed Horro breed chickens from 8 to 20 weeks of age under three stocking densities are presented in Table 6.

The computed biweekly average body weight gain in unsexed Horro chicken during different stages of growth from 8 to 20 weeks of age under three stocking densities were highest under D2 followed by D1 and D3 at all stages of growth. The differences between body weight gains of chicken under three stocking densities were found to be significance (P≤0.01).

Table 6: Means ± SE of biweekly body weight gain in Horro breed chicken during 8 to 20 weeks of age under three stocking densities.

Age of Birds (wks)	Body weight gains (g)			Sign.
	D1 Means ± SE	D2 Means ± SE	D3 Means ± SE	
8 - 10	145.61±9.27[b]	151.37±9.27[a]	125.92±11.68[ab]	*
10 - 12	129.52±8.95[b]	142.41±12.23[a]	116.97±7.23[c]	*
12 - 14	130.95±11.32[b]	135.17±12.74[a]	113.94±7.12[c]	*
14 - 16	112.85±10.84[b]	124.93±11.23[a]	108.81±6.91[c]	*
16 - 18	112.85±9.81[b]	116.55±10.84[a]	106.57±5.73[c]	*
18 - 20	94.04±8.62[b]	100.51±7.95[a]	92.51±6.14[c]	*
Over all	110.16±9.8[b]	124.49±10.71[a]	102.78±7.46[c]	*

*: Means with in rows different superscripted letters are statistically significant (P<0.05).

4.4. Feed Conversion Ratio

The computed biweekly feed conversion ratios during different stages of growth from 8 to 20 weeks of age are presented in Table 7.

The results showed that birds were most efficient feed converter under D2 stocking density followed by D1 and D3 at all the stages of growth and the differences at all stages of recoding were found to be significant (P≤0.01). During experimental period, on 16 to 18 weeks of chicken growth age, feed conversion ratio was recorded low under D3 than other stocking density, but it did not statistically differ with compared to D1 and D2.

Table 7: Means ± SE of biweekly feed conversion ratio in Horro breed chicken during 8 to 20 weeks of age under three stocking densities.

Age of Birds (wks)	Feed conversion ratio D1 Means ± SE	D2 Means ± SE	D3 Means ± SE	Sign.
8 - 10	$1.25±0.56^{b}$	$1.15±0.69^{a}$	$1.44±0.43^{c}$	*
10 - 12	$1.65±0.44^{b}$	$1.55±2.80^{a}$	$1.80±0.46^{c}$	*
12 - 14	$1.92±1.53^{b}$	$1.89±2.21^{a}$	$2.09±1.02^{c}$	*
14 - 16	$2.19±1.22^{b}$	$2.12±1.18^{a}$	$2.41±0.84^{c}$	*
16 - 18	$2.69±1.86^{b}$	$2.65±1.80^{a}$	$2.89±0.64^{ab}$	*
18 - 20	$3.13±1.54^{b}$	$3.08±0.66^{a}$	$3.22±1.03^{c}$	*
Over all	$2.13±1.19^{b}$	$2.07±1.55^{a}$	$2.30±0.74^{c}$	*

*: Means with in rows different superscripted letters are statistically significant ($P<0.05$).

4.5. Mortality

The recorded mortality during 8 to 20 weeks of age in Horro chickens are presented in Table 12 and depicted in figure 9. These results indicated that percent mortality was lowest under D1 (5.83%) followed by D2 (9.16%) and D3 (11.66%) and the difference in mortality among three stocking densities were significant ($P\leq0.01$).

Table 8: Mean ± SE of mortality in Horro chicken during 8 to 20 weeks of age under three stocking densities.

Stocking Density	Mortality (%)	Sign
D1 (8 Birds/m^2)	$5.83±0.10^{c}$	*
D2 (10Birds/m^2)	$9.16±0.09^{b}$	
D3 (12Birds/m^2)	$11.66±0.08^{a}$	

*: Means with in column different superscripted letters are statistically significant ($P<0.05$).

4.6. Effect of Stocking Density on Behavior of Birds

The observed effects of stocking density on performance traits of unsexed Horro breed chicken under three stocking densities during 8 to 20 weeks of age are presented in Table 13.

These observations indicated that cannibalism, locomotion and molting behavior of the birds were highly affected with increased stocking density, while leg deformation did not show any change due to the increased stocking density of birds.

Table 9: The effect of stocking density on behavior of birds reared during 8 to 20 weeks of age under three stocking densities.

	Stocking Density		
Behavior	**D1**	**D2**	**D3**
Cannibalism	Low	Medium	High
Locomotion	High	Medium	Low
Molting	Low	Medium	High
Leg deformation	No	No	No

Low, Medium and High: Mean level of stocking density effect on behavior; No: Not exist (Not found).

5. DISCUSSION

5.1. Feed Intake

Feed intake was significantly ($p \leq 0.01$) higher under D1 followed by D2 and D3 in Table 4. There was a decreasing pattern of feed intake with the increasing stocking density of unsexed Horro chicken during 8 to 20 weeks of age. This could be due to less feeder space available. Estevez, (2007) observed that there was a reduction of feed intake in response to increasing density even though the feeder space per bird was kept constant. Puron *et al*. (1995) and Anon, (2013) attributed the decline in feed intake with increased stoking density to restricted access to the feed, increased heat stress and increased ammonia level which occurs under heavily stocked birds. These results are in agreement with, Al-Homidan and Robertson, (2007), Gupta *et al*. (2015) and Iyasere *et al*. (2012), as they have also reported that there was a decrease in feed intake with the increased stock density. Similarly, Tong *et al.* (2012) observed that under three stocking densities (12.5, 17.5 and 22.5 birds/m^2) feed intake decreased significantly as stocking density increased. Beg *et al*. (2011) also found that lower stocking density D1 (8 birds/m^2) consumed significantly ($p<0.05$) higher amount of feed (4466 g/bird), where as birds under higher stocking density D4 (14 birds/m^2) consumed less amount of feed (4307 g/bird). Similarly, Dozier *et al*. (2005) observed a linear decrease in feed intake with increasing stocking density ranging from 10 to 20 birds/m^2.

Several other authors have observed that feed consumption decreased with increased stocking density Valdivie and Dieppa, (2002), Singh and Sharma, (2003) and Santos *et al*. (2005), which were agreed to the present findings. Other authors in agreement with present finding Seker *et al*. (2009), Beloor *et al*. (2010) and Benyi, (2012), they found that feed intake decreased with increasing density. However, disagree with present study Sirri *et al*. (2007) and Turkyilmaz, (2008), as they have reported feed intake was increased as stocking density increased. In contrast with the current study, Feddes *et al.* (2002), found that birds reared at lower stocking density (11.9 birds/m^2) consumed the less feed (2,993 g/bird) compared to those at higher stocking density (14.3 birds/m^2), which consumed more feed (3,183 g/bird) and disagreed with observations under present study. The difference in feed intake under different stocking densities observed in this study and as reported by others may be due to breed and size of birds used in experimentation. From these results it is concluded that for required feed intake of birds during their growing period optimum stocking density in housing of birds may be practiced.

5.2. Body Weight

Biweekly body weights (Table 5) of unsexed Horro breed chicken from 8 to 20 weeks of age were higher under D2 followed by D1 and D3, and differences in body weight under three stocking densities were significant (P≤0.01). In D1 less body weight might be due to more activity of the birds because of low stocking density. This result was similar to Gupta *et al.* (2015), who have found that group II (12 birds/m^2) was higher in body weight than Group I (16 birds/m^2) and Group III (8 birds/m^2). Also Beg *et al*. (2011) found that birds under the stocking density D3 (12 birds/m^2) had higher body weight than body weights under D2 (10 birds/m^2) and D4 (14 birds/m^2) stocking densities. The significant differences in body weights observed under three stocking densities in this study are in agreement with Dozier *et al.* (2006), Yadgari *et al*. (2006), Nahashon *et al*. (2009), Sekeroglu *et al.* (2011) and Kenaleone *et al*. (2014), as they have also found a significant effect of stocking density on body weight of birds. Present findig also in agreement with Tong *et al*. (2012), Dozier *et al*. (2005) and Bandyopadhyay *et al.* (2006), as they have observed a decrease in body weight with increased stocking density, ranging from 10 to 20 birds/m^2.

Similarly, to the present study Das and Lacin, (2014), who found that mean body weight of the group raised under low stocking density was significantly higher as compared to the high stocking density. In agreement to the present study Dozier *et al*. (2005), Simitzis *et al.* (2012), Wang *et al*. (2014) and Škrbic, 2007) also they observed that body weight was adversely affected by increasing the stocking density above 30 kg of BW/m^2 (12 birds/m^2) of floor. However, the present results do not agree with the reports of Feddes *et* *al*. (2002) and Valdivie *et al*. (2004) as they have reported that higher stocking density could be used to get higher body weight. The current finding is in disagreement with El Deek and Ai-Harthi, (2004), Makowski *et al*. (2004) and Tayeb *et al.* (2011) as they did not find any significant influence of stocking density on body weight of broiler chicks. Also, Buijs *et al.* (2009), found no significant difference in final body weight of birds as stocking density increased. From above discussion it can be concluded that for achieving maximum body weight an optimum stocking density for unsexed Horro breed of chicken may be found out.

5.3. Body Weight Gain

Body weight gain of unsexed Horro breed chicken from 8 to 20 weeks of age were higher under D2 followed by D1 and D3, and differences in body weight under three stocking densities were significant ($P \leq 0.01$). These results indicate that D2 stocking density was optimum for achieving the better body weight gain than D1 and D3 stocking densities during 8 to 20 weeks of age for unsexed Horro breed chicken (Table 6). The higher body weight gain under stocking density D2 (10 birds/ m^2) than D1 (8 birds/ m^2) might be due to more activity of the birds in low stocking density and wasting most of the energy in unproductive activity. The higher body weight gain under stocking density D2 than D3. The depression in body weight gain due to increased stocking density D3 (12 birds/ m^2) may be due to limited physical access to feeders leading to reduced feed consumption and overcrowding stress.

The current finding is consistent with Iyasere *et al*. (2012) and Kenaleone *et al*. (2014) who have found that increased stocking density reduces body weight gain of the birds. Similarly, Sekeroglu *et al.* (2011) raised broilers under three stocking densities (9, 13 and 17 birds/m^2) and observed that body weight gain at stocking density of 13 birds/m^2 was higher than that of other two stocking densities. In agreement with current study, Tong *et al*. (2012) and Dozier *et al*. (2005) also found decrease in body weight gain, as the stocking density increased. However, Thomas *et al*. (2004), Tong *et al*. (2012) and Ravindran *et al*. (2006) found that there was no difference in body weight gain of birds reared at different stocking densities. It can be concluded from this discussion that lower and higher stocking densities of birds than required floor space affect the performance of birds for body weight adversely.

5.4. Feed Conversion Ratio

Feed conversion ratio of unsexed Horro breed chicken during 8 to 20 weeks of age were higher under D2 (10 birds/m^2) followed by under D1 (8 birds/m^2) and D3 (12 birds/m^2). The difference in feed conversion ratio of birds under three stocking densities were significant ($P \leq 0.01$). The lower feed conversion ratio values indicate the better feed efficiency of birds. The birds under lower stocking density D1 (8 birds/m^2) may have more feed intake than their actual requirement, resulting in wastage of excess feed intake by not converting it into body mass and finally unable to show better feed conversion ratio value. These results are in agreement with those of Ravindran and Thomas, (2004), Valdivie *et al*. (2004) and Sreehari and Sharma, (2010) as they have observed that feed conversion was better at the higher density than at the lower densities.

However, the lower feed conversion ratio under D3 (12birds/m^2) than D2 (10birds/m^2) may be due to the overcrowding stress to the birds and agreed with Feddes *et al*. (2002), as they have found that feed conversion may be negatively affected by increased stocking density. However, present findings did not agree with Lewis *et al.* (1997), Sekeroglu *et al.* (2011) and Sreehari and Sharma, (2010) as they have found that higher feed conversion ratio were under high stocking densities. The present finding disagree with Al-Homidan and Robertson (2007), Waldroup *et al.* (1992) and Mortari *et al.* (2002), also they have found that there was no influence or even a worse feed conversion when stocking density was increased. It may be concluded from these discussion that to maximize the feed conversion ratio of growing birds an optimum stocking density housing of birds should be practiced.

5.5. Mortality

The average mortality (Table 12) found under three stocking densities of unsexed Horro breed chicken from 8 to 20 weeks of age were lowest under D1(5.83%) followed by D2 (9.16%) and D3 (11.66%). The differences in mortality among three stocking densities were significant ($P \leq 0.01$). Birds were affected more as stocking density increases. In agreement with current study, Hall, (2001), reported significant increase in mortality with the increase of stocking density of birds. But present observations also disagreed with Yardimci and Kenar (2008), as they have reported that mortality was lower in high stocking density group (14-17 birds/m^2) than group (10-13 birds/m^2). Similar, to the present study, Bilgili and Hess, (1995) observed that mortality was significantly improved when birds were given more housing floor space.

However, Škrbić, (2007) and Thomas *et al.* (2004), found no statistical difference of mortality on stocking density, although it should not be overlooked that percentage of died broilers increases with the increase of stocking density, especially in stocking densities above 10 bird/m^2. In addition, Tong, (2012) found that, stocking density did not lead to apparent differences in the incidence of mortality ($P > 0.05$). In contrast to the current study, Tinoco *et al*. (2007), Beg *et al*. (2011), Offiong *et al*. (2001), Hadorn *et al*. (2002) and Meluzzi *et al*. (2008) have found that the stocking density had no effect on mortality among different stocking densities. Also, Feddes *et al.* (2002) who have found that stocking density had no effect on mortality. The difference in present results and the observations of other authors may be attributed to the type of breed and other environmental conditions available to the experimental birds in poultry house. It may be concluded from the present discussion that mortality of birds can be minimized by providing proper hosing space and controlling the different attributes of housing environment viz. temperature, humidity, and ventilation.

5.6. Effect of Stocking Density on Behavior of Birds

The observations on behavioral aspects of unsexed Horro breed during 8 to 20 weeks of age (Table 13), indicated that cannibalism, locomotion and molting were increasingly affected with increased stocking density, while leg deformation were not affected. The observed results show that, at low stocking density chickens preferred to stay near the feeders and drinkers and there was no infighting among the birds for feed and water, whereas under higher stocking density chickens have to compete for their feed and water, resulting in increased cannibalism, and molting.

Similar, to the current study Bilsing *et al*. (1992), Savory *et al*. (1999), Appleby *et al*. (2002), Bilcik and Keeling (2000), they have also found that increasing stocking density increases the frequency of pecks resulting in greater feather picking and cannibalism. However, present observations disagree to Baum, (1995), Johnsen *et al*. (1998) and Tablante *et al.* (2000) as they have found that unsatisfactory housing conditions such as a wire floor system or cages promote the occurrence of cannibalism.

The time spent on locomotion was found to decrease with increasing stocking density in this study; this could be due to overcrowding effects. In agreement with current finding, Heckert *et al*. (2002), Hall, (2001), Leone and Estevez, (2008) and Ventura *et al*. (2012) have also found that, the time spent on locomotion decreased with increased stocking density, however, other authors have that reported movement and time spent on locomotion were unaffected due to increased stocking density Cornetto and Estevez, (2001a), McLean *et al*. (2002) and Collins, (2008). Additionally, Febrer *et al*. (2006) and Buijs *et al*. (2011b) reported that although the total time spent in walking did not decrease with increasing stocking density. Increased disturbance of the birds due to increased stocking density observed in present study, agreed with Newberry and Hall, (1990), Hall, (2001), Buijs *et al*. (2010) and Buijs *et al*. (2011b) as they also found that birds were increasingly disturbed by each other as stocking density increased. Similar to present findings Dawkins *et al*. (2004), Buijs *et al*. (2011b) and Arnould and Faure, (2003) found that under low stocking density chickens preferred to stay near the feeders and drinkers, whereas under high stocking density chicken stayed in the ‘free area’ of the pen. However, the present observations were in disagreement to the results of Bessei, (1992) as he has observed for commercial broilers under densities of 10 and 20 bird/m^2 (19 and 35 kg/m^2 respectively) and 15, 20 and 25 birds/m^2 (30, 37.5 and 45kg/m^2) that there was no significant difference in loco motor activity, feeding, drinking, scratching or resting of birds.

The observations on behavioral aspects molting were increasingly affected with increased stocking density. However, the studies of Kashmiri, L. and Vatsalya, V. (2011), McCowan *et al*. (2006), Hall *et al*. (1993) and Yousaf, (2002), revealed that molting was a natural occurring process in birds and various contributing factors to molting includes shorter day length, low environmental temperature, environmental disturbances, changes in feed, shifting of birds to a new location, feed and water restrictions and shorter photoperiod. It can be stated here that generally under normal conditions birds molt after completion of one year of egg production but if layer birds are stressed due to any of the factor, including overcrowding due to high stocking density the birds may undergo in an early molting.

No leg deformation in unsexed Horro chicken was not observed due to increased in stocking density during 8 to 20 weeks of age. In agreement with the current study, Sorensen *et al*. (2000) and Dawkins *et al*. (2004) found no effect of stocking density on leg deformations. Similarly, Grashorn and Kutritz, (1991) also found no direct links between stocking density and leg deformation. However, present observations disagreed with Kestin *et al. (*1994), who found the locomotion problems, likely to be a consequence of leg disorders associated with increased stocking density of birds. It can be concluded from present discussion that housing of birds with high stocking density / overcrowding may result in to the increased cannibalism and molting problems. Also overcrowding may be result in to frequently disturbances and reduced movement of birds.

6. CONCLUSION AND RECOMMENDATIONS

Rearing of unsexed Horro breed chicken under different stocking densities has significant effects on performance traits of chicken produced under intensive production system. High stocking density resulted in to decreased feed intake, body weight, body weight gain and feed conversion ratio but increased mortality. We can improve the performance of birds for the above traits by maintaining the proper stocking density in the poultry house without increasing the feed cost. Rearing unsexed Horro breed chicken stocking density of 10 birds/m^2 were found better in terms of performance for body weight, body weight gain and feed conversion ratio as compared to other stocking densities (8 birds/ m^2 and 12 birds/ m^2). However, the bird's mortality was lower under low stocking density.

- To achieve the required growth performances of birds Horro chicken should be kept under 10 birds/m^2.
- To reduce the effect of cannibalism, molting and mortality proper stocking should be practiced.

Based on the above conclusion, the following recommendations are forwarded:

1. For most efficient spacing stocking density further studies should be conducted for laying phase of Horro breed of chicken.

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