DETERMINATION OF PHENOTYPIC CHARACTERISTICS, PRODUCTION SYSTEMS, PRODUCTIVITY, AND CONTRIBUTION OF LOCAL CHICKENS TO HOUSEHOLDS IN NORTH-CENTRAL NAMIBIA

by

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DECLARATION

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Determination of phenotypic characteristics, production methods, productivity, and contribution of local chickens to households in north-central Namibia

I declare that the above dissertation/thesis is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

Signature: ____________________________
Date: 23/01/2015
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ABSTRACT

The phenotypic characteristics, level of production, management system and contribution of the local chickens to household studied in the north central Namibia. The study involved both qualitative and quantitative methods to gather the data. The questionnaire was used for survey while phenotypic characteristics and egg production forms were used to collect the actual data. The findings revealed that farmers in the study area regarded chicken production as their primary source of domestic animal protein, with the domestic fowl being the most widely kept poultry species. Other uses are participation in socio-cultural ceremonies, selling for money and gifts. The average number of eggs per clutch ranged from 10 to 15. The hatchability ranged between 50% and 60%.

Phenotypic characteristics measures revealed the absence of pure white plumage colour that can be associated with the introduction of White Leghorn to the flock. Generally, normal feather cover was the main feather morphology of local chicken populations in north central Namibia. However, features like crested heads, naked necked, frizzling, and feathered shanks occurred sporadically among local chickens in the study area. Fifty-seven percentages of chickens in the surveyed region had single comb, while 29.6% and 13.8% had rose and pea combs respectively. The most frequent shank colour was black followed by yellow, whitish, orange, and reddish shank. The wing span had positive correlation with body weight and chest circumference at \( r = 0.994 \). Other researchers discover the strong correlation of chest circumference with length shank at \( r = 0.827 \). The current study attained the mean body weight of 1.7 to 2.1 kg of both sexes combined which falls within the range of 1.6 to 2.18 kg reported by (Alabi et al. 2012). In conclusion, the current study revealed large variation of phenotypical characteristics with poor correlation to their productivity due to lack of record keeping although production forms were made available to the farmers. The part of productivity according to their identified phenotypic characteristics is not accepted nor rejected due to poor records, but recommended for further study with training on record keeping by farmers.

Keywords: phenotypic characterisation, production system, local chickens.
CHAPTER 1

1 INTRODUCTION

1.1 Background information

The local chicken strains is a general term given to those animals or birds kept in the wide-ranging, scavenging in the free-range, have no identified description, multi-purpose and unimproved (Mengesha, 2012a). Farmers in Africa gave these chickens names like; family chickens, bush chickens or African hen (Gueye, 2009). Local chickens are mostly in each household throughout the northern regions of Namibia and every culture owns them. Besbes et al. (2012) stated that family chickens, is from their production by families to get food, income and employment. Farmers in north-central Namibia regard local chickens as secondary to the major farming such as crops, cattle, pig and goat production and they are mostly under the care of women. Local chickens contribute significantly to the livelihood of the rural farmers by providing them with high-quality animal protein in the form of eggs and meat for family consumption (Molla, 2010). Local chickens ease poverty and provide their owners with income and nutritional benefits (Reta, 2009). Food security ensures that members of a household have access to an enough diet to lead to an active and normal life (Moreki et al. 2010). Households are secure in food when all members of their families have access to food and not at risk of mislaying such access (Okeno et al. 2012).

However, local chickens through sales also provide some petty cash to the rural farmers. Keeping chickens is common throughout the world and chickens are the most widely used species of all poultry (Kanginakuduru et al. 2008). Most farmers keep local chickens including the poorest of the poor, women, and children. They need little care and adapt well to rural conditions than exotic chickens (Gueye, 2010). Unlike pigs, local chickens have few taboos attached to them (Meyer-Rochow, 2009), and occasionally they have kept importance in religious and cultural rights (Isidahomen et al. 2012). Consumers prefer local chicken meat because of their better texture and strong flavour than those of commercial chickens (Sow & Gronget 2010).
In Namibia, as in other developing countries (Okeno et al. 2012) indicates that chickens get food by scavenging in the house and areas around the house. Scavenging allows rearing of chickens under exposure of predators, vulnerable to diseases because of lack of vaccinations, and uncontrolled breeding (Mengesha, 2012b). Local chickens make the best use of locally available feeds including household wastes (Leta & Endalew, 2010). However, challenges like; poor health, poor feeding, improper housing and mortality results in low production (Okeno et al. 2012). In most households, chickens do not get extra feeds. However, in households where they get extra feeds, farmers spread cereals like millet and maize on the ground from which chickens eat. Both young and adult chickens eat together.

Several reports from developing countries stressed disease as the most important challenge that influences production performances of local chickens throughout the developing world (Serrao et al. 2012). Newcastle disease is the most important disease for the local chickens in the tropics. Other diseases reported are fowl pox, infectious coryza, internal and external parasites (Simainga et al. 2010). Apart from diseases, problems like predators because of the absence of proper housing also influences production performances. Farmers do not make houses, so chickens sleep on top of trees, in, around the houses, and in corners of the owners’ homes (Holt et al. 2011). Local chickens have characteristics like disease resistance, cold and heat tolerance, able to escape predators, and scavenging which are important to the village environment (Fotsa, 2012). Although they lay few eggs and grow slowly, they have the potential to improve if farmers build good houses to protect them from predators.

Despite their importance, information about their productivity, best breed to farm with, disease resistance and their contribution to households is lacking in Namibia. Local chickens in north central Namibia varied in the following features: plumage colour, plumage morphology, comb types, and shank colour. As a result, farmers use the differences in physical characteristics to identify their chickens from others. Therefore, there is a strong need to use differences in their physical characteristics to identify breeds, which produce more meat and eggs. There is also a strong need to identify suitable methods to control diseases and predators, improve feeds and
feeding, housing, and improve breeding to increase production performances of local chickens in Namibia.

The objective of this study was to determine current production methods for local chickens (feeding, breeding, housing, diseases, and predator prevention). In addition, to ascertain a breed that produces more eggs and meat by using physical characteristics. The results will be able to address challenges faced by farmers in the study area and provide data that will assist in improving local chicken production.

1.2 Problem statement
The study arose from recognising how important local chickens are to contributing food to meet rural farmers’ needs. Most researchers think local chickens offer a means of easing poverty, creating income, and promote women empowerment in the rural regions of developing countries. The present study is therefore, introduced to determine rearing methods for local chickens and what they contribute to households in north central Namibia. Many studies have found that local chickens contribute significantly to food security and poverty alleviation. However, such studies also found the cost of producing these chickens to be low, because they feed by scavenging (Kingori et al. 2010; Okeno et al. 2012, and Mengesha, 2012a). Other studies show that local chickens need little space for rearing (Gueye, 2009 and Molla, 2010). Furthermore, most social groups including landless families keep local chickens (Deshingkar et al. 2008). In Namibia however, there is a lack of information on local chicken production and production performances. Information about breeds that produce more eggs and meat is also lacking. This information will be useful in identifying possible areas for improvement and future research.

1.3 Research questions
What are the phenotypic characteristics, productivity, and contribution of local chickens to household in north central Namibia?

1.4 Aim and objectives
1.4.1 The aim
The aim of the current study was to determine the physical characteristics, productivity, and contribution of local chickens to household in north central Namibia.

1.4.2 The objectives

i) To determine how the current management methods influence the productivity of the local chicken and their contribution to household in north central Namibia.

ii) To identify the physical characteristics of local chickens and determine the productivity of identified phenotypic characteristics in north central Namibia.

1.5 Hypothesis

The hypothesis tested:

i) The management methods do not influence the productivity of the local chickens and their contribution to household in north central Namibia.

ii) There are no different phenotypic characteristics on local chickens and their productivity of identified phenotypic characteristics in north central Namibia.
CHAPTER 2

2. LITERATURE REVIEW

2.1 Origin of chickens

History and spread of chickens across the African continent is a subject of debate and speculation among researchers (Hassaballah et al. 2015). Although many authors in developing countries documented the origin of domestic chickens, their introduction into the African is unknown (Dueppen, 2011). However, Mwacharo et al. (2011) argued that terrestrial and maritime introduction likely brought chickens to Africa. Kanginakuduru et al. (2008) contended that chickens were the first domestic animals in South-east Asia in the region called Indus Valley. According to Mtileni et al. (2011) chickens in Africa existed since thousands of years ago. Further, keeping chickens as domestic animals in South Africa probably came from traders on the way to India and European settlers in the early 15th and 16th centuries. Local chickens vary especially in morphological characteristics (Dana et al. 2010). Domestic fowl or chickens occur throughout the world and according to Kanginakuduru et al. (2008) they are the most used species and the most popular of poultry kept under rural conditions.

2.2 Population of local chickens

Local chickens are the most poultry species used in the rural areas and their reported number vary from one country to another. Their distributions outnumber that of other livestock (Gueye, 2010). Kanginakuduru et al. (2008) reported that local chickens represent about 98% of the total number of poultry kept in Africa. Although most rural farmers keep chickens, Sonaiya, (2009) pointed out that rural farmers often regard local chickens as secondary to other livestock and crop farming. Fisseha et al. (2010) have found an average flock size of 13 chickens per household in Bure district, north-west Ethiopia. Samson and Endalew (2010) and Kingori et al. (2010) respectively, reported in the central highlands of Ethiopia and in the south coast of Kenya sixteen birds per household. They further stressed that majority of farmers keep chickens when there is plenty of feeds and few predators. Results of
the study done by the same authors further revealed that flock sizes per household varied between seasons mainly because of, diseases, and predators.

2.3 Characteristics of local chickens

The most important characteristic of local chickens is their potential to produce meat and eggs (dual-purpose) for human consumption. Most local chickens are in rural areas, have good maternal qualities, have high survival rate and hardier than exotic breeds (Kingori et al. 2010). Although they grow slowly, they have the potential to grow fast if farmers select chickens with such characteristic for breeding (Mengesha, 2012b). Lyimo et al. (2014) pointed out that variation in their growth and productivity is from gene possession. However, Apuno et al. (2011) reported that some differences in appearance of local chickens are because of major gene marker, which increases adaptability of these breeds to tropical environments. They further explained that, large comb allows efficient heat control, while frizzled and naked necked allow better heat dissipation.

According to Okeno et al. (2012) local chickens need little care and adapt well to rural condition. It is these reasons that farmers with little or no income can also keep local chickens because they eat by scavenging from the surrounding. The method of producing local chickens is still primitive and suffers setback such as poor housing, poor feeds and feeding systems, disease outbreaks and predators (Blackie, 2014). Dorji et al. (2011) stressed that production performances of local chickens is low because of inadequate feeding and the harsh environmental conditions in which they exist.

Olwande et al. (2010) noted large variations in physical appearance and body weights of local chickens. Results by Faruque et al. (2010) showed the variations in local chicken appearance exist in features like; plumage colour, comb types, shank colour and feathers on shanks. According to Yakubu (2009) one chicken can have multi-coloured plumage and shank feathers at the same time. The complexity in nature of the local chickens, have made it difficult for several researchers to describe them (Faruque et al. 2010). However, Egahi et al. (2010) reported that local
chickens’ gene possession is responsible for the differences in appearances and science in that country found them to have an influence on production performances.

2.4 Productivity for local chickens

Fisseha et al. (2010) reported that small body size, lateness in maturing, egg sizes, and clutch sizes as production characteristics for local chicken breeds. Addisu et al. (2013) reported that local chickens grow slowly and reach sexual maturity late and this influences production performance. Magothe et al. (2012) showed that a hen would lay 36 eggs a year in 3 cycles of 12 to 13 eggs. Each cycle lasts about 16 days. They further explained that hens spend 21 days brooding on eggs, 84 days rearing their young and 18 days recovering before another production cycle sets in. Thus each reproductive cycle would last 139 days, of which only about 16-days spent on laying eggs. The same authors suggested from their results that egg incubation and rearing young is a load, which hampers production potentials of local hens. Furthermore, Kgwatalala et al. (2013) reported that a hatchability of 80 percentages from natural incubation is normal, while 75 to 80 % is satisfactory. It is for this reasons, authors throughout the world described local chicken production performances as below standard than exotic breeds (Kingori et al. 2010). According to Moreki (2014) hatchability by definition means percentages of eggs hatched, reported as several fertile eggs hatched or percentage of chicks hatched from all incubation. Dzoma, (2010) listed egg weight, humidity, shell strength, and gene make up as reasons that influence hatchability. Alabi et al. (2012) found 1.02 kilograms body weight in male and 1.00 kilograms in females at five months of age. Mengesha, (2012b) pointed out that local chickens produce small eggs, with thick shell and a deep yellow yolk. Fisseha et al. (2010) stressed that productivity of local chickens is related to poor feeding and poor housing.

Wilson (2010) noted average annual egg production of about thirty-four eggs a hen, with an average egg weight of 38 grams in Ethiopia. When comparing local chickens to exotic breeds they lay few numbers of eggs, which weighed about 43 grams (Kingori et al. 2010). According to Isidahomen et al. (2013) commercial breeds can produce up to 300 eggs per year with an average weight of 63 to 65 grams. However, Olwande et al. (2010) reported that local chickens are broody, able to take
care of their young ones. Table 2.1 below shows variations in egg production by local chickens in some African countries.

Table 2.1: Number of eggs local chickens produce in some African countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of eggs per hen per year</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethiopia</td>
<td>Less than 80</td>
<td>Fisseha et al. (2010)</td>
</tr>
<tr>
<td>Nigeria</td>
<td>30 to 128</td>
<td>Yakubu (2009)</td>
</tr>
<tr>
<td>Mali</td>
<td>20 to 100</td>
<td>Gueye (2009)</td>
</tr>
<tr>
<td>Botswana</td>
<td>30 to 150</td>
<td>Kgwatalala et al. (2013)</td>
</tr>
</tbody>
</table>

Isidahomen et al. (2013) found that local chickens produce four clutches per hen per year with up to ten eggs per clutch. Blackie, (2014) listed poor feeding, diseases and lack of proper housing as causes of few eggs production in local chickens. Farmers mostly use all eggs for incubation and eat a few (Lambio et al. 2010). However a study by Olwande et al. (2010) showed that predators (dogs eating eggs) and parasites are some of the reasons for poor hatching in most rural areas. Similarly, Addisu et al. (2013) and Kingori et al. (2010) stressed that lack of housing subjects newly hatched chickens to the unfavourable results of weather (torrential rain) and predators. According to Ajuyah (2013) about 40 to 60% of young chickens die during the first 8 weeks of age, mainly because of disease and predator attack.

2.5 Importance of local chickens

Literature and other presentations give enough evidence to support the impact of local chickens in the livelihood of rural communities in nutrition, health status, income and socio-cultural. Gabanokgosi et al. (2013) and Melesse, (2010) described local chickens as valuable in rural areas because they fulfil major roles and benefits in the livelihood of rural families. Okeno et al. (2012) described local chickens as an investment to the welfare of women and children in the tropics. According to Fotsa (2012) local chickens need little care and adapt to rural environment. For that reason, even farmers without income may afford keeping local chickens. However, Conan et al. (2012) reported the main objectives of keeping poultry are production of eggs for hatching, sale, home consumption, and sacrifice for healing ceremonies.
Kingori et al. (2010) described local chickens as efficient converters of leftover grains as well as insects into valuable protein, for example meat and eggs. Since the local chickens scavenge in crop fields, Gueye (2009) suggested that farmers might use local chickens to control weeds and insects. Moreki, (2012b) suggested that farmers might also use local chicken faeces as fertiliser for vegetable gardens and crop fields.

Chowdhury (2013); Gueye (2009); and Magothe et al. (2012), reported that consumers prefer local chicken meat because of their texture and strong flavour. Rural farmers in Jordan believe that by consuming meat of local chickens, they are lesser prone to cancer and other diseases than urban people. Farmers in this area also revealed that food produced from local livestock breeds, poultry in particular, is healthier and make them stronger (Al-Atiyat, 2009). Meanwhile Aila et al. (2012) reported that local chicken meat contains low fats than commercial chickens, because their diet consist of kitchen leftovers, worms, insects, green leaves and other plant materials. Sow & Grongnet (2010) argued that local chicken meat contains lower fat and muscle weight than commercial chickens because they use energy to find food. An example, in the United States of America, consumers prefer free-ranged chickens to those reared indoors. Dyubele et al. (2010) contended that even though commercial chickens have high muscle weight, their meat contains high fats, which can be a risk for diseases like heart diseases and diabetes in humans.

Moreki et al. (2010), stressed that consumers also recognised the low price, the typically convenient portions, and the lack of religious limits for the consumption of local chickens. Meyer-Rochow, (2009) stressed that unlike pork which Muslims and Jews do not eat or beef which; Hindus do not eat, chicken meat has little dietary limits. Sanka & Mbaga, (2014) also reported that local chicken is superior to exotic chickens in protein content and high in water retention but low in fat content. They also assumed that meat from local chickens has some unique features and have more advantages over commercial chickens, especially when determined for niche market-serving consumers who prefer chewy, low-fat meat. Sow & Grongnet, (2010) pointed out that poultry meat, eggs account for more than 30% of the animal protein consumed throughout the world, and the rate is increasingly steadily.
Local chickens play a role in various religious and socio-cultural of many African people. Sonaiya (2009) reported the use of red cocks to ask for rain and good harvest, white cocks in thanksgiving and black cocks to keep away bad luck, diseases, war, and quarrel. Similarly, Yakubu (2009) reported the use of frizzled and naked neck for rituals and sacrifices in Nigeria. In Senegal, Gueye (2010) reported that outside the urban centres and especially in non-coastal areas of that country, local chicken provides the population with a source of protein and income. Meisert et al. (2011) reported the use of chickens as banquets, the use of cocks as alarm clocks, and the use of cocks as offerings to deities.

2.6 Chicken ownership and management

A study carried out by Mlambo et al. (2011) revealed that among poultry species, chickens are the most common species in many rural areas. Setlalekgomo, (2012) reported that women in Botswana own 98% of chickens and men own 2% of chickens in that country. Similarly, Kingori et al. (2010) reported that women and children in some African countries own 80% of local chickens in rural areas. However, Abubakar et al. (2007) noted that in Nigeria the whole family own chickens, with women owning majority of chickens, followed by the children and men last. They further stressed that in Borno state of Nigeria men own majority of chickens, followed by women and children last.

Olwande et al. (2010) reported that in Kenya family members divide chicken management duties among themselves. Furthermore, they explained that feeding, cleaning of chicken houses and treatment of sick chickens is the duty of women, while building chicken houses a duty of men. Similarly, Mapiye et al. (2008) reported that in Zimbabwe, feeding, watering, cleaning of chicken houses is the duty of women, whereas building chicken houses, and treatment of sick chickens is the duty of men. However, men alone decide which chicken to slaughter, to sell, to buy drugs for sick chickens and replacement stock.

2.7 Rearing methods for local chickens

Mlambo et al. (2011) reported that in developing countries the most common rearing methods for local chicken are free-range and backyard. Magothe et al. (2012)
stressed that chickens in free-range are not in confinement, but scavenges for food over a wide area. Furthermore, according to the same authors chickens sleep in simple houses within the house of the farmer but may roost on trees and nest in bushes. Meanwhile, Kingori et al. (2010) reported that in backyard rearing method, chickens sleep in houses at night and scavenges during the day. However, they may get grains in the morning and evening to add extra feeds to scavenging.

According to Mlambo et al. (2011) full confinement rearing method is not common in rural area; however, in urban and villages close to cities most farmers use it in rearing specialised breeds. A study carried out in Kenya by Okeno et al. (2012) showed that local chicken rearing method was free-range (78%), followed by a combination of free-range and confinement (12.7%) and then full confinement (9.3%). Although, Fentie et al. (2013) and Yakubu (2009) describe local chickens as able to survive in a rural environment, scavenge-able feeds are difficult to find. Ajuyah, (2013) pointed out that in free-range local chickens spend most of the daytime scratching the ground in a search for food.

2.8 Feeds and feeding
The major feed sources of local chickens are earthworms, insects, seeds, green leaves and other plant materials in the household yard. Gunaratne, (2013) pointed out that scavenge-able feed does not contain enough nutrients needed by local chickens. Scavenge-able feed contain little protein and vitamins (Hailemariam et al. (2009). Also, lack of protein and vitamins make chickens weak and vulnerable to predators. However, Olwande et al. (2010) reported that chickens become vulnerable to predators and susceptible to diseases because of feed shortage and a lack of proper nutrition. According to Ravindran (2013), nutrients that local chickens get from scavenge-able feeds are depending on foraging habits, which varies with chickens. Furthermore, foraging habits of young chickens varies with that of old chickens, because they cannot compete with old and aggressive chickens for feed available from scavenging.

However, according to Mutayoba et al. (2011) in developing countries scavenge-able feeds varies with seasons and districts. In addition, in dry season, local chickens do not get enough protein because of a lack of freshly leaves and stems in the range.
Chowdhury (2013) showed that scavenge-able feed mainly consists of household leftover, green materials, insects, earthworms, crop residues, grass shoots, and fruits. Momoh et al. (2010) reported that household leftover form a major part of the total diet of local chickens. In addition, household leftover range from 69% in the rainy season to 90% in the dry season. Goromela et al. (2008) however, reported that only a small part of 10% to 31% of the diet in dry season and rainy season come from scavenging in the environment. Hailemariam et al. (2009) reported that more than 70% of local chickens’ feed intake was household leftovers.

Ajuyah (2013) reported that, generally feed intake for local chickens consists of cooked rice (27%), coconut leftovers (30%), broken rice (8%), and other scraps (36%). The rest was from the environment (13% grass shoots, 8% small animals, and 7% rice kernels). However, Mutayoba et al. (2011) pointed out that scavenge-able feed contained 8.8 g of crude protein and 2864 calories of energy. Furthermore, they stated that 8.8 g is below the estimated 11g of protein needed by each chicken each day to meet maintenance needs in the tropics. A study carried out by Hailemariam, et al. (2009) showed that scavenged feed for each household flock per day was 550g of dry weight.

Mutayoba et al. (2011) reported that seasons, breeds, social habits and life cycle of insects and other invertebrates influences the quality and quantity of scavenge-able feeds and highlighted the importance of supplementary feeds in seasons when scavenge-able feeds are hard to find. According to Ravindran (2013) chickens hardly get extra feeds in developing countries. In addition, if they do, it is small amounts of grains thrown on the ground. Similarly, Mapiye et al. (2008) reported that rural farmers offer extra feeds in the form of kitchen leftovers and small amounts of grains. Other extra feeds reported are small amounts of cereals, which include millets, sorghum, and maize (Kyule et al. 2014). According to Gunaratne (2013) some farmers give, extra feeds to their chickens in the morning or in the afternoon and others give two times a day.
2.9 Diseases in local chickens

Disease is a condition that hinders normal body roles (Permin & Bisgaard, 2013). Diseases result from a combination of indirect and direct causes. Indirect causes are those conditions that influence resistance and direct causes are those that produce diseases (Mesert et al. 2011). Reports by Bell (2009), Njagi et al. (2010) and Adebayo et al. (2013) showed that disease outbreak is one of the constraints to poultry production in developing countries. According to Simainga et al. (2010) the impact of disease on poultry industry has both monetary and gene fault losses. Furthermore, they explained that monetary losses are direct result of deaths, medicine costs, veterinary service costs, and low production. At village level, contacts between flocks of different households, exchange of chickens as gifts or even entrusting sales and buying are the main sources of disease transmission (Alders & Pym, 2009).

Njagi et al. (2010) noted that local chickens have low resistance to diseases such as Newcastle, fowl pox and coccidiosis. Permin & Bisgaard (2013) pointed out that coccidiosis is caused by parasites which live in the ground. Coccidiosis occurs mainly in winter and that good management can prevent coccidiosis. A study by Adebayo et al. (2013) revealed that local chickens are susceptible to diseases such as infectious bursal disease than commercial chickens. According to the author, infectious bursal disease is a contagious disease of young chickens, causing deaths at 3 to 6 weeks of age. Other diseases reported include Newcastle, typhoid, diarrhoea, and coryza (Alders & Pym, 2009). Simainga et al. (2010), described Newcastle as contagious. They further explained that, Newcastle would infect all chickens in a flock within three to four days. Bell (2009) reported that when Newcastle appears it would often kill almost all the flock sat ones. According to Permin & Bisgaard (2013) a virus that causes Newcastle is disastrous than other disease causing organisms. Newcastle disease is disastrous in chickens than other avian species. Mapiye et al. (2008) reported that Newcastle spread by direct contact (between healthy and infected chickens) and by contaminated shoes, clothing, and syringes. It is, further explained that the course of the disease varies according to the virulence of the strain involved, age of chicken and immune status as well as the general well-being of a particular chicken. According to Simainga et al. (2010) mortality caused by Newcastle disease ranges from 50 to 100% in some African
countries. Newcastle disease has no treatment; however, vaccination and hygiene can prevent the disease (Njagi et al. 2010). Simainga et al. (2010), listed greenish diarrhoea, sudden death, nervous signs such as tremors, convulsions, and paralysis of legs and wings as clinical signs for Newcastle disease. However, Permin & Bisgaard (2013) listed wet nasal, coughing, swollen heads, sneezing, decline in feed and water intake, nervous signs and diarrhoea as signs of Newcastle disease. Another disease of poultry which is, by far not of major importance to scavenging chickens is avian influenza (Serrao et al. 2012). Duangjinda et al. (2012) reported that avian influenza is a noticeable disease caused by a viral infection. According to Molla et al. (2015) the disease depends on the age of chickens, poultry species, characteristics of the viral strains involved and environmental conditions.

Adebayo et al. (2013) reported that rural farmers describe diseases by the symptoms chickens’ display and the most common symptoms noted in their studies include noisy breathing, and coughing and watery eyes. Other symptoms include swollen head, sharp cough, sneezing, and gasping. The authors further explained that rural areas regard sneezing and gasping as infectious bronchitis and bloody diarrhoea as coccidiosis.

Table 2.2: Diagnostic signs of poultry diseases noted in rural areas (Permin & Bisgaard, 2013)

<table>
<thead>
<tr>
<th>Signs</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chickens huddle together</td>
<td>16.1</td>
</tr>
<tr>
<td>Coughing, sneezing, rapid breathing</td>
<td>13.2</td>
</tr>
<tr>
<td>Watery mouth and nostrils</td>
<td>10.9</td>
</tr>
<tr>
<td>Dullness, no appetite, closed eyes</td>
<td>10.9</td>
</tr>
<tr>
<td>White droppings</td>
<td>8.6</td>
</tr>
<tr>
<td>Turned or twisted neck</td>
<td>8.0</td>
</tr>
<tr>
<td>Dark red colour of head and comb</td>
<td>6.9</td>
</tr>
<tr>
<td>Greenish or yellow droppings</td>
<td>4.6</td>
</tr>
<tr>
<td>Bloody reddish droppings</td>
<td>4.0</td>
</tr>
<tr>
<td>Swellings of head and comb</td>
<td>2.9</td>
</tr>
</tbody>
</table>
2.10 Disease control

Moreki, (2013) reported that absence of disease control in many rural areas contribute to high mortality among local chickens. Vaccination with standard vaccines is not common in rural areas because many chicken farmers do not have income to buy such vaccines. As a result, most farmers in rural areas use herbs. Table 2.3 lists herbs rural farmers use to treat sick chickens in different countries in Africa. According to SriBalaji & Chakravarthi (2010) the limited use of modern or conventional vaccines in local chickens is a result of reasons like cost, dose format, and lack of thermo-stability. The dose format is difficult because of flock sizes, scattered, multi-aged and under slight condition, are expensive and produced in large dose units suitable only for large commercial flocks (Moreki, 2012a).

Table 2.3: Lists of herbs rural farmers use to treat sick chickens

<table>
<thead>
<tr>
<th>Disease</th>
<th>Herbs</th>
<th>Application</th>
<th>Country and sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye infection</td>
<td>Leaves</td>
<td>Fluid (Used as eye drops)</td>
<td>Botswana, Moreki, (2013)</td>
</tr>
<tr>
<td>Eye infection</td>
<td>Leaves</td>
<td>Mashed and used as eye drops to open gummed up eye of young chickens.</td>
<td>Zimbabwe, Masimba et al. (2011)</td>
</tr>
<tr>
<td>Sore eyes</td>
<td>Bulbs</td>
<td>Fluid (Used as eye drops)</td>
<td>Zimbabwe, Masimba et al. (2011)</td>
</tr>
<tr>
<td>Cough</td>
<td>Fruits</td>
<td>Soaked in drinking water</td>
<td>Nigeria, Adebayo et al. (2013)</td>
</tr>
</tbody>
</table>
Moreki et al. (2010) reported that 95% of the medical recipes used to treat infected chickens in the villages are from plants origin. Similarly, Lagu & Kayanja (2010) reported many plant products that rural farmers believe to cure chicken diseases in developing countries.

Simainga et al. (2011) referred to herbs used to cure disease as Ethno-veterinary medicine. Furthermore, Moreki (2013) defined Ethno-veterinary medicine as the use of local knowledge and methods for caring, healing, and managing livestock. Ethno-veterinary medicine, come from the guide of older people, which they pass on from one generation to another. Masimba et al. (2011) reported that rural farmers in many developing countries regard Ethno-veterinary medicine suitable for preventing and curing various diseases of chickens. Yirga et al. (2012) reported that farmers use more than one plant products in preparing Ethno-veterinary medicines. Farmers do not measure the quantity of herbs, making it difficult to measure the impact of Ethno-veterinary medicine in preventing and curing diseases.

2.11 Mortality rates
According to Nathi et al. (2012) predators (fox, hawks, cats, and dogs), limited feed supply, low-level of management and diseases are the causes of mortality among local chickens. Fentie et al. (2013) reported that 55% of mortality rate noted in their study was among young chickens. They further listed predators, diseases, external parasites, rains, and accidents as the main causes of deaths among chicks. Molla, (2010) reported high mortality of chicks in their early weeks of age. Kebede et al. (2012) observed that chicken mortality was a result of poor management, predators, and accidents. The 12% of chicken losses noted in their study were because of accidental stepping, crushed under objects, children beating and drowning. Mapiye et al. (2008) reported hawks, crows, dogs, rats, squirrels, eagles, and thieves as the main causes of chicken losses in rural areas. However, Ndathi et al. (2012) reported heat stress as the main causes of chicken deaths in rural areas. The same authors therefore, advised farmers to provide chickens with water regularly to prevent heat stress. Mutibvu et al. (2012) reported contacts between flocks, exchange of chicken as gifts, buying live chickens as sources of infection transmission.
Gunaratne, (2013) reported a lack of protein and vitamins weakened young chickens and made them vulnerable to diseases and predators that in turn led to high mortality rates. Mekonnen et al. (2010) observed a shortage of protein in scavenge-able feeds during short rain and dry season and listed lack of protein and vitamins as the main causes of chicken deaths in rural areas. Mekuria & Gezahegn, (2010) reported parasites as the main causes of free-range chicken deaths. The most common parasites noted in their study include lice, fleas, mites (feather and legs).

2.12 Housing for local chickens
Good housing is a precondition for any sustainable poultry project (Holt et al. 2011). In rural areas, housing occupies a low priority in managing poultry including chickens under free-range. According to Kingori et al. (2010) in modern poultry enterprises farmers built and design housing in consideration of chickens' welfare and efficiency of production. Although, there is little information on the monetary efficiency of traditional housing in Africa, reports by Mutibvu et al. (2012); Fentie, (2012) and Zewdu et al. (2013) revealed that farmers at rural level do not provide houses for chickens. Holt et al. (2011) listed three types of traditional poultry houses in Africa, namely saddle roofed houses, round thatched huts, boxes, and basket types. However, chickens sometimes roost in family house, kitchen or on tree branches. According to Kebede et al. (2012) reasons for lack of housing in rural areas include income of farmers, importance of housing to farmers and the purpose of production. Mengesha, (2011); Atsbeha, (2014); Khandait et al. (2011) and Nathi et al. (2012) reported that where farmers provided housing to local chickens, they use local materials such as sugar cane stems, wood, mud bricks, cereal residues, and bamboo because they are readily available. According to Magothe et al. (2012), most popular chicken houses in rural areas of Kenya are made of bricks and litter types. The farmers feel such houses provide more warmth and security from both thieves and predators than other housing. However, according to Holt et al. (2011) proper housing must not only protect chickens from heat and cold but must provide enough ventilation for chickens to feed and sleep in comfort and security.

A study carried out in Zimbabwe by Mapiye et al. (2008), showed that 94% of farmers keep chickens in poorly built houses. Three percentages left their chickens to stay on trees or in the open space and the remaining 3% only provided housing to
hens. The lack of acceptable housing to a certain extent explains chicken losses because they have slight protection from predators and thieves. Mengesha et al. (2011) reported 48.3% provided overnight housing, 20.6% kept chickens overnight within the main house, and 30.9% did not provide houses and their chickens sleep on trees or rooftops. However, during planting season 8.3% kept their chickens in houses to protect the crops. Meanwhile, Holt et al. (2011) highlighted the importance of proper housing especially to protect young chickens from hawks, crows, cats, dogs, reptiles and unpredictable weather.

2.13 Breeds and breeding for local chickens
A study carried out by Lyimo et al. (2014) showed that local chickens have various characteristics. The variations are in body size, plumage colour, shank colour, comb types, and feather morphology. According to Mengesha (2012b) variations among local chickens are because of random breeding practised at farm level, both male and female run and feed together. Therefore, farmers in rural areas use their characteristics to distinguish them from other chickens and to give them names. Kingori et al. (2010) reported that farmers use names like; bush chicken, African hen, Deshi chicken, village chicken, native chicken, runner chicken, and family chicken to call their chickens. In Egypt, Cameroon, Burkina Faso, and Sudan a remarkable variety in local chickens has been reported (Gueye, 2010).

Van Marle-Koester et al. (2008) reported that most groups of local chicken population are from their physical characteristics for example naked neck. Some are from geographical location for example; the Owambo chickens originate from Owambo land in Northern Namibia and the Lebowa-Venda from Venda in the Limpopo province in South Africa. It was difficult to classify local chickens into breeds as the European breeds. It was also, revealed that classification into breeds or types of local chickens in many developing countries is difficult. According to Lyimo et al. (2014) classification of local chickens into breeds in many developing countries is from plumage colour, feather morphology, body length, and sizes. Studies carried out in Mali by Sonaiya (2009) and Gueye (2009), resulted in classification of local chickens into breeds like Kolochie, Kolokochie, Toulouchi and Centrichrochie. In Tanzania Lyimo et al. (2014) classified local chickens into five breeds namely: Morogoro-medium, Kuchi, Ching’wekwe, Pemba, and Unguya.
Another breed identified in South Africa by Van Marle-Koester et al. (2008) is Koekkoek. They further explained that Koekoes came from a cross between Black Australorp and White Leghorn during the 1950, followed by crosses with Plymouth Rock to produce a black-and-white speckled chicken.

The study on biodiversity has also made it possible to distinguish genes carried by local chickens that are of monetary importance, which local chicken farmers preferred. According to Lambio et al. (2010), breeds like; Assel of India produced more meat, whereas Fayoumi of Egypt and Deshi of Bangladesh produce more eggs. However, Hossain et al. (2012) argued that naked neck produces more meat than full feather and commercial chickens in Bangladesh. A study carried out in Ethiopia by Moreda et al. (2014) showed that light colour plumage chickens produce large eggs, whereas black and red feathered chickens produce more meat.

2.14 Marketing for local chickens

Marketing is not important to subsistence farmers because chicken keeping is a tradition. However, Dadheech and Vyas (2014) reported that farmers only sell chickens when they need money or barter their free-range chickens for food and household items. According to Molla (2010) the greatest reason farmers sell their chickens is for income generation. Furthermore, farmers sell chickens at households within the villages, on roadsides, during entertainment ceremonies and local and city markets. Yitbarek & Gurumu (2013) described the marketing channel for selling chickens as informal and poorly developed. Meanwhile, Mesert et al. (2011) reported that major channels through which farmers sell their chickens in the markets are direct selling to hawkers. However, Kyule et al. (2014) pointed out that farmers have little knowledge on how market works and why price rise or falls and have almost no information on market conditions. Thus, most farmers sell chickens within the vicinity. According to Molla (2010), reasons for selling chickens in vicinity include; small number of chickens, long-distance to urban markets, and occasional selling of chickens (based on prevalent pressing needs of the family). Yitbarek & Gurumu (2013) reported that consumer preference, high consumption during holy holidays, festivals, and disease outbreak as reasons for chicken prices falling dramatically because of high supply than demand. According to Aila et al. (2012) traders mostly
use public transport (buses and minibuses) to transport chickens to urban markets. During transport, farmers keep chickens with bags, and or binding their legs together can result in losses because of stressful conditions.
3 RESEARCH METHODOLOGY

3.1 Materials and methods

3.1.1 Description of the study area

The study took place in north central Namibia as presented in Figure 3.1. Northern Namibia borders Kunene and Okavango rivers along the Angolan border. Although Windhoek is Namibia’s capital, north central Namibia is the most densely populated regions. North-central Namibia has a semi-arid climate, with hot summer and warm winter. The average annual rainfall is 447 mm, with most rainfall occurring mainly during summer. The most prominent ethnic group in north central Namibia is the Owambos occupying the regions such as Omusati, Oshana, Ohangwena, and Oshikoto. However, the Owambos’ method of farming is subsistence, whereby they grow staple crops (millet, sorghum, and beans), and farm cattle, goats, pigs, donkeys and chickens.

Figure 3.1: Map of the study area (De Pauw et al. 1998)

3.1.2 Ethical clearance

The University of South Africa ethics committee granted ethical clearance to carry out research work in north central Namibia. Furthermore, the Ministry of agriculture,
water, and fisheries in Namibia also granted permission to carry out research work in north central Namibia. Before starting interviews with selected farmers, project leader discussed the aims of the study and farmers agreed or disagreed to take part in the study. The study therefore employed the consent form (Appendix A) to get consent to take part in the study from farmers. The current study assigned codes to all data collected as well as pictures taken to protect farmer’s identity and privacy. The researcher did not cause any harm or injuries to chickens examined in the current study.

3.1.3 Sampling procedures and sample size
A proportional sampling method employed to select 200 chicken farmers randomly. The respective numbers of chicken farmers in each region were Oshana (n = 50), Omusati (n = 60), Ohangwena (n = 50), Oshikoto (n = 40). In addition, the study applied stratified random sampling method to select 159 chickens of mixed age groups from the four regions randomly. Numbers of chickens selected from each region were Oshana (n = 34) male = 10 and female = 24), Omusati (n = 59) male = 13 and female = 46), Ohangwena (n = 34) male = 14 and female = 20) and Oshikoto (n = 32) male=11 and female = 21). The survey and physical examination took place during July to November of 2014.

3.2 Data collection
3.2.1 Survey
Questionnaires (appendix B), were used to conduct face-to-face interview to 200 households at their homesteads in a dialect language. A bilingual research assistant conducted the interviews in local languages and completed the questionnaires in English. The interview based on chicken houses, feed and feeding, diseases, marketing, production data, number of chickens in each household, causes of deaths and importance of keeping chickens. The purpose of the survey was to find out the farming method for local chickens in north-central Namibia. Pictures of chicken houses, feeders, and drinkers were collect from the study area.
3.2.2 Physical examination and photographs
Metric characteristics (shank length, comb size, body weight, and length, wingspan and chest circumferences) for each of the 159 (48 males and 111 females) chickens selected measurements were taken. In addition, measurement of egg weights, egg lengths, and egg widths for eggs collected from households visited using a calliper. Visual appearances of categorical traits recorded on the following: (eggshell colour, shank colour, feather colour, morphology and distribution, comb type and ear lobe colour). A designed form (Appendix C), was used to record both metric and categorical traits noted. Pictures of categorical traits noted were from local chickens in the study area.

3.2.3 Linear body measurements
Body weight for each of the 159 chickens selected using a digital weighing balance scale in kg was measured. Shanks (from hock joint to footpad), wings (from scapula to last digit of the wing), body length (from tip of beak to tail), and chests (breast region) using a textile measuring tape were measured. The same person took all measurement and weighing twice to cut out error and increase accuracy.

3.2.4 Production data sheet
Each of the 200 selected farmers received data sheets (Appendix D) to record production of their chickens during the study period.

3.3 Data analysis
The SPSS 21 was used to analyse the questionnaire data, by employing correlations, multiple regressions. Descriptive statistics method such as figures, frequencies, and percentages were used to summarise and present the results.

Phenotypic characteristics analysis
Analysis of variance of data from phenotypic characteristics was conducted using the general linear model (GLM) procedure of the Statistical Analysis Systems (SAS) of 2010 or a completely randomized design (Yee, 2010). The model used was:
\[ Y = \mu + B_i + S_j + R_k + (B \times S \times R)_{ijk} + \theta_{ijkl} \]
Where;
Y = response variable
μ = mean
$B_i = effect of breed \ (i= \ 
S_j = effect of sex \ (j= \ 
R_k = effect of region \ (k= \ 
(B\times R) = interaction of breed and region
$e_{ijkl}$ = residual error

3.4 Limitations of the study

Limits impacted negatively on the results of this study include:
The researcher had difficulty in getting precise number of chickens in each household and production information such as first age of laying first egg and number of clutches because of a lack of recording.
CHAPTER 4

4 RESULTS AND DISCUSSIONS

4.1 Respondent profile

Demographic characteristics of the respondents presented in Table 4.1 show the marital status of respondents with majority being married (55%) followed by widows at 26%. Furthermore, the study revealed that majority of chicken farmers were women (51.5%), this is so, because some men were either working in towns while some took large livestock to grazing areas.

Table 4.1: Marital status of participants

<table>
<thead>
<tr>
<th>Marital status</th>
<th>Frequencies</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>28</td>
<td>14</td>
</tr>
<tr>
<td>Married</td>
<td>110</td>
<td>55</td>
</tr>
<tr>
<td>Never married</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Separated</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Divorced</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Widowed</td>
<td>52</td>
<td>26</td>
</tr>
</tbody>
</table>

The 3.5% of interviewed farmers did not have any formal education; majority of them 58.5% had formal education background up to high school level (Table 4.2). Although the influence of education on flock size was not important in the current study, majority of farmers with no formal education had large flock sizes.

Table 4.2: Education level of participants

<table>
<thead>
<tr>
<th>Education level</th>
<th>Frequencies</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No education training</td>
<td>7</td>
<td>3.5</td>
</tr>
<tr>
<td>Grade 12 and below</td>
<td>117</td>
<td>58.5</td>
</tr>
<tr>
<td>Vocational training</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Others</td>
<td>66</td>
<td>33</td>
</tr>
</tbody>
</table>
Table 4.3 shows the gender of respondents by region, while Figure 4.1 shows the overall age of respondent in four regions whereby majority of the farmers (30%) were above 60 years old. Figure 4.2 shows the age of respondent per gender. The majority of farmers at the age of 30 to 49 were male while 20 to 29 years and 50 and above were female. This shows some shift gender on different generations.

Table 4.3: Gender of respondents per region

<table>
<thead>
<tr>
<th>Regions</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohangwena</td>
<td>24</td>
<td>26</td>
<td>50</td>
</tr>
<tr>
<td>Omusati</td>
<td>29</td>
<td>31</td>
<td>60</td>
</tr>
<tr>
<td>Oshana</td>
<td>24</td>
<td>26</td>
<td>50</td>
</tr>
<tr>
<td>Oshikoto</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>97</strong></td>
<td><strong>103</strong></td>
<td><strong>200</strong></td>
</tr>
</tbody>
</table>

According to Fisseha et al. (2010), age influenced the successful likelihood of a person in farming. Results from their study suggested that older farmers are barely able to carry out physical tasks than younger ones and that as farmers get older, they become conservative and reluctant to accept risks, they work for shorter hours and are reluctant to adopt modern farming technology.

Table 4.4: Age groups of respondents in each region

<table>
<thead>
<tr>
<th>Regions</th>
<th>Age of respondents</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20 to 29 years</td>
<td>30 to 39 years</td>
</tr>
<tr>
<td>Ohangwena</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Omusati</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Oshana</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Oshikoto</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6</strong></td>
<td><strong>41</strong></td>
</tr>
</tbody>
</table>
Figure 4.1: Distribution of age for all respondents

Figure 4.2: Ages of respondents split by gender

Figure 4.2 explains the partial regression on link between number of chickens and level of education of respondent. There is a weak positive correlation between highest education and number of chickens kept by farmers \((r = 0.195 < p \text{ value})\). However, Figure 4.3 shows the correlation between employment and level of education per gender of respondent, tested at the sensitivity of 95%. Figure 4.4 indicates that farmers with no education and vocational training could not easily be employed compared to farmers with grade 12 and other high education qualification. However, the study revealed that there was a weak positive correlation between highest education and employment at \((p < 0.165)\). Highest education was further
test at sensitivity of 99% and results revealed a weak positive correlation between education and age of respondent (p< 0.195) and marital status at (p< 0.216 value). However, analysis of variance further revealed the significance difference (p< 0.001) on marital status of farmers. Results of the current study are similar to those of Shamsuddoha et al. (2015), Conan et al. (2012); Gueye (2010); Mesert et al. (2011); and Fisseha et al. (2010).

Figure 4.3: Partial regression on the link between number of chickens and education

Figure 4.4: Level of education and employment per gender
Figure 4.5: Correlation between education and employment of respondents

4.2 Distribution of local chickens in the study area
The results showed that local chicken production is an integral part of mixed farming because in all households visited, none of the farmers had chickens alone. Apart from chickens, farming of cattle, goats, pigs, and donkeys as well as growing different kinds of crops were common in the surveyed regions. Although all households visited kept chickens, the numbers noted in individual households varied as shown in Figure 4.6. Majority of interviewed farmers did not keep records, they only counted chickens for the current study, and more often, they only count adults. A lack of record keeping noted in this study agrees with a report by (Mlambo et al. 2011). Farmers in rural areas do not keep records because they pay little attention to chickens than other livestock and crops.

Flock size noted in household visited was 12. In Ethiopia, Fisseha et al. (2010) recorded 13 chickens per household. Flock size noted in the current study falls within the range of 5 to 20, which according to Gueye (2010) is the range for low-income farmers in most rural households of Africa. However, Masimba et al. (2011) reported a high number (22 and above) of chickens in each household in Gutu district of Zimbabwe.
4.3 Flock characteristics

There were few cocks in all households visited. Farmers said they slaughter or sell more male chickens than female chickens. Slaughtering of cocks for consumption and selling noted in this study agrees with the study carried out by Molla, (2010). Farmers also reported slaughtering hens, which lay small sized eggs or injured. Farmers contended that slaughtering pullets is not common. However, offering pullets as gifts to visitors and relatives for breeding purposes is common. Most farmers pointed out that they keep at least one cock and more females for breeding purpose. The results of the current study agree with the study carried out in Ethiopia by Fisseha et al. (2010). According to Yakubu (2009), households in Nigeria only keep a few numbers of male chickens, because of regular culling of males especially during festivity periods. The other farmers kept four to six cocks. Similarly, a study carried out in Ghana by Blackie, (2014) showed that farmers keep few cocks to prevent cockfighting when competing for females.

Faruque et al. (2010) defined flock characteristic as the relative number of different age and sex classes of the current stock. The information on flocks clarifies the
objective of the farmer, whether the main interest is to produce eggs or meat. Flock characteristics in the current study showed that farmers kept more hens than cocks to increase flock sizes. The purpose for increasing flock sizes is because, their occasional consumption, or selling of chickens is depended on flock sizes.

4.4 Means of getting chickens and breeding for replacement stock

4.4.1 Means of getting chickens

Most respondents (40%) got their first stock from friends and relatives during weddings; or when visiting as newly wedded couples. Seventeen percentages bought their first stock from neighbours and other farmers. Sixteen percentages declared that their first stock was from both gifts and buying. The remaining twenty-seven percentages of the respondents did not specify the sources of their first stock. Similarly, Fajemilehin (2011) reported that most households in Nigeria got their chickens through a combination of two or more ways which include buying, given as gifts or exchange for labour.

4.4.2 Breeding for replacement

Most breeding aimed at improving the productivity of local chickens used cross-breeding. For example, a study in Uganda used a cross breeding method; between a Local Rakai and Bovan cock (Roothaert et al. 2011). Farmers in the current study did not follow any planned breeding method, and as a result, inbreeding often occurs among local chickens. This confirms the results of Addisu et al. (2013) which showed that in free-range males and females run together in the flocks. Thus, no controlled breeding takes place in rural areas. However, 55% of interviewed farmers selected their chickens for breeding, and 45% did not select chickens for breeding. Farmers in the current study identified a few traits that are of importance in selection of chicken replacement stock. Some farmers ranked hatching as the first selection trait, followed by hen parenting skills and last body weight and or plumage colour. Although all farmers relied on natural hatching of eggs by a hen as the only means of stock replacement, some reported buying stock from neighbours and other farmers. Using the latter depends on for example when all chickens die because of diseases or predators.
4.5 Types of chicken breeds kept

Hundred percentages of the farmers owned local chicken breeds as shown in Table 4.5. None of the farmers owned exotic breeds. This finding is similar to a study made by Gueye (2009), which showed that in most developing countries rural farmers only keep local chicken breeds. Furthermore, Kingori et al. (2010), reported that almost 80% of the total chicken population in rural households in Kenya was local chickens. Majority farmers (99%) preferred local chickens because they are not capital-intensive, easy to manage and are readily available. These results are similar to a study done by Mlambo et al. (2011), confirming that in rural areas of Zimbabwe, majority of farmers keep only local chicken breeds. Yakubu, (2009) reported that 80% of 120 species of poultry in Nigeria were local chickens. Local chickens are important because they need little care, which rural farmers can easily provide (Mlambo et al. 2011).

Table 4.5: Local chicken breeds owned by farmers

<table>
<thead>
<tr>
<th>Recorded breeds</th>
<th>Frequency</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid Owambo</td>
<td>148</td>
<td>90.8</td>
</tr>
<tr>
<td>Frizzled</td>
<td>2</td>
<td>1.2</td>
</tr>
<tr>
<td>Naked neck</td>
<td>9</td>
<td>5.5</td>
</tr>
<tr>
<td>Total</td>
<td>159</td>
<td>97.5</td>
</tr>
<tr>
<td>Missing System</td>
<td>4</td>
<td>2.5</td>
</tr>
<tr>
<td>Total</td>
<td>163</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Ninety-five percentages of farmers kept chickens for more than ten years and remaining 5% kept chickens for lesser than ten years as shown in Figure 4.7. According to farmers, keeping chickens is a custom for them. Few farmers considered chickens as companions that every family ought to have. Some farmers stated that keeping chickens is a trend they pass on from one generation to the next. This explains reasons chickens were in every household. However, larger number of farmers has been farming with chickens for more than for more than 21 years except in Oshikoto region where most farmers were between 16 and 20 years. Figure 4.7 shows the negative correlation between how long farmers kept chickens and high
qualification. The multiple regressions under the analysis of variance tested between years of keeping chickens, number of chickens kept and employment status and revealed the significance different ($p<0.012$).

![Figure 4.7: Correlation between period in chicken farming and qualification](image)

**Figure 4.7: Correlation between period in chicken farming and qualification**

### 4.6 Role of local chickens

Farmers mentioned multiple roles of local chickens. However, majority ranked slaughtering for family, visitors and during ceremonies as the most roles. Keeping chickens as a custom counted for 29% and income generation was 10%. Larger number of farmers kept chickens for home consumption and custom functions (Figure 4.8). Due to limited number of chickens kept, a sale for income is not the priority.
Farmers did not sell chickens at a precise age, but any time they need cash. Farmers further stressed that flock size at the time they need cash is a determinant of whether to sell or not. For example if flock size is less than three, then they do not sell. According to farmers, they use cash made from chicken sales for buying food, school fees and medical bills payment. Other expenses include; restocking, transport fares and labour. One can however, speculate that local chickens contribute to household food security, education, social welfare, custom, and income. Furthermore, farmers in the current study used local chickens as a saving to finance special circumstances like sickness, payment of school fees, social, as well as cultural gatherings. Farmers highlighted that sale of chickens is always high during the festive seasons such as Christmas, Easter and weddings.

Keeping of chickens for various reasons reported in this study agrees with various researchers like (Conan et al. 2012; Gueye 2010; Mesert et al. 2011; and Fisseha et al. 2010). According to a study carried out in Kenya by Okeno et al. (2011), reasons for keeping local chickens include eating within the home, food for visitors, gifts to friends and or church and rituals. However, Yitbarek & Gurumu (2013) reported a motive for keeping local chickens in Ethiopia is to strengthen marriages. For example, future in-laws assess how future wives will care for their husbands from how they prepare and serve a chicken dish. Similarly, in the current study serving a chicken dish is also a symbol of best hospitality and respect to guests (for example,
in-laws). Respondents said they honour woman or men introduced to their families as future husbands and wives with chicken dishes. Farmers also stated that serving a chicken dish as part of payment for labour during, crop weeding and harvesting was another motive for keeping chickens.

According to Magothe *et al.* (2012) and Samson & Endalew (2010), household food supply was the greatest reason of why rural farmers keep chickens in their respective countries. However, Mapiye *et al.* (2008) reported that farmers in Rushinga district of Zimbabwe use chickens to strengthen relations with in-laws or keep contact with their families by entrusting the other family members with the chickens. In addition, farmers in the same district sell chickens to pay for school fees and medical costs. However, a study carried out by Reta (2009), revealed that poverty alleviation was the main reason farmers keep chickens in many developing countries. Furthermore, advantages of keeping local chickens include sources of protein for farmers living with HIV and AIDS, and fund community conservancies. Although most farmers did admit the use of chicken for sacrifices, only a few respondents (1%) were open and willing to share details on the issue of rituals or sacrifices using chickens. According to farmers, herbalists mostly demands cocks or hens with white or black plumage colours. Similarly, Fisseha *et al.* (2010) pointed out that some farmers in Ethiopia believed that slaughtering a white feathered chicken could turn away evil spirits that target a family member.

### 4.7 Chicken ownership and management

Overall, women owned majority of chickens, followed by men and then children. Men argued that chicken farming is minor and not worthy of men’s efforts. They also argued that chickens are livestock species for women and children, while cattle and goats are for men. Results of this study reaffirm the consent that chicken production is a sphere for women. Further, the result was consistent with the findings of Kingori *et al.* (2010) by that managing chickens is a sphere for women for various past and social reasons.

Adult heads of households made majority of decisions on chicken management and marketing with youths playing a minor role. Adult females passed decisions on which
chicken to slaughter, restocking and chicken health management while males passed decisions on the sale of chickens. Majority (90%) of farmers said it is the duty of women to feed, care, and treat sick chickens followed by children. Men do not feed nor treat chickens but look after cattle, goats, and donkeys. Similarly, feeding and treating sick chickens is the duty of women in Zimbabwe (Mapiye et al. 2008).

4.8 Feeds and feeding habits
Local chickens feed themselves by scratching the ground for snails, insects, earthworms, grains, worms, seeds, and grass. Majority of farmers said their chickens depend on what the environment offers. Therefore, local chickens feed by scavenging. This finding was similar to that reported by Olwande et al. (2010), from Kenya where (99%) of local chickens feed by scavenging. Feeds scavenged by chickens in the study area include insects, leftover from the kitchen and crop residues. Farmers explained that scavenge-able feed varied with seasons. For example during rain seasons, there were more feedstuffs than in dry seasons. For example, insects, green grasses, and vegetables are plenty during rainy season. Similarly, Kingori et al. (2014) reported that vitamin rich feedstuffs like green-young grass, weeds and vegetable are plenty during rainy season. The authors further recommended the importance of providing extra feeds in seasons when such feedstuffs are rare.

In the dry season, farmers in the current study give chickens extra feeds twice a day because feed is rare. Majority (97%) of farmers gave extra feeds on top of scavenging. However, few farmers did not give extra feeds. Similarly, Mapiye et al. (2008) reported 6.2% of farmers in Zimbabwe did not give extra feeds, 96.6% gave extra feeds in summer, and 0.2% always gave extra feeds. Further, majority of farmers in north central Namibia gave extra feeds twice a day and a few gave once a day.

The supplements fed to chickens in the study area include millet, maize, sorghum, and melon seeds. Pearl millet is a staple food and most cultivated crop in the study area so it is readily available to most farmers other than maize. Interviewed farmers
explained that they do not crush the grains but give them, as they are (whole grain). Few farmers bought extra feeds from shops. None of the farmers in the current study formulated feeds. The most used supplementary feeds in order of frequency of use was pearl millet (70.7%), followed by maize (20.2%) and then others which include commercial feeds (9.1%) as shown in Figure 4.9 below.

![Figure 4.9: Percentages of supplementary feeds](image)

Farmers did not measure supplementary feeds they gave to chickens; so they did not know exact quantity they gave. However, from the observation, quantities of supplementary feeds given to chickens depended on the estimation of individual farmers and food available in the house. Results for the current study are similar to those of other researchers including (Hailemariam et al, 2009; Olwande et al. 2010; Gunaratne, 2013; and Mutayoba et al. 2011).

Farmers further explained that when food reserves from harvested crops runs out, they gave limited quantity of supplementary feeds or none. Furthermore, when food for humans is rare, chickens also had little access to leftovers and residues they usually eat. These findings, attested to the results of Hailemariam et al. (2009), that in Africa, most households experience food shortfalls, resulting in farmers giving none or limited quantities of supplementary feeds to their chickens. During the current study, chickens were scratching the ground in search of food in homesteads and crop fields (Figure 4.10).
Figure 4.10: Chickens feeding in a crop field and in the homestead

Farmers in the current study did not provide feeders. Even if they use feeders, chickens will force feed out of feeder and eat from the ground. Therefore, the common feeding method used is of throwing feed on the ground from where chickens feed (Fig 4.11). Farmers gave supplementary feeds to both adult and young chickens together (Figure 4.11). According to Olwande et al. (2010), young chickens learn to scavenge from adult chickens. One can assume young chickens have little feeding rate than adult chickens and may get lesser feeds.
The study found the method of throwing feeds on the ground having problems to chicks. Because, bigger chickens buried feeds in the ground through scratching and some are aggressive. These results are consistent with Gunaratne (2013), that throwing feeds on the ground was a waste because chickens do not make the best use of limited feeds. The use of feeders is best, to prevent wasting feeds and make the best use of limited feeds farmers provide.

Farmers provided water to their chickens each day, in dry season but in rainy season, they only gave limited quantity of water. However, observation of chicken houses in the current study showed little evidence that chickens received water daily. Some drinkers were empty and dirty. Some chicken houses had no drinkers. Chickens were drinking water drops after washing dishes or bathing. The current study also noted that, farmers gave water to chickens using dirty drinkers; this subjected chickens to diseases. According to Hailemariam et al. (2009), water is important in digestion and respiration. Further, water transport nutrients to body cells and help to excrete metabolic wastes. The author stressed the importance of providing chickens with clean water regularly for improving chicken production performance. Drinkers used include; flat plastic, stone dishes, locally made wood,
tyres, pieces of calabash, clay pots, trays and pot lids as shown in Figure 4.12 to Figure 4.16 below.

Figure 4.12: Stone drinker

Figure 4.13: Wood madedrinker

Figure 4.14: Plastic container drinker
4.9 Housing

Fifty percentages of the farmers kept chickens in houses during cropping season, to prevent them from damaging crop seedlings. The remaining 50% did not build houses for chickens; instead, chickens roost on trees, on poles made up the homestead, on roof huts, and on any raised item in the homestead. These findings are similar to those of Mengesha et al. (2011) in Ethiopia. Farmers listed reasons for not housing chickens as lack of building materials, lack of workforce, few chickens, and belief that housing chickens make them prone to parasites and diseases. According to Holt et al. (2011) housing is essential because it protects chickens against predators, theft, harsh weather condition (rain, cold wind, dropping night temperature), and to provide shelter for egg-laying.

Chicken houses were traditional type made from local materials like Mopani tree poles, crop straws, thatching grass, scrap metals, fishing nets, and old mesh wires (Figure 4.17 to 4.21). Similarly, Mapiye et al. (2008); Addisu et al. (2013); and
Kingori *et al.* (2010), also reported the use of bamboo slats, wattle, mud and palm leaves in building chicken houses. Houses examined in the current study were too small and at times dirty than standard houses for chickens. None of the chicken houses could protect them from rain or cold.

Majority (32%) of farmers used thatching grass as roofing materials for chicken houses, some used corrugated irons, mesh wires, and or nets and a few chicken houses had no roofs. Farmers described thatching grass as a readily available material than corrugated irons. The thatching grass is plenty during rainy season therefore renewal of roofs of chicken houses is done during this season.

Figure 4.17: Mesh wire chicken house

Figure 4.18: Fishing net, corrugated irons and scrap metal chicken house
Figure 4.19: Mopani poles chicken house

Figure 4.20: Mesh wire and corrugated irons chicken house

Figure 4.21: Mesh wire, corrugated irons and scrap metals chicken house
Although farmers built chicken houses, observation to such houses showed that they were rough, unhygienic, and not spacious. The current study did not notice formal cleaning of chicken houses, because some houses were too small such that only chickens could enter. The nature of chicken houses (Figure 4.17 to 4.22), made cleaning of such houses difficult. Parasites and disease organisms could breed in these houses and cause diseases to chickens. The reasons farmers provided housing, was the fear of attacks by snakes. However, none of the chicken houses could prevent snakes getting into the houses. The housing condition was not different from reports of several researchers in countries like; Zimbabwe: Mlambo et al. (2011); Ethiopia: Mengesha et al. (2011); Kenya: Magothe et al. (2012); and Nigeria: Yakubu, (2009). However, finding of the current study is in contrast with findings of Khandait et al. (2011) who reported that chicken farmers in Bhandara district of India cleaned their chicken houses regularly.

Chickens with different sexes and ages were in same houses. Farmers did not consider it necessary to house chickens of different ages and sexes separately. For them, building many houses is expensive, considering that, their flock size was small. Therefore, farmers did not know the importance of housing chickens according to sex and ages. There is however, a strong need for farmers’ training in chicken production to correct housing crisis in the study area.
The study did not take place during cropping season, and majority of farmers in the study area did not keep chickens in houses in such season. Therefore, both old and young chickens were roaming in all crop fields and in bushes close to homesteads searching for food as shown in Figure 4.23. Furthermore, as chickens search for food in crop fields and or bushes hawks, eagles, dogs and cats can attack them. It is important for farmers to keep chickens in houses to protect them from predators and thieves. According to Holt et al. (2011), proper housing should keep chickens secured from wild animals, hawks, be roomy, well lit, and airy, have perches, be easy to clean and keep.

Figure 4.23: Chickens roaming in bushes close to the homestead

4.10 Disease, parasites and their control

4.10.1 Disease and their control

In free-range chicken production, diseases are the major limiting factors to the production performances of local chickens (Ndathi et al. 2012). Farmers admitted that diseases outbreak were one of the major causes of mortality in the study area. Farmers regarded clinical symptoms as diseases. Disease symptoms listed by farmers were many and included; shivering, coughing, head swelling, diarrhoea, sudden death, blindness and crouch down (Figure 4.24). Some symptoms reported in the study area and description of diseases by the symptoms looked similar to the study carried out in Nigeria by (Adebayo et al. 2013).
Figure 4.24: Responses on disease symptoms per region

Although farmers did not know the root causes of diseases, this could be mixing of chickens with other chickens during scavenging. Exchanging chickens through gifts or sales of live chickens can also spread diseases. Furthermore, animal diseases passed on naturally to humans can spread from the intersection between humans and their chickens. Because of a lack of proper housing, chickens scavenge all over the house including kitchens. This is similar to the findings of Mengesha et al. (2011) which described protection of free-range chickens from infectious agent as poor and risky because scavenging chickens live with people and other species of livestock.

Farmers used herbs to treat sick chickens because it is sustainable, cheap, and culturally acceptable. According to them, there is no money involved in getting herbs; they get them freely from the bush. However, 18% used antibiotics from pharmacies; 3% used human medicine and 20% did not give treatment (Figure 4.25). Similarly, Simainga et al. (2010) reported the use of leftover human medicines to treat sick chickens.
Mapiye, (2008) reported that most farmers in rural areas of Zimbabwe use herbs to treat sick chickens. Using herbs to treat sick chickens was better than a no treatment. Farmers used herbs to treat sick chickens had large flock sizes than those who did not use any form of treatment. In the current study however, farmers prepared herbs by mixing different plants or single plant parts depending on the indigenous knowledge of individual farmers. Farmers further explained that; firstly, they harvested, washed and crushed leaves, roots, bulbs, and stems before using them as medicines. A list of herbs farmers in the study area use to treat sick chickens (Table 4.6).

Table 4.6: Summary of herbs used by farmers to treat sick chickens

<table>
<thead>
<tr>
<th>Common names</th>
<th>Local name</th>
<th>Parts used</th>
<th>Preparation method</th>
<th>Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitter bush</td>
<td>Ezimba</td>
<td>Fresh leaves and stems</td>
<td>Grounded</td>
<td>Added to drinking water</td>
</tr>
<tr>
<td>Aloe</td>
<td>Endombo</td>
<td>Fresh leaves</td>
<td>Squeezed</td>
<td>Eye drops</td>
</tr>
<tr>
<td>Tobacco</td>
<td>Ekaya</td>
<td>Dried leaves</td>
<td>Grounded</td>
<td>Added to drinking water</td>
</tr>
</tbody>
</table>
According to Adebayo et al. (2013) herbs used by rural farmers to treat sick chickens in developing countries are not the same. Medicaments used by rural farmers in Nigeria are those from plants origin and they include; mahogany, wild garden eggs and pepper. However, Moreki et al. (2010) reported that farmers in Botswana used pepper and sisal leaves to treat sick chickens. In addition, Masimba et al. (2011) reported that the use of Aloe vera, pepper and sisal to prepare traditional medicine in Zimbabwe.

Farmers did not measure the ingredients when preparing traditional medicine therefore they did not know the dosage levels. This means that there are high chances of chickens receiving overdose and or under dose. Furthermore, farmers did not consider age, when giving traditional medicine. Both adult and young chickens got same doses. They also did not exclude healthy chickens when giving herbs, because administration of herbs is through drinking water for all chickens. These results are similar to findings by Yirga et al. (2012) which showed that farmers in Ethiopia did not know dosage levels of herbs and that treatments were not for any specific disease.

4.10.2 Parasites and their control
The common parasites of local chickens in the study area were fleas, fowl lice, and mites. Similarly, Mengesha et al. (2011) reported lice as the main external parasites in rural areas of Ethiopia. According to Moyo (2009) external parasites are bloodsuckers that burrow into the skin or live on or in the feathers causing severe irritation, occasionally the eyes of the chickens may swell leading to blindness. These external parasites can cause anaemia, poor growth, poor egg production, and may lead to death.
Farmers in the current study used wood ash to remove parasites from chickens. They used ash from any wood depending on the individual knowledge of individual farmers. Farmers used wood ash by spreading it in chicken houses or shelters, on tree trunks and piles of bricks where chickens roosted at night to kill parasites. Similarly, Moreki (2012a) also reported the use of wood ash in Botswana and Moyo, (2012) in South Africa.

4.11 Mortality rates
Mortality rates in young chickens (aged 0-6 weeks) were the highest (52%). The rest (23% and 18%) of mortality occurred among growers (age group 7 – 28 weeks) and 7% among mature chickens (above 28 weeks). Mortality rates decreased with increasing age (Figure 4.26).

![Graph showing chicken mortality rate at different age categories](image)

Figure 4.26: Chicken mortality rate at different age categories

Diseases were not the only cause of deaths in local chickens but rather predators and accidents. The results from the current study are similar to the findings of Fisseha et al. (2010), who recorded a survival rate of 59.7% in young chickens (1-10 weeks old) in Ethiopia. In the current study, farmers listed hawks, crows, snakes, dogs and cats as the main predators preying on young chickens. Human beings
sometimes mistakenly step on young chickens and kill them, because local chickens mix with people in the homestead when scavenging. The tough hens with good parenting skills are sometimes able to protect their chicks from hawks and crows by giving them cover when they sense danger. Farmers contended that when chickens get supplementary feeds every time, they remain inside the homestead. Therefore, snakes and other wild animals do not attack them.

For saving chicks from predators, some farmers (18%) built small cages, where they keep chicks for the first four weeks (Figure 4.27). Keeping chicks in cages protected them from hawks, crows, dogs, and cats. Although farmers built cages, observation of cages showed that they were too small and unhygienic. From results of the current study, one can assume that good management of chicks can drastically prevent their deaths. This confirms the findings by Mutibvu et al. (2012) which showed a decline in losses of chicks through provision of proper houses.

Figure 4.27: Tyre and mesh wire cage.

According to Gunaratne (2013) reason for high death rates in chicks is inadequate nutrients to meet their growing needs. Therefore, chicks grow weak to defend themselves from predator attacks. Chicks did not have enough experience and competency in searching for feeds. Ajuyah (2013) pointed to low protein and energy in feeds, low hatching weight of chicks and high environmental temperature as reasons for high mortality rates. Cold winter temperature, rain, and starvation contributed to the deaths of chicks (Mengesha et al. 2011). Consequently, it is
important to make local chicken producers aware that it is possible to increase benefits from local chickens with limited resources and good management.

4.12 Productivity of local chickens

4.12.1 Age at laying first egg

According to Addisu et al. 2013 the average age at laying first egg of local chickens in developing countries is 7 months. However, in the current study majority of farmers (81%) did not know the age at laying first egg of their chickens. About 8% guessed 5 months, 7% said 6 to 7 months and 4% said more than 7 months of age. Similarly, Kgwatalala et al. (2013) reported lack of records by chicken farmers in Botswana such that farmers did not know the age at laying first egg. As mentioned earlier farmers in rural areas do not keep records. There is however, a strong need for farmers’ education and training on the importance of keeping records in chicken production.

4.12.2 Egg production

As reported by Atsbeha, (2014) and Issa et al. (2013) local chickens lay fewer eggs than exotic chickens. Majority (64%) of farmers said their chickens laid three clutches each year and each clutch contained 10 to 15 eggs. About 36% of farmers did not know the number of clutches laid by their chickens. Three clutches a year was also noted in Ethiopia by (Samson & Endalew, 2010) and Botswana by (Kgwatalala et al. 2013). Average annual egg production of 30 to 45 eggs a chicken per year noted in the current study signals that local chickens have the potential to produce more eggs under intensive management. According to Kgwatalala et al. (2013), reasons like; genes, feeds, and feeding systems, diseases and poor management influenced egg production. To improve egg production, research is important to find out why commercial and or exotic breeds produce more eggs than local chickens.

Eggshell colour noted in the current study ranged from cream white to light brown colour (Figure 4.28). Similarly, Fisseha et al. (2010) reported white and brown shell colours in Ethiopia. However, Nonga et al. (2010) reported whitish, brownish, and cream eggshell colours. Cavero et al. (2012) reported that location do not influence
eggshell colour but a pigment produced in the uterus during shell formation is responsible for eggshell colour. Results of the present study confirmed their report because individual hens from same flock and eggs from same clutch varied in their eggshell colour (Figure 4.28). According to Barerjee (2012) shell colour is not a sign of egg quality or nutrients the egg contains but plays a major role in marketing because some consumers prefer eggs with certain colours.

Figure 4.28: Eggshell colours

The average of egg weight was 49.95g in the current study. The egg weight in this study was higher than 39.89g reported in Sudan by (Yousif & Eltayeb, 2011). However, Isadahomen et al. (2013), pointed to genes, environment, food shortage, and parental body weight as reasons for the differences in the weight of eggs. In the current study, average egg length was 5.68 cm. The egg length in the current study is higher than 4.36 cm reported in Nigeria by Yabubu et al. (2008), and 5.09 cm reported in Sudan by (Yousif & Eltayeb, 2011). Egg width of 4.23 cm noted in this study is similar to research from Sudan by (Yousif & Eltayeb, 2011). However, the egg index of 74.74% is higher than the value (68.29%) reported by Yakubu et al. (2008). According to Isadahomen et al. (2013), higher egg index signals good external egg quality.

None of the farmers in the study area provided nesting boxes. Hens made their own nests wherever they find a suitable place in the homestead to lay eggs (Figure 4.29).
Some hens were sharing incubation episodes on one nest, while others made nests in corners around the homesteads. Farmers said these hens made one nest and laid eggs together. Some farmers said sharing incubation episodes gives good result of up to 100% hatchability. Hens made nests on thatched roofs, some on edge of fences, bushes, and on piles of thatching grass. This supports the findings of; (Mutibvu et al. 2012; Nathi et al. 2012 and Mengesha et al. 2011). The current study found that the lack of nesting boxes have problems, because nesting boxes provide privacy to hens, they are warm and drier than for example the edge of a fence. Above all, it is important to make chicken producers aware that a lack of nesting boxes subjects eggs to; predators, heat, cold and rain. In addition, they can use local materials to make nesting boxes.

4.12.3 Hatchability and mortality rates
According to Kebede et al. (2012) egg production, hatchability and chicks survival indicates flock productivity. None of the farmers brooded and hatched eggs artificially. All farmers (100%) in the study area brooded and hatched eggs naturally by a hen. The average hatchability in this study was 63%. The finding in this study was lower than 89.1% reported in Ethiopia by Mengesha, (2012b). However, this result is within the range reported for local chickens in most developing countries, which is 60 to 95% (Gueye, 2009). High hatchability improved chicken production when there is good chicks’ survival. However, a high chicks’ mortality (52%) noted in this study could be a reason for low flock sizes in the study area.
Blackie, (2014) mentioned; poor management, lack of freshwater, poor scavengeable feeds, predators and diseases as the main causes of chicks deaths in free-range chicken production. The chicks’ mortality rate noted in this study was lower than the value of (61%) reported in Ethiopia by (Molla, 2010). Most of the chicks died before reaching sexual maturity. Similarly, Fentie et al. (2013), reported that a clutch of 10 to 16 eggs, only about seven chicks hatched from those eggs managed to reach sexual maturity. The losses occurred in the first three weeks of life and adult mortality was variable which depended on specific local conditions and diseases. Farmers reported poor hatchability especially during rainy seasons, because rain filled clutches with water, causing hens to abandon their nests. The quality of chicken houses built was responsible for poor hatchability during rain. Some houses had no roofs, allowing rain to fall into houses and eggs.

4.13 Production challenges

4.13.1 Lack of quality feeds
Lack of quality feed has harmful results on local chicken production in the study area. Farmers explained that lack of feeds is more severe during the dry season when scavengeable feed is rare. Similarly, Goromela et al. (2008) reported a shortage of scavengeable feeds in the dry season because of the absence of insects and green material including grasses. Provision of supplementary feeds in the study area depended on food in the house. Farmers gave little or nothing when food in the house is rare.

4.13.2 Lack of markets
Interviewed farmers complained that lack of settled markets in the study area has led them to sell chickens to neighbours, at local taverns and on pensioners’ days. Majority of the farmers (62%) said that selling at taverns was a problem because, after selling, they tend to spend money on liquor before important items. The 38% (n=76) preferred to sell their chickens to neighbours but mentioned that the main purpose of keeping chickens is for home consumption. Majority of farmers stressed a need to have a market within the study area. Farmers further explained that lack of proper marketing avenues forced them to sell their chickens at a rip-off price. Also
chicken buyers, especially the hawkers, bargain for low prices to increase profit when they sell them in their local areas. Occasionally farmers sold their chickens on credit and sometimes they did not recover their money on time or never recover them at all.

4.13.3 Health status and disease management
Farmers described symptoms they noted in their chickens as diseases because of a lack of veterinary knowledge on chicken diseases. Farmers never isolated sick chickens from healthy ones. Lack of diagnostic, vaccination and control services made disease crisis worse. Without modern treatment farmers in the study area, used herbs and sometimes others use leftover from their own or their children’s prescription to treat their chickens. This agreed with Moreki et al. (2010) and Ndathi et al. (2012) in that major challenge in production of chickens in rural areas is income to control diseases. Furthermore, farmers were aware of the need to keep their chickens in good health. However, modern drugs are either unavailable or too expensive for them to afford, hence their dependence on herbs and leftover human medicines.

Farmers benefited from chickens through the supply of protein and other socio-cultural roles; therefore, there is a need for improving local chicken production in health control. Clearly greater productivity and profitability will result from such interventions.

4.13.4 Poor chicken management
According to farmers and visual observation in various villages in the study area, production losses were due to poor feeding, watering, lack of hygiene and predators. The study took place during the dry season when green grasses or insects which chicken presumably feed on during the rainy season were rare. Chickens were scratching and picking from the bare ground. Farmers mentioned that they provided water to their chickens each day. However, from visual observation there was little evidence that chickens received water each day. Water containers were empty and some filled with dirty water. Water is essential for the control of body temperature in hot environments like the one in north central Namibia. Chickens suffer at high
temperatures because feather cover hinders internal heat dissipation (Dana et al. 2010). The exposure of chickens to high temperature results in changes at metabolic, physiological, and cellular levels (Mekonnen et al. 2010). According to Gunaratne (2013), chickens drank more water at high environmental temperatures than at low environmental temperatures. Furthermore, the diet, rate of laying eggs and size of chickens influenced water intake of chickens. There was however, a strong need to train farmers on the importance of providing chickens with clean water regularly to increase production in the study area.

Although some farmers built chicken houses, observation to such chicken houses showed that they were too small and unhygienic. The size of houses farmers built for their chickens made it difficult to enter and clean. Lack of frequent cleaning of chicken houses might cause diseases and deaths of chickens. Thus, raising awareness on the need for cleaning chicken houses regularly is important in the study region.

4.14 Consumption, marketing of chickens and their products

4.14.1 Consumption of chickens and their products
Farmers slaughtered chickens for home consumption, visitors, and weddings. Majority of farmers (75%) consumed chickens occasionally and the remaining (25%) consumed when the need arose. Slaughtering for visitors depends on the importance of the visitor and flock size in the house at time of visit. Farmers listed the following as reasons for slaughtering chickens; to reduce number of cocks, infertile chickens; hens with a tendency of laying eggs on roofs; and injured chickens. According to farmers, slaughtering chickens for consumption depends on flock sizes in a household. Therefore, there is a need to increase flock sizes through good care management.

The primary role of eggs is incubation, and hatching and then consumption. These findings are similar to research from Ethiopia by Kebede et al. (2012) in which availability of commercial eggs and hatching of all eggs to produce chicks as reasons for farmers, not consuming eggs. Similarly, Blackie (2014), stressed that
enough protein would be available to farmers, if they consume eggs than allowing hens to hatch them into chicks, which eventually die before reaching sexual maturity.

4.14.2 Marketing of chickens and their products
Farmers sold chickens when they need cash to neighbours, hawkers and to people who need to slaughter during weddings, birthday parties, and celebration. They use cash made from chicken sales to support school fees and other households’ needs. Majority of farmers (90%) did not sell chickens but slaughter some occasionally for home and visitors consumption. Out of the 200 households only 4% (n=8) sold chicken eggs. The remaining 96% (n=192) did not sell eggs, but allowed hens to hatch them to increase flock sizes and for home consumption. There were no specific market where farmers could sell chickens and their products. Farmers sold chickens to their neighbours and during pension days when senior citizens come to receive their pension or at local taverns where people come on daily basis to socialise. Research conducted in Ethiopia by Mesert et al. (2011), also reported a lack of specific markets where farmers could sell their chickens, described them as informal, and poorly developed.

Majority of farmers (7%) sold chickens mostly to their neighbours. However, (3%) sold to people who resell at markets in urban areas and or sell cooked chickens at local taverns. They sold cocks because they are heavier and had a higher sale value than hens. According to farmers, season of the year influenced the price, for example in December; they had more sales at higher prices than other months. The highest demand for local chickens coincided with the major social and religious festivals of the year, which include weddings and Christmas. Farmers said there is popular belief that rural eggs and or chicken meat is delicious and healthier than commercial chickens.

According to farmers, chicken prices ranged from 70 to 90 Namibian Dollars (equivalent to South African Rand) for a cock and 50 to 70 Namibian Dollars for a hen. They sold chickens when a need for money arose at urban markets. Farmers mentioned that they sold their chickens without weighing because of a lack of weight scales. Furthermore, farmers complained that pricing chickens or eggs depended on
their sizes and weight gauged by visual appraisal forced them to sell their chickens at a rip-off price.

4.15 Phenotypic characteristics of local chickens

Phenotypical features represent an important measure of how organisms adapts to their environment. Physical features interact with living and non-living parts of the environment. A study in Tunisia by Raach-Moujahed et al. (2011), revealed that local chickens have different skin and plumage colours, diverse body conformation, and different feather morphology (smooth and curly). Similarly, differences observed among local chickens in this study were those of various plumage colours, feather morphology, feathering of legs and feet and feather arrangement (for example crested heads). However, according to Magothe et al. (2012) local chickens vary depending on their body size, productive, adaptability and plumage colour.

4.15.1 Plumage colour

Majority of local chickens in study area had multi-colouration of the plumage. Similarly, Egahi et al. (2010) also reported multi-colouration of plumage in Nigeria. According to Daikwo et al. (2011) lack of selection directed towards choice of plumage colour caused multi-colouration of plumage in local chickens. Sonaiya (2009) described local chickens as unimproved and difficult to describe. The current study noted the absence of pure white plumage colour in all chickens throughout the study area. Figure 4.30 to Figure 4.41 shows plumage colour observed in the study area.

![Figure 4.30: White light brown plumage](image1)

![Figure 4.31: Multi-coloured plumage](image2)
Figure 4.32: Greyish plumage
Figure 4.33: Black and white plumage

Figure 4.34: Multi-coloured plumage
Figure 4.35: Yellowish plumage

Figure 4.36: Multi-coloured plumage
Figure 4.37: Pure black plumage
Farmers use traits such as plumage colour and feather patterns, to identify their chickens from others. The local names given to chickens came from physical characteristics and include; plumage colour, crested, naked neck, frizzled feathered and shank feathered among others. The diverse morphological traits noted in the current study are consistent with those of Faruque et al. (2010), who stated that variation in phenotypes is exactly what characterises local chickens. Fotsa, (2012) described plumage colours as transmissible from parents to offspring and caused by single gene pairs.

According to Melesse & Negesse (2011), multi-colourations of plumage in local chickens have some advantages to chickens, which include camouflage against predators. Furthermore, Faruque et al. (2010) and Dana et al. (2010), in their
separate studies explained the purpose for local chickens having diverse plumage colour is for camouflage against predators. It became obvious in this study because of a lack of pure white colour in local chickens population. The role of plumage colour in chickens may go beyond camouflaging. For instance, Cabarles et al. (2012) stated that white and or light plumage colour is important in breeding commercial breeds because it has a clean carcass and cut-up parts.

4.15.2 Comb types
Single comb was the commonest comb types in the surveyed region followed by rose and pea last as shown in Table 4.7.

<table>
<thead>
<tr>
<th>Comb types</th>
<th>Regions</th>
<th>Total noted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OHA</td>
<td>OMU</td>
</tr>
<tr>
<td>No noted</td>
<td>34</td>
<td>59</td>
</tr>
<tr>
<td>Cushion</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Double</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Duplex</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pea</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Rose</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td>Single</td>
<td>25</td>
<td>28</td>
</tr>
<tr>
<td>Strawberry</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>V-shaped</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Walnut</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

OHA = Ohangwena; OMU = Omusati; OSHA = Oshana; OSHI = Oshikoto

These observations agreed with the findings made by Daikwo et al. (2011), which showed that among rose, walnut and pea, single was the commonest comb type in Nigeria. Further, this study noted the absence of; cushion, double, duplex, strawberry, v-shaped and walnut combs. Using chickens in rituals caused the absence of some comb types in rural areas (Yakubu et al. 2009). Similarly, Egahi et al. (2010) reported that most chickens with peas and rose combs they examined in
their study were with traditional worshippers in Nigeria. However, in the current study farmers reluctantly agreed that they use chickens for ritual purposes. Similarly, natural selection and adaptation of certain genes to a particular environment caused differences in comb types (Melesse & Negesse, 2011). The current study also noted differences between rose combs, single and pea combs as shown in Figure 4.42 to Figure 4.44 below.

Fig 4.42: Rose combs
The size of combs occurring in chicken population in the study area ranged from small to medium and then large. In general, chickens with small combs were most frequent followed by those with medium-sized combs, and large-sized combs least frequent. Small and medium-sized combs occurred more often in hens while cocks had large combs. The findings are similar to those made in Nigeria by (Ige et al. 2012). The high number of small sized combs in local chickens suggested hormones connected to egg production influences face size and head attachments. Thus, one could speculate that genes for egg production rate could have influences on size of face and head attachments. Since selection for high egg production does not take place in rural areas, secretion of hormones could be low; therefore, similarly sizes of
face and head attachments would be small. This debate conforms to that of Dana et al. (2010), who associated size of combs with gonad development and secretion of sex hormones. Differences in comb sizes between hens and cocks became clear in the current study because all cocks had bigger combs than hens.

4.15.3 Ear lobe colour
Almost all local chickens in the study area had ear lobes. The common earlobe colour was a mixture of red and white, followed by red and then white (Table 4.8). In general, red and white colour was dominant. Faruque et al. (2010) and Egahi et al. (2010) also reported same differences as observed in the current study. According to Cabarles et al. (2012), chickens inherited earlobe colour from their parents.

Table 4.8: Ear lobe colours recorded per region

<table>
<thead>
<tr>
<th>Ear lobe colour</th>
<th>OHA</th>
<th>OMU</th>
<th>OSHA</th>
<th>OSHI</th>
<th>Total noted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number noted</td>
<td>34</td>
<td>59</td>
<td>34</td>
<td>32</td>
<td>159</td>
</tr>
<tr>
<td>Mixture of red and white</td>
<td>25</td>
<td>48</td>
<td>20</td>
<td>24</td>
<td>117</td>
</tr>
<tr>
<td>Red</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>5</td>
<td>27</td>
</tr>
<tr>
<td>White</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>3</td>
<td>15</td>
</tr>
</tbody>
</table>

OHA = Ohangwena; OMU = Omusati; OSHA = Oshana; OSHI = Oshikoto

4.16 Feather morphology
Majority of local chickens in the study area had normal feather morphology. However, few chickens had frizzling and naked-necked morphology.

4.16.1 Frizzle feather morphology
Frizzle chickens have feathers curved outward and not laying smoothly along chickens’ body (Figure 4.45).
According to Egahi et al. (2010), frizzled feather morphology feature lowers insulation by the feather cover, which makes it easier for a chicken to radiate heat from the body. Furthermore, frizzle chickens have genes, which make them adjust to native hot environment, influencing either meat characters or egg production. Feather distributions gene associates itself with increased heat resistance (Ige et al. 2012). Similarly, Fathi et al. (2014) reported that frizzle chickens performed well at high temperatures because of their potential to spread heat by convection than normal feathered chickens. The study conducted by Egahi et al. (2010) and Dana et al. (2010) also reported that frizzle chickens produce more meat and or eggs and resist diseases in tropical environments than normal feathered chickens.

Despite their important features, frizzled chickens were rare (0.72%) in the study area. According to Fathi et al. (2014) rare mutant genes with recessive results and no selective advantage in the populations is responsible for rare frequency of frizzled chickens in developing countries. The social preferences and natural selection may be responsible for rare frequencies of frizzled chickens. Similarly, a study by Fajemilehin (2011) showed that people in Nigeria had a belief that farmers who own frizzle chickens are fetish or witches. Owners of frizzle chickens prefer to slaughter or sell them for rituals before they reach maturity. The use of local chickens with frizzle feather morphology for rituals needs scientific concern to ensure preservation of such features for use in local chicken improvement.
4.16.2 Naked necked

Naked necked chickens have no feather follicles from head and neck as shown in Figure 4.46. According to Khobondo et al. (2014) naked necked is characterised by featherless skin on the neck, on the breast, and on ventral part of the thigh.

![Figure 4.46: Naked necked morphology](image)

Naked-necked chickens in the current study were few (5.48%), but more than (2%) reported in Ethiopia by (Dana et al. 2010) and close to 6% reported in Nigeria by (Fajemilehin, 2011). According to Ige et al. (2012), naked necked chickens have 30% less feathers than full feathered. According to farmers, few feathers on the naked necked chickens make it easier to remove when preparing for cooking such chickens than full feathered. Islam & Nishibori (2009) argued that, major genes found in local chickens of the tropics and viewed to have desirable results on heat endurance caused naked necked. Naked necked feature lowers insulation by feather cover, and makes it easier for chickens to radiate heat from the body. According to Fathi et al. (2014) naked necked gene allows chickens to adjust to hot environment, influencing either meat characters or egg production. Furthermore, naked necked chickens may perform well at high temperatures because of their potential to spread heat by convection, leading to low heat stress (Ige et al. 2012). However, naked necked chickens adapt well to tropical environment, poor feeding and resist disease (Islam & Nishibori, 2009). In addition, according to Fathi et al. (2014) a decrease in
feather coverage in naked necked chickens resulted in little protein for feather production and more protein for meat and egg production.

4.17 Feather arrangements

4.17.1 Crested head
Some local chickens in the study area had tuft of feathers on their heads as shown in Figure 4.47. Out of the total populations studied only 8.66% had crest-heads, the remaining chickens had normal head shape. Many crest-headed chickens in this study were hens. The findings of this study are similar to those reported by (Getu et al. 2013). According to Faruque et al. (2010) an incomplete dominant gene is responsible for a tuft of feathers above the head behind the comb.

![Figure 4.47: Crested heads](image)

4.17.2 Feathered shanks
Most chickens in the study area had no feathers on their shanks however; a few chickens had sparse feathers (Figure 4.48).
4.18 Shank colours

According to Cabarles et al. (2012) a combination of pigments in the upper and lower layers of the skin decides shank colour in local chickens. The current study noted various shank colours in chicken population studied. Overall, black shanks were most frequent, followed by yellow shanks, white shanks with orange and reddish shanks least frequent. The high frequency of black shanks noted in the current study was similar to reports of other researchers (Egahi et al. 2010 and El-Safty, 2012). In contrast, Cabarles et al. (2012) and Daikwo et al. (2011) reported yellow shanks as most frequent shank colour in their studies. Figure 4.49 to 4.53 below shows shank colours noted in the current study.

Figure 4.48: Feathered shanks

Figure 4.49: Black shanks

Figure 4.50: Yellow shanks
4.19 **Body measurement features of local chickens.**

According to Dorji *et al.* (2011) and Al-Atiyat (2013b), local chickens have small sized bodies than exotic breeds. Figure 4.54 shows the average body weight and body linear measurements of chickens noted in this study. Their body weight was lower than exotic chickens reported. However, similar correlation ($r = 0.944$) was, obtain between body weight and wingspan. The analysis shows that there is a strong positive correlation ($r = 0.944$) between chest circumference and wingspan. Table 4.9 shows frequency of shank length size. Shank length had shown strong positive correlation ($r = 0.827$) to the chest circumference. Thus, strengthen earlier reports by Dorji *et al.* (2011) and Al-Atiyat (2013b) that local chickens are small. However, Semakula *et al.* (2011) argued that small stature of local chickens shows their adaptability in the tropics. Small body size results in little maintenance, feed needs, and an increase in feed use in the tropics.
According to Yakubu et al. (2009) smaller sized bodies are necessary for chickens’ survival in the free-range because of rare feed sources and the doubt surrounding feed supply. According to Alabi et al. (2012) body weight and body size play a role in adaptability. The adaptability of chickens can be measured by the survivability and productivity. Majority of local chicken farmers measured the productivity of their chickens with eggs laid and chicks hatched. Due to lack of traceable records on which chicken laid which eggs, the correlation between body weight and egg weight was not tested. However, measures taken on eggs were tested and study revealed that there is a moderate positive correlation ($p = 0.704$) between egg weight and egg width.

However, Fajemilehin (2011) reported that small chickens showed smaller change in body temperature when subjected to extreme heat than larger body weight chickens. Thus, one could speculate that local chicken breeds used by farmers in this study adjust well under thermal straps because of their small body weight and size. Furthermore, low body weights might be making it easy for them to roost in places above the ground to avoid predators. The study further revealed that local chickens of North-central Namibia had not undergone remarkable gene mixing with the exotic breeds, otherwise their body weight could be high.

In the current study the mean body weight of 1.7 to 2.1 kg of both sexes combined falls within the range of 1.6 to 2.18 kg reported by (Alabi et al. 2012). However, the other mean body features reported in this study do not agree with the findings of several authors (Yakubu et al. 2009; Aklilu et al. 2013 and Getu et al. 2013). The most probable reason is that apart from gene possession, the environment plays an important role in the differences in phenotypic appearances of the chickens.

Table 4.9: The frequency and percentages of shank length

<table>
<thead>
<tr>
<th>Shank length</th>
<th>Frequency</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid 7.7 to 7.9 cm</td>
<td>21</td>
<td>12.9</td>
</tr>
<tr>
<td>8.0 to 8.2 cm</td>
<td>90</td>
<td>55.2</td>
</tr>
<tr>
<td>8.3 to 8.8 cm</td>
<td>22</td>
<td>13.5</td>
</tr>
<tr>
<td>8.9 to 10.3 cm</td>
<td>26</td>
<td>16.0</td>
</tr>
</tbody>
</table>
The results further showed that cocks were consistently superior to hens in all physical features measured in Figure 4.54. Hormonal difference exists between male and female animals could be causing superiority of cocks noted in the current study. The differences in body weight and other body measures between cocks and hens are similar to the findings discovered in Nigeria by (Yakubu et al. 2009) and in Ethiopia by (Dana et al. 2010). Hens use more energy on maintenance and producing eggs than for growth, while cocks use most energy for growth. Similar study made by Egahi et al. (2010) also reported the cocks of the native chicken from Nigeria were heavier than the hens.

\[
\begin{array}{ccc}
\text{Total} & 159 & 97.5 \\
\text{Missing System} & 4 & 2.5 \\
\text{Total} & 163 & 100.0 \\
\end{array}
\]

**OHA** = OHANGWENA, **OMU** = OMUSA TI, **OSHA** = OSHANA, **OSHI** = OSHIKOTO

**Figure 4.54:** Body measurement features of local chickens per gender per region.
CHAPTER 5

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion
The current study conducted to find out the relation between local chickens’ phenotypic characteristics and their productivity. To find out what local chickens contribute to household in north central Namibia. The study tested two hypothesis and results are as follows:

First hypothesis: There is no influence of production methods on local chicken productivity and evaluation of their contribution to household in north central Namibia.

Results of this study revealed that local chickens play an integral role in the livelihoods of rural families in the study area. Farmers regarded chicken production as their primary source of domestic animal protein, with the domestic fowl being the most widely kept poultry species. Other uses of chickens are participation in socio-cultural ceremonies such as celebration, weddings, selling for money and gifts. The current study proved that there is a chance to meet the challenges of fighting poverty and malnutrition in rural areas by strengthening local chicken production. However, farmers should value chickens as a source of daily food and regular income than a source of food or income in times of need.

Nevertheless, several challenges face farmers who rear chickens. The challenges are enormous and include lack of regular feeds, housing, outbreak of diseases and parasites, predators and lack of markets. The results also showed a lack of veterinary knowledge among farmers in rural areas and it is therefore important for extension officers to provide training services. Furthermore, there is also a need to train rural farmers on building proper chicken houses by using local materials, which all farmers can afford. Marketing of local chickens is still informal. A lack of organised markets forced farmers to sell live chickens and these present many challenges on transporting them to markets and the spread of diseases.
Results of this study showed that local chicken farmers regarded chicken rearing as secondary to, for example crop production and other animals, in that they provided little care or no care to their chickens, which resulted in low productivity. Livestock researchers and veterinary services put greater emphasis on other animals at the expense of chickens.

Across north central Namibia, local chickens face inadequate feeding and housing, leading to low productivity. Since proper housing, cleaning, provision of extra feeds and health care substantially improve chicken performance, therefore it is important to promote such measures through training and extension services. Studies made thus far showed that quality and availability of scavenge-able feed depends on season and food available in the household. The current study proved that current management system (poor housing, lack of feeding, lack of programme on disease prevention and others) have negative effects on productivity of local chickens and their meaningful contribution to household. Thus, lead to rejection of hypothesis 1.

Second hypothesis: There are no different phenotypic characteristics on local chickens and their productivity of identified phenotypic characteristics in north central Namibia.

Phenotypic characteristics of local chickens in the study area revealed the absence of pure white plumage colour. The study therefore, assumed that farmers in the study area might not have introduced White Leghorn breed. However, there were some variations on plumage colours, feather morphology, feather arrangement, and shank colours. Furthermore, majority of chickens had single combs with no shank feathers while a few had peas and roses comb with sparse shank feathering. The results of the current study revealed that local chickens in north central Namibia had remarkable phenotypic characteristics variations. It is possible with further work to standardise the phenotypic characters noted and come up with some traits or values as characteristics of local chickens in the study area. The study has revealed a strong correlation (0.944) between chest circumference and wingspan when tested at the sensitivity of 99%. However, lack of records on which chickens is laying eggs, made it difficult for the current study to correlate productivity with particular phenotypic characteristic of local chickens identified in the study. The study revealed that majority of local chickens had average body weight of 1.7 to 2.1 kg, with
average production of 10 to 15 eggs per clutch. The hatchability of (50% to 60%) recorded by counting eggs (5 to 7 eggs hatched out of total 10 to 15 eggs laid) revealed that chickens kept by farmers did not show good productivity although some farmers claimed to have good sales.

Almost all farmers need to aim for boosting up their chicken production and productivity. The result for phenotypical characteristic revealed large variation of phenotypical characteristics with poor correlation to their productivity due to lack of record keeping. The part of productivity according to their identified phenotypic characteristics is not accepted nor rejected due to poor records, but recommended for further study with training on record keeping by farmers.

5.2 Recommendations
Result for this study is a step in planning identification of chicken breeds and conservation of local chickens in Namibia. Therefore, this study recommended further studies in other parts of Namibia to have a national picture of local chickens’ diversity for the whole country. The research has also showed that local chickens represent a pool of diverse individuals that are largely different in morphology some of which were important in disease resistance. Local chicken characteristics need conservation because some of their traits are of future importance in being vigorous and adapted to the harsh environment. Therefore, this study suggested research studies to find out whether genes variation caused dissimilarity in their physical characteristics and use the results to design conservation plans.

Simple changes in managing local chickens such as housing, feeding and health care could improve their productivity and lower mortality rate. For instance, predators are major causes of chicken losses from flocks in the study area. Simple house construction specifically designed for young chickens (for the first 4-5 weeks of life) using local available materials can easily save from harm. However, administration of regular disease prevention and proper vaccination will undoubtedly prevent mortality. A little technical support on farmers’ experience or knowledge on feeding and watering could also improve productivity of chickens. It is equally important to
research the use of traditional herbs to cure diseases and wood ash to get rid of parasites.

Cost of feed associated with feed waste because of broadcasting feeding does not warrant farmers adopting rearing chickens under confined surroundings because it may not benefit them financially. Advising farmers to continue providing their chickens with cheap and locally available feeds regularly and in feeders made from materials available locally is therefore important. Furthermore, this study does not warrant rural farmers adopting rearing exotic chicken breeds because it may lead to loss of vigorous and unique breeds. Making farmers aware that local chicken breeds suits rural conditions than exotic or commercial breeds is therefore important. The overall results of the current study allow research to recommend the need to focus on building the power of chicken farmers through training and support services as they play a dominant role on production and management of local chickens. It is therefore, important to carry out further research and relevant trainings aiming to improving management of local chickens, and conservation of identified breeds in north central Namibia.

5.3 Further research suggested
To aid undisturbed conservation plans it is important to put more effort on improving productivity of local chickens. First focus should be on the design of housing with build-in nests suitable for local chickens, improvement of feed nutrients, and use of proper feeders and drinkers for improving health and production. Second focus should be to examine disease prevalence in rural areas. Third focus should explore how the first focus can improve productivity and liveability versus chickens kept under scavenging production methods without proper housing and feeding.
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APPENDICES

Appendix A: Consent form

TITLE OF RESEARCH PROJECT: DETERMINATION OF THE CHARACTERISTICS, PRODUCTIVITY, AND CONTRIBUTION OF LOCAL CHICKENS TO HOUSEHOLD IN NORTH-CENTRAL NAMIBIA

CONFIDENTIALITY

The ratings and assessments as well as your opinions are viewed as strictly confidential and only members of the research team will have access to the information. No data published in dissertations and journals will contain any information by which you may be identified. Your anonymity is therefore ensured.

WITHDRAWAL CLAUSE

I understand that I may withdraw from the study. I therefore take part voluntarily until I request otherwise.

CONSENT

I, the undersigned, .......................................................... have read the information about the project and have also heard the oral version, and declare that I understand it. I have been allowed to discuss relevant aspects of the project with the project leaders, and by this declare that I agree voluntarily to take part in the project.

I indemnify University of South Africa and any employee or student of University of South Africa against any liability that I may incur during the project. I further undertake to make no claim against University of South Africa about damages to my person or reputation that may be incurred because of the project and trial or through the fault of other participants, unless resulting from negligence by the University of South Africa, its employees or students.

Signature of participant: ...........................................................................

Signed at ........................................ on ........................................... 2014
# Appendix B: Questionnaire

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<th>Region:</th>
<th>Questionnaire no:</th>
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</table>

## PART A: DEMOGRAPHIC

1. **Gender**<br>   a) Male   b) Female

2. **Age**<br>   a) 18-29 years   b) 30-49 years   c) 50-64 years   d) 65 - more years

3. **Marital status**<br>   a) Married   b) never married   c) Separated   d) Divorced   e) Widowed   f) Single

4. **What is your highest education you have completed?**<br>   a) No education training   b) Grade 12 and below   c) Vocational training   d) Others

5. **Are you employed?**<br>   a) Full-time   b) Part-time   c) Not employed   d) Retired   e) Others

6. **Including yourself, how many people live within your household?**<br>   a) One   b) Two   c) Three   d) Four   e) Five & More   f) Others

7. **How many chickens do you keep?**<br>   a) 1 – 10   b) 11 – 20   c) 21 – 30   d) 31 – 40   e) 41 & more

8. **How long have you been keeping chickens?**<br>   a) 5 years   b) 6 – 10 years   c) 11 – 15 years   d) 16 – 20 years   e) 21 and more

9. **Reasons for keeping chickens**<br>   a) Income generation   b) Visitors   c) Custom   d) Home consumption   e) Other reasons

---

## Part B: (Feeding of local chickens)

1. **Do you feed your chickens?**<br>   a) Yes   b) No

2. **How often do you feed your chickens?**<br>   a) Once a day   b) Twice a day   c) Three times a day   d) Once a week   e) No feeding
3. What types of feeds do you give your chickens?

| a) Maize   | b) Self-mix feed | c) Commercial feed | d) Leftover | e) Other |

4. How many kilograms do you feed chickens a day?

| a) <One kg | b) One to two kg | c) two to three kg | d) Calibrated container | e) Unknown amount |

5. How much does it cost you to feed chickens a month?

| a)       | b)       | c)       | d)       | e)       |

6. Among the family who is responsible for feeding chickens?

| a) Women | b) Children and women | c) Men | d) Everyone | e) Other |

**Part C: (Breeding)**

1. Which breeds do you keep? Write breeds names use for cross

| a) Ovambo | b) Venda | c) Naked neck | d) Potch-koekoek | e) Cross | f) Cross |

2. Do you practise breeding?

| a) Yes | b) No |

3. If yes, which type of breeding?

| a) Inbreeding within household | b) Outbreeding indigenous | c) Cross-breed indigenous and exotic | d) Other |

4. Why did you choose the above breeding practice?

| a) Keep pure breed | b) Improving fertility | c) Improving growth (weight) | d) Other |

**Part D: (Housing)**

1. Do you house your chickens?

| a) Yes | b) No |

2. If yes, which type of structure?

| a) Concrete house | b) Metal sheet | c) Old organised materials | d) Traditional house | e) Mobile house |

3. How often do you house your chicken a year?

| a) Once | b) Twice | c) During ploughing | d) Whole year | e) No housing |
4. Which time of the year do you house your chicken?

| a) Summer | b) Autumn | c) Winter | d) Spring |

**Part E: (Disease and mortality)**

1. Have you experienced disease outbreak of your chickens?

| a) Yes | b) No |

2. If yes, which time of the year did disease occurs.

| a) Summer | b) Autumn | c) Winter | d) Spring |

3. Describe symptoms of the disease on following body parts.

| a) Parallel legs | b) Skew neck | c) Helicopter feather | d) Nose discharge and respiratory | e) Diarrhoea |

4. When your chickens are sick what type (s) of medicine (s) do you give them?

| a) Antibiotic | b) Vaccine | c) Traditional herbs | d) No treatment | e) Other |

5. Where do you get your medicine and how?

| a) Buy from co-op | b) Buy from pharmacy | c) Buy from manufacture | d) Other |

6. At what age are your flock dies most?

| a) Young age - Zero to 6 weeks | b) Growing stage - Seven to twelve | c) Middle stage - Fifteen to twenty-eight | d) Adult - Twenty-eight and above |

**Part F: (Consumption and marketing of eggs and chickens)**

1. How often do you slaughter your chicken and for what purpose?

| a) Weekly | b) Monthly | c) Visitors present | d) Once in 3 months | e) Once in 6 months |

2. How many chickens do you slaughter for family? Write number on blocks.

| a) Weekly | b) Monthly | c) Yearly | d) Other |

3. How is your target market for chickens you sell?

| a) Pensioners days | b) Community | c) Hawkers | d) Other farmers | e) Shops |

4. How often do you sell your chickens?

| a) Daily at home | b) Once in 3 months | c) Once in 6 months | d) Once a year | e) Any time |

5. In which form do you sell your chickens?
<table>
<thead>
<tr>
<th></th>
<th>a) One</th>
<th>b) Flock of ten</th>
<th>c) No selling</th>
<th>d) Other</th>
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</thead>
<tbody>
<tr>
<td>6 Do you sell eggs?</td>
<td>a) Yes</td>
<td>b) No</td>
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<tr>
<td>7 If yes, how do you packed your eggs?</td>
<td>a) 18 Eggs tray</td>
<td>b) Half-dozen and Dozen box</td>
<td>c) Thirty eggs tray</td>
<td>d) Sixty eggs</td>
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<tr>
<td>8 How many eggs do you sell a year?</td>
<td>a) One to five dozen</td>
<td>b) Six to ten dozen</td>
<td>c) Eleven to fifteen dozen</td>
<td>d) Fifteen and more</td>
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<tr>
<td>9 What do you do with money generated from sales?</td>
<td>a) Buy family food and transport</td>
<td>b) School fees and transport</td>
<td>c) Buy chicken food</td>
<td>d) Pay debts</td>
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</table>
## Appendix C: Form for physical characteristics assessment

Region: ................................................................. House No: ............

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<thead>
<tr>
<th>No &amp; Breed</th>
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<td><strong>Comb type</strong></td>
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<td>S/ P/ R/ W/ C/ St/D/ Dob/ other</td>
<td>S/ P/ R/ W/ C/ St/D/ Dob/ other</td>
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<td>W / Bl / B / R / Wh / Br / C / other</td>
<td>W / Bl / B / R / Wh / Br / C / other</td>
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<td>N / F / S</td>
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<td>Feather distribution</td>
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<td>Ear lobe colour</td>
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<td>Wing span</td>
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<td>Egg weight (g)</td>
<td>Egg height (mm)</td>
<td>Egg width (mm)</td>
<td>Egg shape index</td>
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<td>Other features</td>
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**DEFINITION OF TERMS**

Comb type:  
S = Single; P = Pea; R = Rose; W = Walnut; C = Cushion; St = Strawberry; D = Duplex; V = V-shaped; Dob = Double.

Comb size:  
S = Small; M = Medium; L = Large.

Shank colour:  
W = White; Y = Yellow; B = Black; G = Green; Bl = Blue; Br = Brown; L = Lead.

Feather colour:  
W = White; Bl = Blue; B = Black; R = Red; Wh = Wheaten; Br = Brown; C = Combination.

Feather morphology:  
N = Normal; F = Frizzle; S = Silky.

Feather distribution:  
N = Normal; Nn = naked neck; Fs&f = Feathered shank & feet; M & B = Muffs & Beard; C = Crest; Vh = Vulture hocks.

Ear lobe colour:  
W = White (not pigmented); R = Red; W&R = White & Red.
## Appendix D: Field production form

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<th>Egg eat by predators</th>
<th>Egg for Family</th>
<th>Egg placed brooding</th>
<th>No hens</th>
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<th>No Slaughter</th>
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