UNIVERSITY OF EDUCATION, WINNEBA

PHENOTYPIC CHARACTERIZATION OF INDIGENOUS TURKEYS (*Meleagris gallopavo*) IN THE ASHANTI, AHAFO, BONO AND BONO EAST REGION OF GHANA

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A THESIS IN THE DEPARTMENT OF ANIMAL SCIENCE EDUCATION, FACULTY OF AGRICULTURE EDUCATION, SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF PHILOSOPHY

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FEBRUARY, 2023

DECLARATION

STUDENT'S DECLARATION

I, DANIEL OKO LARYEA, declare that this dissertation, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: …………………………………………

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SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of the research work was supervised in accordance with the guidelines on supervision of long essay, laid down by the University of Education, Winneba,

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DATE: ………………………...

DEDICATION

This work is dedicated to my caring mother Mavis Quartey and father Paul Oblie Laryea their love, financial, assistance and care throughout my education.

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I wish to express my profound gratitude to the Almighty God for His endless mercy, guidance and protection throughout the course. I am also grateful to Dr. Duodu Addison, who ingeniously and indefatigably supervised this work by offering me with valuable guidance and constructive criticisms. His directives, corrections and treasured suggestions were timely and supportive during the write-up.

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ACRONYMS/ABBREVIATIONS

ACRONYM		MEANING
AFLPs	-	Amplified Fragment Length Polymorphisms
AnGR	-	Animal Genetic Resources
BC	-	Before Christ
DNA	-	Deoxyribonucleic Acid
FAnGR	-	Farm Animal Genetic Resources
FAO	-	Food and Agricultural Organisation
GLM	-	General Linear Model
ILRI	-	International Livestock Research Institute
LTD	-	Limited
MOH	-	Ministry of Health
ML	-	Micro Livestock
NAFIS	-	National Farmers Information Service
RAPDs	-	Random Amplified Polymorphic
RFLPs	-	Restriction Fragment Length Polymorphisms
US	-	United States

ABSTRACT

Two experiments were conducted in this study. In Experiment one, a study was conducted in Ashanti, Ahafo, Bono East and Bono region with the aim of generating information on village-based Turkey utilization, management practices, opportunities, and challenges, to identify, characterize and describe the phenotypic variation of indigenous Turkey populations. Questionnaires and interviews were used for the study. Twenty-four towns/villages (6 from each region) were sampled at random and 154 Turkey farmers were randomly selected from these towns/village. Descriptive statistics such as mean, range, frequency and percentage was used to analyse the data from the survey. The results of this study showed that the majority of the respondents were females (79 %). This showed that most of the time the women, either in male-headed or female-headed family circles are responsible for poultry rearing, while the men are responsible for crop cultivation and other off-farm activities. Majority (92 %) of the respondents gave supplementary feed to their Turkeys. Night shelter was provided by almost all farmers in a separate shed purpose-made for Turkeys (51 %). Majority of the farmers provided shelter for their Turkeys. Experiment two was conducted to assess the effects of variety, region, and sex on body measurements and phenotypic correlations between various body measurements were estimated. Three hundred indigenous Turkeys from the Ashanti, Ahafo, and Bono and Bono East region of Ghana were randomly sampled. The average age for Turkeys used in this study was 6-7 months old. Colour varieties Frequencies were computed. Five colour varieties were identified: White, Bronze, Black, Black, White and Buff. The largest representation was the Black colour variety (39 %). The least represented were the Buff (6 %) and Bronze (7 %). The overall mean body weights for the five colour varieties were: White (4.792±0.201 kg), Black (4.744±0.112 kg), Bronze (4.783±0.284 kg), Black & white (4.547±0.113) and Buff (5.059±0.292 kg). Turkeys from the Bono East region had much higher body weights than Turkeys from Ashanti, Bono and Ahafo regions. Cases of genotype-environment interaction were observed. The effect of Sex and Region was a highly significant ($p<0.05$) source of variation for most of the traits. There were positive moderate to high correlation between the various body measurements. The highest correlation ($P <0.05$) with body weight, ranging from 0.69 for head length to 0.96 for the wing length. Turkey production is a profitable and promising venture based on cash generated after sale of the Turkeys. In conclusion, despite the factors limiting Turkey production as outlined by the respondents, turkey production has great potential in bridging the animal protein supply therefore, poultry farmers should be encouraged by government to increase their level of production by establishing reliable breeding centres in the Ashanti, Ahafo, Bono and Bono East Region which will ensure regular supply of day old poult, prompt disease control by employing of more veterinarians and provide soft loans to farmers.

Keywords: Indigenous, Potential, Turkey, Production,

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Poultry production has witnessed fast changes since 1940 when contemporary intensive production systems were introduced together with new breeds, preventive health measures and improved biosecurity (Permin and Pedersen, 2000; Djebbi *et al*., 2014). By far, poultry is now the foremost livestock species worldwide (FAO, 2011), accounting for more than 30% of all animal protein. Poultry is high capital, high ration and labour intensive. They are also "family sized": easily killed and dressed, with little waste or spoilage (Kinsella, 2012). Native poultry in Africa are resilient in general, adaptive to rural settings, survive on little or no inputs and adjust to variations in feed availability. Chickens mostly dominate flock composition and constitute about 98 % (Gueye, 2003; Mengesha, 2013) of the overall poultry numbers kept in Africa.

The subdued Turkey which advanced from North American, is reared all over the world especially in Southwestern and Eastern United State and central/northern Mexico (Thornton *et al*., 2012) where its wild ancestor descends. The current domesticated Turkey has been developed by crossbreeding and line breeding programs and mostly characterized by a single breed with 8 distinct varieties based on the plumage colour (McMichen, 2017). Eight (8) diverse varieties of *M. gallopavo* as Royal Palm, Bronze, Slate, Narragansett, Bourbon Red, Black, White Holland and Beltsville Small White has been documented by American Standard of Perfection (American Poultry Association, 2001).

In Ghana, breeding Turkey (*Meleagris gallopavo*) is managed in either industrial or traditional mode. The industrial system of farming is built on well-controlled settings.

Traditional Turkey keeping is practiced by virtually every family in rural Ghana in general, and in the Middle-belt sectors in particular since they provide protein for the rural populace, produce employment and generate family income (MOH, 2010). In their natural habitat of Central America and Mexico the “unaltered” Turkeys are habitually fashioned as a cash crop for market. They obtain slight care or feed, and thus they are almost all profit. Also providing a substantial income to complement numerous rural homes (Kinsella, 2012).

Tamed Turkeys pace relatively than fly, and find nearly all their nutrition on the ground. They can, however, fly short distances to avoid predators. The Turkeys in the commercialized sector have lost several abilities for survival in the wild; they can no longer exist without human maintenance. However, village types can do well with little management (Kinsella, 2012). The decline in the production of Turkeys is normally due to the sensitivity of this animal to infectious diseases and the strain to cope with an unfavourable environment (Marchewka *et al*., 2013) and also due to their low reproductive performance (Zahraddeen *et al*., 2011). The village poultry production in general and the gradual performance improvement of Turkeys in particular can contribute to economic development.

1.2 Problem Statement

Animal Genetic Resource (AnGR) is of enormous importance to every nation since they act as an important source of employment, income and food (Mogre, 2010). Some of the indigenous Animal Genetic Resource includes pigs, grasscutters, rabbits, equines, cattle, small ruminants and poultry (Mogre, 2010). Ghana's upsurge in population has led to an augmented urge for meat (Osei *et al.*, 2012). This has necessitated the need for producers to often import improved AnGR (Mogre, 2010). In most developing countries, the demand for improved breeds has led to indiscriminate crossing leading to dilution or loss of the adapted breeds (Boulet, 1999; Serem, 2014). This strategy has led to undiscovered genes being lost forever. Genetic depletion of local animal variety has placed 20 percent of the world's breeds at risk of extermination (FAO, 2011). This feat has lessened the use of local breeds and positioned their subsistence in peril (Rexhaj *et al*., 2018), which is also the challenge among Ghanaian breeds and Turkey is no exception. To overcome the problem of breed annihilation and contain the loss of important undiscovered genes, conservation and sustainable development of Farm Animal Genetic Resources (FAnGR) relying on the several varieties that live well in the low external input agriculture typical of developing countries is suggested (FAO, 2012). The Food and Agricultural Organization (FAO, 2007) of the United Nations suggested creating conversation programmes for the preservation of animal genetic resources. Prominent amongst these agenda embrace the characterization of these home-grown breeds.

Turkey is gaining much consideration in Ghana (FAO, 2006). Most of the nation's conventional livestock comes from the Ashanti, Brong Ahafo and Upper West Region (MOFA, 2000). The resourceful and overall ability to take care of themselves makes it a choice of animal for cold dry or hot climates and feed farther than chickens. They are also large, fast growing, highly marketable, low in fat, and tasty (Kinsella, 2012). In operations in peri-urban areas, wheat bran may also be given. Generally, however these birds fend for themselves (FAO, 2006). Thus, the indigenous Ghanaian Turkey is one of the AnGR in Ghana that requires much attention and improvement towards increase in production. To some extent numerous works have been done on Turkeys in Ghana including Characterization. FAO (2011) reported that Turkeys in Ghana generally exhibited various feather colours including bronze, white/black, black and red/buff as a whole or in combination. It was also noted that the red/buff, white and bronze breeds were popular due to high feed to meat conversion rate. Few or none of similar studies has been done in the middle-belt regions including characterization.

Characterization of AnGR incorporates all activities linked with the identification, documentation of breed populations, quantifiable and qualitative description, accepted habitat and production system to which they are or are not adapted (Rege and Okeye, 2006). Characterization of animals' variety is the first method to a sustainable use of its animal genetic resources (Mbelayim, 2015). The goal is to obtain better understanding of AnGR, their contemporary and potential future uses for nourishment and agriculture in a well-defined environment and their present state as distinct breed populations (Mbelayim, 2015). The initial step of characterization of local genetic resources is established on knowledge of variation in the morphological traits (Delgado *et al.,* 2001; Dekhili, 2014). Morphometric dimension on characters have been used to evaluate the characteristics of numerous breeds of animal for selection decisions (Ogah, 2011; Annor *et al*., 2012; Djebbi *et al*., 2014).

The Global Plan for Action (GPA) for AnGR stipulates in its strategic Priority Area 1 that conservation, sustainable use and development programs must begin with characterization and record of local animal population and recommends the development of technical standards and guidelines for such arrangements (Au-IBAR, 2015).

The village poultry and the measured improvement of Turkey performance can contribute to economic development (Djebbi *et al*., 2014). Unfortunately, in Ghana, research on local Turkey is very limited. Indeed, few studies have been done on local poultry in Ghana (Hagan *et al*., 2012; Osei-Amponsah *et al.*, 2013; Brown *et al.*, 2017). Nevertheless, little or no study has been done on the home-grown Turkeys in Ghana and hereafter requires a study to be steered to phenotypically characterize the native Turkey breeds in Ghana. The data provided through the characterization process empowers a range of interest groups, national governments, including farmers and as well as world-wide bodies to make well-versed decisions on priorities for the management of AnGR (Au-IBAR, 2015)

1.3 Main Objective of the Study

The goal of this project was to partially characterize the indigenous Ghanaian Turkey resources.

1.3.1 The specific objective of the project were

1. To carry out a systematic survey in order to generate information on village based Turkey utilization, management practices, opportunities and challenges.
2. To estimate the frequency and describe morphological features of some selected descriptive traits of Turkey in Middle-belt (Ashanti, Ahafo, Bono and Bono East region) of Ghana.

3. To investigate the effect of breed, colour variety, region and sex on morphometric traits of Turkeys.
4. To estimate phenotypic correlations between selected morphometric traits.

1.4 Significance of the Study

The project would lead to a better understanding of biological characteristics and comparative performance of Turkeys in Ghana. The information generated can be used to formulate policies that would lead to a better and sustainable use of Turkey genetic resources. The result can be used by animal breeders to develop breeding strategies to produce fast growing animals. The information would also become Ghana's contribution to the AnGR component of the global biodiversity inventory.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Origin and Distribution of Turkey

The Turkey (*Meleagris gallopavo*) is well-known in Europe and native to North America. The Turkey was domesticated by Indians about 400 BC, and today's Mexican birds seem to be direct descendants (Kinsella, 2012). Wild Turkey populations dipped to their lowest numbers between the end of the 19th century and the 1930s, surviving only in the most inaccessible habitats (Kilburg *et al.,* 2015)

There are two theories for the derivation of the name Turkey, one theory is that when Europeans first encountered Turkeys in America, they incorrectly identified the birds as a type of Guinea fowl which were already being imported into Europe by Turkey merchant and were therefore nicknamed "Turkey coqs". The name of the bird consequently became Turkey fowl which was later shortened to just Turkeys (Kilburg *et al.,* 2015). A subsequent postulation arises from Turkeys coming to England not unswervingly from the Americas, but through merchant ships from the Middle East, where they were tamed effectively. Once more, the importers conferred the name to the bird; Middle Eastern traders were termed Turkey merchants as most of that zone was part of the Ottoman Empire. Hereafter the name Turkey-cocks and Turkey-hens, and soon subsequently, Turkeys (Kilburg *et al.,* 2014).

The game type of bird and belong to the scientific bird family *Phasianidae.* While the other wild Turkey only has one close relative, the ocellated Turkey (*Meleagris ocellata*) are distant cousins to other game birds, including pheasants, quail, grouse and partridges. Today, five distinct subspecies have evolved, all of which have slightly different plumages and ranges (Dickson, 1992). The five subspecies - Eastern, Osceola, Meriam, Gould and Rio Grande. Their territories range from most of North America (Eastern wild Turkey) to extremely regional (Osceola and Gould wild Turkey) (Buchanan, 2020). Turkeys were initially selectively bred for traits such as feather, colour and pattern, but were later bred for meat production, body conformation and white feathering, resulting in most commercial domestic Turkey being white feathered by the 1960s (Erasmus, 2017). Commercial Turkey breeding showed a dynamic growth since 1970s with the main production goal being Turkey meat (Bir, 2020). The Turkey is considered as one of the two most economically vital poultry types with a genome very comparable to that of the chicken. The locus proteome for *Meleagris gallopavo* is derivative from the gathering of the tamed Turkey genome issued in 2001. The genome size is about 1.1 GB and comprises of 33 chromosomes (Dickson, 1992).

2.2 Taxonomy of Turkey

Every documented species on earth is given a two-part scientific name. This arrangement is termed "binomial nomenclature." These names are vital because they license people all over the world to communicate unmistakeably on animal species. The idea of scientific Naming/Classification was first coined by Linnaeus (1735). He classified living organisms using different levels. The idea was to create two names for the organism, the genus and the species. Thus, a general and a specific name. The Turkey belongs the genus *Meleagris*, and species *Gallopavo*.

The detailed biological Classification has been presented by Linnaeus (1758)

Kingdom	Animalia
Phylum	Chordata
Class	Aves
Order	Galliformes
Family	Phasianidae
Subfamily	Meleagridinae
Genus	Meleagris

2.3 Overview of Poultry Production in Ghana

The word poultry refers to all domesticated birds that are reared for the production of meat and eggs for human consumption as well as for commercial profits. It includes chickens, Turkeys, ducks, geese, quails, Guinea fowls and other domesticated birds (Khobondo, 2015). The local chickens remains the predominant type despite the introduction of exotic and crossbred chickens because, farmers have not been able to afford the high input requirement of introduced strains. In most emerging countries, village poultry makes up the major percentage of the general poultry meat egg production (Akilu, 2017). The traditional poultry production system is characterized by small flock sizes, low input and output and periodic devastation of the flock by diseases such as Avian Influenza (Bird Flu), Newcastle disease, Infectious Bursal Disease (Gumboro), Coccidiosis, Avian Pox, and Aspergillosis (Atuahene *et al.*, 2012). There is no separate poultry house and the Turkeys live in family dwellings together with the human population. There is no planned feeding of Turkey and scavenging is almost the only source of diet. There is no planned breeding and it is by natural incubation and brooding that chicks/poult are hatched and raised all over rural Ghana. A broody hen hatching, rearing and protecting few chicks (6-

8) ceases egg laying during the entire incubation and brooding periods of 81 days (Solomon, 2012).

Moreover, the rearing of poultry is one of the most appropriate activities for rural women and for farmers with marginal revenue for whom it provides an income. It also generates employment opportunities for the poor and at the same time increases the overall supply of high-quality animal protein to the community (Thornton, 2010). This is particularly true in Ghana because there are few alternative animal protein sources available to the population, and little cultural or religious taboos of any kind relating to the consumption of eggs and poultry meat, in contrast to pig meat. Furthermore, poultry are the only affordable animals to be slaughtered for consumption for the resource-poor farmers (Thornton, 2010).

2.4 Large Scale and Commercial Production System

Modern poultry production started in Ghana about 60 years ago, mainly in colleges and on research stations. The actions of these organisations primarily focused on the introduction of exotic strains to the country and the distribution of these breeds to farmers, including management, feeding, housing and health care packages. The poultry research projects conducted during those early years was exploratory and dealt with the appraisal of the country's poultry population (indigenous chicks), breeds, utility and their productivity. Three breeds of local Turkey were found in Ghana. White, Bronze and Buff (FAO, 2006). The California white are normally imported from the United States. Trials and experimental activities in the area of poultry housing, feeding, brooding, management and disease and parasite control were initiated soon after importation. The activities of the experimental stations were further strengthened with the establishment of modern poultry farms starting in 2000 (FAO, 2006). All of which were involved in the distribution of exotic genotype to urban poultry producers (Sisay, 2017). This would seem to be a positive trend in increasing the supply of animal protein for the Ghanaian people, whose primary source of protein is of plant origin, because poultry are efficient converters of by-products and grains into eggs and meat, and have a fast turnover percentage and rapid growth capacity (Tadele *et al.,* 2003). There is also an emerging small scale intensive system in urban and peri-urban areas, under this system of production; a small number of exotic breeds of Turkeys (50-1,000) are produced along commercial lines using relatively modern management systems. This activity is being undertaken as a source of income in and around major cities and towns such as Greater Accra, Ashanti, Bono, and Ahafo Region. Most of these farms obtain their feeds and foundation stocks from Akate farm and trading company and Darko Farms occasionally from nearby government owned breeding and multiplication centres. They are also involved in the production and supply of table eggs to various supermarkets kiosks and small roadside restaurants through middlemen (Solomon, 2012).

Turkey production can be a profitable enterprise when the major risk factors like disease and predators are controlled through vaccinations and night-time shelter. With these elements in place, commercial firms can make a living out of Turkeys. The output differences between the backyard system using local scavenging hens and the commercial sector which uses exotic breeds in confinement is astounding. Chris *et al.,* (2016) reported 17 eggs per nest (i.e., almost constant laying). Thus, for those with the capital to finance feed, housing and health inputs, the resulting output could be profitable.

2.4.1 Challenges and opportunities of Turkey production

Indigenous turkeys provide major opportunities for increased protein production and income for smallholders (Gwala, 2014). Turkeys also play a complementary role in relation to other livestock venture. Indigenous Turkey are good scavengers as well as foragers and have high levels of disease tolerance, possess good maternal qualities and are adapted to harsh conditions and poor-quality feeds as compared to the exotic varieties (Tanya *et al*., 2016). In some communities, village Turkeys are important in breaking the vicious cycle of poverty, malnutrition and disease (Ogah, 2011).

In Ghana, however, lack of knowledge about poultry production, limitation of feed resources, prevalence of diseases (Newcastle, Coccidiosis, etc.) as well as institutional and socio-economic constraints (Ashenafi *et al*., 2004) remains the major challenges in village-based poultry productions. Adene (1996) has also reported that Newcastle disease (ND), Infectious Bursal disease (IBD) or Gumboro, Marek disease (MD), Fowl typhoid, Cholera, Mycoplasmosis and Coccidiosis are major diseases that have been predominantly identified in commercial poultry in most African countries. Chaheuf (1990) argued that the most devastating disease in village chickens in Cameroon is ND, whereas in commercial poultry, Coccidiosis, MD and IBD are more prevalent. Research work in Mauritania (Bell *et al*., 1990), Burkina Faso (Bourzat & Saunders, 1990), Benin (Chrysostome *et al*., 1995) and Tanzania (Yongolo, 1996) supports the argument that ND is the most devastating disease threatening village chickens. This forced the owners to sell and purchase chickens with the lowest and highest prices during the beginning of the rainy and dry seasons, respectively.

2.5 Non-Genetic Factors

2.5.1 Non-genetic factors affecting animals

Non-genetic factors are measurable environmental effects that affect animal performance (Annor, 2011; Mbelayim, 2015). They include sex, age, litter size, parity, season of mating and of birth, and year of birth (Annor, 2011; Mbelayim, 2015). In choosing animals to be parents of the next generation, comparison should be made between contemporary groups of animals. Consequently, to improve the rate at which genetic gains can be made, measured performance of an animal with regards to a particular trait should be adjusted for various known environmental or non-genetic factors which disguise or mask the genetic expression of that trait (Beffa *et al.*, 2009; Mbelayim, 2015). A kid reared in a litter size of five is likely to be fairly lighter in weight than its equivalent that has been born and reared as a single. If the goal of the breeding programme is to improve pre-weaning growth rate, the kid from a litter of five has received an unfair handicap which has nothing to do with its genetic ability to grow. The effect of non-genetic factors on the performance of domestic livestock is very well documented in traditional livestock species reared in both temperate and tropical environments (Annor, 2011; Mbelayim, 2015).

A summary of all these studies according to Annor (2011) indicate the following:

Herd-year-season: Animals in different herds perform differently because they are given different treatment. Animal performance varies with years due to differences in climatic variables in different years. The performances of animals in dry and rainy seasons are different. In the rainy season, there is adequate amount of grass, which is also of good quality, compared to what is obtained in the dry season. However, there are many diseases and pests that attack animals in the rainy season.

Sex of animal: Males tend to be bigger and also grow faster than females.

Litter size: Animals in small litter grow faster than those in large litter.

Birth rank: Birth rank refers to the order of giving birth to individuals in a litter. In multiple births, animals born first are heavier and grow faster than those born last.

Parity of dam: Females giving birth for the first time, produce smaller litter that has low weights and growth rates than older females.

Dam age: Dam age is related to parity but it is a different factor altogether. Young dams produce offspring with smaller weights and growth rates than older dams.

2.5.2 Effects of non-genetic factors on Turkey

The environment of an animal consists of all those factors which influence it in any way but which are not inherited (Mbelayim, 2015). The major group of environmental factors includes diet, housing, management and contact with disease, but there are many others. All factors that cause worry in any manner are part of the environment of the animal. Maintenance of high bird densities per unit of space is a common practice in intensive Turkey production systems. Although literature for Turkeys is scarce, the abundant references on the effects of density in broilers (Estevez, 2007) shows the important behavioural and performance changes that may occur when increasing density, especially when environmental control is not matched to maintain the increased number of animals needed (Dawkins *et al.*, 2004; Mbelayim, 2015). This situation may lead to more or less severe performance problems. This was similar to the findings for other density studies conducted in broilers (Ventura *et al*., 2012). Turkey poults at 6-12 weeks fed with pellets spent less time feeding compared with their behaviour at the younger age of 1 to 5 week, when fed with crumbs (Hughes and Grigor, 1996). On the contrary, Hale and Schein (1962) found that 12-wk-old pellet-fed birds spent more time feeding; less time drinking, preening, and resting; and had higher engagement in other behaviours compared with mash-fed ones. The main differences between these results may relate to genetic factors due to 30-yr difference between them, the age of the birds, and how the feed was presented.

2.5.3 Estimation of non-genetic factors

Statistical models are normally used for estimating non-genetic effects or factors (Mpofu *et al*., 2006). Environmental factors are either discrete (e.g. litter size and parity) or continuous (e.g. birth weight, weaning weight and heart girth) Discrete and continuous variables are known as quantitative variables. These variables are quantitative but others like feather colour, shank colour and beak colour are qualitative because such variables cannot be measured objectively but may be measured subjectively in descriptive terms (Steel and Torrie, 1980). Statistical models used in breeding are linear models, with the set of factors being assumed to be additively affect the observations. However, more recently, non-linear models are being used to evaluate traits that exhibits categorical phenotypes and covariance functions are used in the analysis of longitudinal or repeated data (e.g. litter size) (Mbelayim, 2015).

Some fixed effect influence data but are of little interest to the investigator. Data are corrected for them and no explicit estimates are obtained for such factors e.g. age of poults at weaning. However, there are some effects (e.g. season of birth and season of mating) whose estimates may be of interest. Traditionally, effects have to be estimated first and the adjustment or correction factors obtained and used to correct the data before analysing the data and making comparison (Willis, 1991). When the effects have been estimated and parameters obtained, hypothesis can be tested to find out whether or not the factors included in the model account for significant variation in the trait measured. There are several statistical packages for analysing non-genetic effects of traits. These include SAS, GenStat and Minitab.

2.6 Characterization and Conservation of Turkey Genetic Resources

The Food and Agriculture Organization (FAO) of the United Nations has recommended an incorporated programme for the global management of animal genetic resources (Project MoDAD, http:// www.fao.org/dad_is) on an international level (Bekerie, 2015). Furthermore, a communication and information system called the Domestic Animal Diversity Information System (DAD-IS) is being developed by FAO, with the main objective to assist countries by providing extensive reliable databases and guidelines for better characterization, utilization and conservation of animal genetic resources. Such programmes are important because the AnGR have been faced with genetic dilution due to foreign or exotic germplasm use, changes in markets preferences, production systems, natural catastrophes, environments and unstable policies from public and private sectors and the availability of very limited funds for conservation activities (Rege & Gibson, 2003; FAO, 2007). Characterization embraces a clear definition of the genetic attributes of an animal species or breed, which has a distinctive genetic environment and uniqueness to which species populations are adapted or known to be partly or not revised altogether (Mogesse, 2007). It should also include the population size of the animal genetic resources, population trends, its physical description, prevalent breeding systems, uses, adaptations, predominant production systems, description of the environment in which it is predominantly found, indications of performance levels (meat, growth, reproduction, egg) and the genetic distinctiveness of the animal (Weigend & Romanov, 2002; Mogesse, 2007).

The countryside poultry population in almost all African countries accounts for more than 60 percent of the over-all national poultry population (Mogesse, 2007; Akinola *et al.,* 2011). However, inadequate attention has been given to evaluating these resources or to setting up realistic and optimum breeding goals for their improvement (Mogesse, 2007). As a consequence, some of the animal genetic resources of Africa are endangered, and except urgent attempts are taken to identify and conserve, they may be lost even before they are described and documented (Mogesse, 2007). Worldwide, over 6379 documented breed populations of some 30 species of livestock have been developed in the 12,000 years since the first livestock types were tamed (FAO, 2011). The majority of livestock genetic diversity is found in the developing world where documentation is scarce and risk of extinction is highest and increasing. More particularly, it is estimated that 35 % of mammalian breeds and 63 % of avian breeds are at risk of extinction, and that two breeds are lost every week (FAO, 2011).

The current breeding strategies for commercial poultry concentrate on specialized production lines, derived by intense selection from a few breeds and very large populations with a great genetic uniformity of traits under selection (Mogesse, 2007). However, there are numerous local poultry that are characterized by medium or low performance and maintained in small populations (Mogesse, 2007). These local poultry face genetic erosion which may lead to the loss of valuable genetic variability in specific characteristics. The local breeds have genes and alleles pertinent to their adaptation to a particular environments and local breeding goals (Romanov *et al*., 1996; Mogesse, 2007).

Ghana is endowed with varied ecological zones and possesses diverse animal genetic resources. The waves of trade and physical movement of people and animals have influenced the genetic make-up of domestic resources, including poultry (Mogesse, 2007). These indigenous animal populations are usually named either after the area they occupy or ethnic group or clans keeping them (www.telecom.net.et).

Characterization, conservation and use of indigenous animal resources under low levels of input in the tropics are usually more productive than is the case with exotic breeds. The locally adapted animals are also more readily available to resource-poor farmers and they can be productive without high disease-control inputs (Mogesse, 2007). Yet, lack of information about the genetic resources presents in the indigenous farm animals in developing countries has led to their underutilization, replacement and dilution through cross-breeding. Hence, characterization, conservation, utilization and of these indigenous genetic resources are of paramount importance.

2.6.1 Methods of breed characterization

Basically, there are three approaches that can be used to characterize livestock breeds. These include on-station studies, on-farm surveys and molecular laboratory analyses of samples collected on-farm or on-station (FAO, 1998). Annor (2011) has given a detailed discussion of the three methods. A controlled environmental study carried out at a research station or a nucleus breeding station is known as an on-station study. On-farm surveys can be useful for collecting basic information on production systems, population statistics, physical or morphological characteristics and performance characteristics stock. Nonetheless, a more reliable compilation of data on characterization of livestock breeds can only be obtained from more detail on-station studies (FAO, 2012). Such studies may involve whole herd/flock as basic experimental units and require collection of data over relatively long period of time. Information such as livestock performance data, estimates of herd/flock structures and population trends essential for assessing rates of decline and identifying causes of such declines can be collected using on-station studies (Mbelayim, 2015).

The advantage of on-station breed characterization (and evaluation) is that the controlled experimental conditions ensure a high precision. Special adaptive attributes, which are difficult to measure at field level (on-farm), are also generally best studied on-station. The high precision to which on-station studies can be undertaken, as has been stated, makes them appealing for breed evaluation despite the fact that they are less accurate as indicators of performance in fanners' herds/flocks (Mbelayim, 2015). According to Rege and Okeyo (2006), indeed, in the presence of genotype x environment interaction, conclusions drawn from on-station characterization could be misleading.

An on-farm study is the type of research carried out at the local site belonging to the fanner or farming community. An on-farm breed survey is organized to collect data on breed phenotypic characteristic, main uses and management of livestock in order to understand the reasons for the distribution and persistence of particular breeds (Mwacharo and Rege, 2002; Zerabruk and Vangen, 2005; Al-Amin *et al.*, 2007). It can also be designed to collect socio-cultural and indigenous knowledge data, which may be of value in understanding farmers' strategies for keeping specific breeds. Where breeds are known to occur in small numbers, a survey to gather this information may need to focus on the areas where they are. Molecular biotechnology is the use of molecular markers to quantify genetic diversity and relationships between and within livestock breeds, to investigate biological processes (mating systems) or to identify specific genotypes (Ruane & Sonnino, 2007; Mbelayim, 2015). Hetzel and Drinkwater (1992) stated that DNA techniques can be used to analyse the phylogeny of breed divergence, to follow gene segregation within populations, and to associate nucleotide variation with changes in gene function and expression of animal phenotype. Techniques for the analysis of variability are essential ingredients for animal conservation. Mbelayim (2015) defined molecular markers as biomolecules (proteins, carbohydrates and DNA), whose heritable traits can be assayed for variation in organism or populations. Molecular markers can be thought of as constant landmarks in the genome of animals that give clues to identification of genes. They are identifiable DNA sequences, found at specific locations of genome, and transmitted by standard laws of inheritance from one generation to the next.

Molecular markers can be used to estimate:

- structures in distribution of variation and inbreeding relationship within and among populations
- kinship and relationship among individuals in a population
- the extent of genetic variability within and among populations
- population history of animals

During the last two decades several DNA markers such as SNP, CAPS, SSR RAPD, AFLP, HA, RFLP and microsatellites have been developed and utilized in genetic diversity analysis (Mondal, 2016). It must be noted that molecular characterization on its own is not adequate; characterization must be presented and undertaken in a broader context of utilization. Molecular characterization, therefore requires, a comprehensive integrated approach with continued emphasis on phenotypic recording programs to enable gene detection, estimation and confirmation of effects, and use of estimates in selection (Ruane and Sonnino, 2007; Mbelayim, 2015).

2.7 Phenotypic Characteristics of Turkey

2.7.1 Breeds characteristics and colour varieties of Turkey

The term 'breed' can be used in a number of different ways but in the birds it is a group of animals, or populations which resemble each other (Mbelayim, 2015).

The term “breed” is also used in phenotypic characterization to identify distinct AnGR populations as units of reference and measurement (FAO, 2012). Seven standard varieties, popularly are recognized (Marsden, 1971). These seven varieties are Bronze, White Holland, Bourbon Red, Narragansett, Black, Slate and Beltsville small White. Including wild Turkeys there are perhaps a dozen nonstandard varieties, chief of which are the Broad Breasted Bronze and the Broad Breasted Large White. All white varieties and strains have white plumage, which frequently contains specks of grey or black pigment. Less frequently, whole feathers or sizeable parts of feathers may be off-coloured. Eyes are medium to dark brown; shanks, feet, and beak are white to pinkish white. Normal mature males of all varieties of Turkeys have a conspicuous black beard attached to the skin of the upper breast region. White females occasionally have small beards but beards are rare in females of coloured varieties. They originated as mutations, or sports, in coloured flocks and such mutations still occur. Their white colour is due to a recessive autosomal gene that prevents almost completely the appearance of any pigmentation in the plumage, shanks, feet, and beak.

White-feathered Turkeys have more feathers than coloured Turkeys and are difficult to dry pick. However, with modern scald-pick methods, white Turkey varieties can be picked as easily as coloured varieties and have the advantage that any pinfeathers present are inconspicuous and do not lower the market grade as they do in the coloured varieties (Marsden, 1971).

Table 2.1: ***Turkey Distribution in Ghana***

REGION	**POPULATION**
Ashanti Region	17,952
Greater Accra Region	2,362
Brong Ahafo Region	47,790
Western Region	7,608
Eastern Region	9,302
Northern Region	7,426
Volta Region	19379
Central Region	972
Upper West Region	3,552
Upper East Region	14,352

Source: Veterinary Services Directorate (2010)

Table 2.2: ***Turkey Breeds in Ghana***

VARIETY	**PERCENTAGES**
White	-
Bronze	-
Buff	-
California White	-

Source: FAO (2014).

2.7.1.1 Description of some Breeds of Turkey

a. Beltsville Small White

The Beltsville Small White is a small bird, with young toms weighing an average of 7.7 kg and young hens weighing an average of 4.5 kg. Male weighs 9.5 kg at 34 weeks of age; female, 5.2 kg. The bird has white plumage and a red to bullish-white head. Additionally, Beltsville Small White Turkey (Plate 2.1) have a black beard, dark brown eyes, horn-coloured beaks and pinkish- white toes and shanks.

Plate 2.1: Beltsville Small White Turkey. Source (OSUBR, 2015)

b. Bourbon

The bourbon (Plate 2.2) has light grey coloured beak, red to blueish wattles, black beard and pink legs toes. The body has not been standardized for meat production since the 1900's. The tom should weigh 6.3 kg. The Bourbon Turkey is active and is great for ornamental uses as well as breeding.it is considered a handsome fowl and great for backyard keeping. They lay potted cream and brown eggs. The eggs are considered large

Plate 2.2: Bourbon Turkey. Source (OSUBR, 2015)

c. **Slate**

The Slate (Plate 2.3) Turkey plumage colouring is a mutation of two genes, one recessive and other dominant. Random black spots on the feathers are expected, however brown and white are considered deficiencies. The Slate is very rare, some experts say it is close to extinction. It can be aggressive and wary of others. The size would be the similar as that of the black Turkey.

Plate 2.3: Slate. Source (OSUBR, 2015).

d. White Holland

The White Holland (Plate 2.4) is very rare because the snow white feathering and the weight are hard to be exact when breeding Turkeys. Most times have blue around the eyes and forehead with red necks. The beak is horn coloured and the beard is black. They can be confused with broad breasted White which are larger than White Hollands. The tom weighs around 16 kg while the hen weighs 9 kg.

Plate 2.4: White Holland. Source (OSUBR, 2015)

e. **Bronze Turkey**

The bronze (Plate 2.5) is a medium to large sized birds with stately and imposing appearance. They are very beautiful and well known for their unique plumage. The have a brown colour which is highlighted by shades of copper and blue-green, and the plumage overall is very similar to that of wild Turkey. Average live body weight of the mature Bronze hens is around 7.25 kg. And the mature tom's average live body is around 11.5 kg. They are mostly kept for meat purposes.

Plate 2.5: Bronze Turkey. Source (OSUBR, 2015)

f. **Black Turkey**

The black Turkey (Plate 2.6) are classified as a medium to large-sized birds. They are naturally good breeders. They easily produce fertile eggs for hatching if you keep good ratio of hens and toms in flocks. Generally, one mature and a healthy tom is enough for breeding around or up to 8-10 hens.

Plate 2.6: Black Turkey. Source (OSUBR, 2015)

g. **Narragansett Turkey**

The Narragansett plumage (Plate 2.7) is unique with tan, black, white and grey patterns throughout. The wings have black and white barred feathering. It has a greyish black beak, orange-pink legs and feet's, red wattles and a black beard. The tom weighs around 10.4 kg while the hen weighs around 6.4 kg The Narragansett was not standardized for its meat so the size is not set for table qualities. The hens are considered nurturing mothers and great layers. The eggs are spotted tinted or brown.

Plate 2.7: Narragansett Turkey. Source (OSUBR, 2015)

2.8 Morphological Characteristics or Traits of Animals

Morphology of an animal involves the aspect of outward appearance size, shape, and structure of an animal like bones and organs (Lindenfors *et al.,* 2007). Lindenfors *et al.* (2007) stated that morphological characteristics or traits of animals are used for the classification and identification of species or breeds. The differences in the morphological body measurements of the sexes are clues to sexual dimorphism (Mbelayim, 2015). Morphological traits can be used to predict body weights in livestock, thus assisting poor farmers who cannot afford expensive weighing scales to use measuring tapes to estimate body weight (Abdelhadi and Babiker, 2009; Annor *et al.,* 2011). Body length and heart girth have long been recognized in livestock production as measures to predict body weight (Abdelhadi and Babiker, 2009; Annor *et al.*, 2011).

In most traditional settings animals are evaluated visually, and it's based on one's method of judgment thus subjective (Mbelayim, 2015). The difficulty associated with this method is that it does not give a true reflection of each animal in terms of its body characteristics. Hence, the development of objective ways (linear body measurements) for describing and evaluating body size and conformation characteristics would help overcome the problems associated with visual evaluation (Yakubu and Ibrahim, 2011; Jimcy *et al.*, 2011; Birteeb *et al.*, 2012).

The linear body measurements of animals are an important factor associated with several management practices including selection for slaughtering or breeding, determining feeding levels, and also it is a good indicator of animal condition (Mbelayim, 2015). According to Pundir *et al.* (2011), biometric traits are used to characterize the different breeds of livestock as they give an idea of body conformation. In addition, linear body measurements describe an individual or population in a better way than the conventional methods of weighing and grading. Body dimensions have been used to designate the breed, origin, and relationship or shape and size of an individual (Pundir *et al.*, 2011, cited by Mbelayim, 2015).

Characterization studies has paved the way for genetic conservation or enhancement programs. In the low external input production environments of developing countries, the reasons for raising particular types of livestock include a range of adaptation traits and non-marketable service functions (FAO, 2012). The result of genetic improvement programs can also be evaluated on a morphological basis (Riva *et al.*, 2004).

Characterization of animal genetic resources (AnGR) for food and agriculture involves three types of information: phenotypic, genetic, and historical. The leverage given to each depends on the country (e.g. whether it is developed or developing) and the objective (e.g. breed differentiation, conservation, or improvement) (FAO, 2012).

Some collective body measurements of both small and large ruminants which have been investigated by researchers include; body length, wither height, hip width, chest girth, chest depth, body depth hip height, ear length, rump height, head depth height at withers, and head length, tail length (Khan *et al.,* 2006; Otoikhian *et al.,* 2008; Sowande and Sobola, 2008; Quaye, 2010; Birteeb *et al.*, 2012). Van Marle-Koster *et al.* (2000) also described body measurements as selection criteria for growth in cattle and that body measurements can be used for the characterization of breeds. Body weight is used the most to evaluate body development in animals (De Brito Ferreira *et al.,* 2001); but it is not easily measured in the field. This is due to the time and energy used while determining it. Regression equations have been recognized to evaluate body weight from body dimensions (Ozoje, 1997; Gorgulu *et al.*, 2005; Birteeb *et al.,* 2012). The quantitative measurements for size and shape are necessary for estimating genetic parameters in animal breeding programs (Chineke, 2005).

2.8.1 Measuring body weight of domestic animals

Body weight is a vital trait that is used in evaluating body condition (Erat and Arikan, 2010) and health status (Lund *et al.,* 2005). Body weight and body condition scores are also often used for assessing the nutritional condition of dogs and cats (Esfandiari and Youssefi, 2010). The easiest way to assess an animal's body mass is to weigh the animal. However, in some situations weighing scale may not be available and prediction of body weight from body measurements could be preferred practically (Latshaw and Bishop, 2001).

For larger animals, measuring body weights in the field is often difficult because of a lack of mobile weighing bridges or scales. In primary characterization studies on cattle or pigs in widely dispersed communities, indirect methods of estimating body weight can be considered. Options include tested regression equations of body weight on body length and chest girth, which in general are highly correlated with body weight. Such equations are, however, population-specific; i.e. they can be developed in a first study of the target population and later applied in other studies of the same population (Sam, 2015), provided their levels of accuracy are known.

2.8.2 Body weight characteristics of Turkey

According to Philip (1990), body weight is regarded as a function of the framework or size of the animal and its condition. Body weight is known to be moderate to highly heritable and hence the selection of heavier individuals for breeding objectives in a population should result in genetic improvement of the traits. A recently published data showed an average weekly weight gain of 107 g/bird by supplying *ad libitum* feed at approximately 36 weeks of age (Das *et al.*, 2018). Conferring to Veldkamp *et al.* (2002), the weight of a Turkey at hatch is about 130g. This weight increased progressively during the suckling phase to reach an average weight of 350g at the end of the fifth week. Similarly, according to Shubash *et al*. (2018), the live weight of Turkey breeds was 379g in the fifth week. The body weight of White, Black, and Bronze colour type female Turkeys at 21 weeks was 2539.71g, 2561.43g, then 2645.43g respectively (Shubash *et al.*, 2018). Karki (2005) studied the growth performance of Turkeys and found an average body weight of 4.525

kg/bird for males and 3.3 kg/bird for females at 20 weeks of age, although he did not mention the type or variety, or colour of birds that were used for the study.

This was in disagreement with the results for body weight in all colour types (Shubash *et al*., 2018) When the hybrid Turkeys were used for observation of growth performance, their live weight recorded was much higher, as reported in many published papers (Austic and Neshein, 1990; Waibel *et al*. 2000; Prasad, 2000). Ogah (2011) found a mean live body weight of 3.38 kg and 2.65 kg (Table 2.3) in both males and females at twenty-four weeks respectively under semi-intensive system in Nigeria. The mean body weight of Turkey at adult age was 6.25kg and 3.72kg for both males and females respectively in Tunisia (Table 2.4) (Djebbi *et al.*, 2014). The values were higher than those reported by Ogah (2011) from Nigeria Turkey birds (3.38 kg for males and 2.65 kg for females, respectively), but lower than those reported by Ekert *et al.* (2009) (7.18 kg for males and 4.26 kg for female) in Dalmatian Turkeys.

2.8.3 Morphometric Traits Characteristics of Turkey

Table 2.3 and 2.4 shows the morphometric measurements of different breeds of Turkey in different environments.

Table 2.3: ***Descriptive statistics of body weight and linear body measurements of indigenous Turkey by sex***

Variable	sex	Mean ± se	Minimum	Maximum	CV
Body weight (kg)	Male	3.38±0.07	2.80	4.20	9.93
	Female	2.65±0.02	2.50	2.80	4.05
Wing length (cm)	Male	26.85±0.40	24.00	32.00	6.89
	Female	24.57±0.49	22.00	28.00	9.15
Neck length (cm)	Male	25.52±0.61	20.00	31.00	10.99
	Female	20.28±0.35	18.00	23.00	7.97
Shank length (cm)	Male	12.52±0.35	10.00	17.00	12.78
	Female	9.14±0.22	8.00	11.00	11.09
Thigh length (cm)	Male	9.62±0.27	6.80	11.80	12.95
	Female	8.13±0.14	7.00	9.00	8.11
Body length (cm)	Male	35.05±0.71	28.00	40.00	9.27
	Female	31.86±0.33	30.00	34.00	4.69
Beak length (cm)	Male	5.02±0.10	3.80	6.20	9.61
	Female	4.20±0.09	3.80	5.00	9.76

Source: Ogah (2011). *M± E S: Mean± standard error.*

Table 2.4: ***Descriptive statistics (mean ± se) of body weight (kg) and body measurements (cm) of indigenous Turkey by sex and phenotype***

	White/black	**Black**	**Bronze**	**Red**
Body Weight				
Male	6.25±0.41[a]	6.23±0.80[a]	6.12±0.73[a]	6.42±0.89[a]
Female	3.72±0.68[b]	3.44±0.16[b]	3.59±0.97[b]	3.53±0.42[b]
Shank length				
Male	13.48±0.44[a]	13.41±0.29[a]	13.48±0.29[a]	13.45±0.35[a]
Female	10.80±0.36[b]	10.16±0.37[d]	10.65±0.27[c]	10.97±0,37[bc]
Body length				
Male	34.56±1.50[a]	34.38±1.62[a]	34.71±1.36[a]	34.66±1.58[a]
Female	28.20±0.63[b]	28.98±1.27[b]	28.92±1.67[b]	28.54±0.42[b]
Beak length				
Male	2.92±0.06[a]	2.91±0.07[a]	2.93±0.07[a]	2.94±0.08[a]
Female	2.65±0.10[b]	2.62±0.04[bc]	2.41±0.16[d]	2.58±0.14[c]
Thigh length				
Male	22.40±0.69a	21.71±0.37ab	21.88±0.35b	22.61±1.19a
Female	18.44±0.56c	17.26±0.29e	17.43±0.25e	18.04±0.56d

Source: Djebbi et al. (2014) *M± E S: Mean± standard error.*

2.8.4 Reproduction in Turkey

Reproduction is generally seasonal and is stimulated by increasing day length. (A minimum day length of 12 hours is required). The birds can reach sexual maturity at six months of age and may start breeding at this time. Ten days after first mating, the hen searches out a nest and commences laying. Industrial birds in temperate climates lay, on average, 90 eggs a year. The nondescript type of Turkey in the tropics seldom lays more than 20 small eggs (weighing about 60 g) before going broody (Kinsella, 2012). The average incubation period lasts 25-28 days (Poultry CRC Ltd, 2016). M.L (1991) indicated that the gestation period in Turkey is 28days. The average commercial litter consists of 8 to 10poults. Low fertility and high embryonic mortality values have been identified in traditional poultry rearing (Hocking, 2010). This can be explained by poor management systems, mating behaviour or reproductive physiology in flocks often maintained in small groups

2.8.5 Carcass characteristics

Meat is defined as the muscle of slaughtered animal (Gunter and Hautzinger, 2007). It is a rich and important source of essential amino acids, vitamins, minerals, and also long-chain polyunsaturated fatty acids (Wilson, 1995; Mbelayim, 2015). Meat productivity of Turkeys is evaluated not only by the live weight, growth performance, and feed conversion but mostly based on its slaughter traits like the weight of edible parts and slaughter yield (Oblakova, 2004). One of the cheapest sources of meat but which has been neglected in many African Countries is the Turkey. Turkey has lean meat with low cholesterol, and a high dressing percentage compared with other domestic animals (Sullivan *et al*., 1968). In addition, commercial Turkey breeds have a high yield of meat that reaches about 14.6 kg and 10.25 kg at 16 weeks for males and females respectively (BUT, 2005).

BUT (2005) reported carcass weight of 9.35 and 6.91kg respectively which was higher than Salim *et al*. (2013) who also reported a carcass weight of 5.00kg. This was attributed to the decrease in carcass weight of the experimental birds (Forrest *et al*., 1975). Moreover, the Turkey has a high dressing percentage that could amount to 87% of slaughter weight (AVEC, 2012). Salim *et al.* (2013) reported a dressing percentage of 78.4% for Turkey. BUT (2005) and Gibril *et al*. (2013) also reported dressing percentages of 75.04 and 76.75% respectively. Dressing out percentage is influenced by the nutrition of the animal and litter size (Kebede *et al*., 2008).

2.8.6 Mortality in Turkey

A mortality rate of up to 6% within the first week under the intensive system has been reported for Turkey flocks (Roehrig, 2019). Post- mortem examinations of some birds have shown that they had no feed in their digestive tract, leading to a condition called "Starve-Outs" (Moran, 1978). Additionally, a small percentage of birds are compromised and die or are culled from the flock when they fall onto their backs or sides and cannot raise themselves, a condition commonly referred to as "flips" (Bate, 1992; Christensen *et al*., 2003). Incidence of high mortality rate for grower and brooder Turkey was observed in summer (39.26%) followed by winter (30.78%) (Pandian *et al*., 2013). This was due to omphalitis in summer followed by winter which might be the results of bacterial contamination such as *E.Coli*, *Staphylococcus*, *Streptococcus,* and *Proteus* contamination which are predominant in summer as well as winter (Pandian *et al*., 2013).

2.9 The Use of Body Measurements to Forecast Body Weight in Turkey

In principle, the preeminent method of knowing the weight of an animal is to weigh the animal (Attah *et al.,* 2004; Goe, 2007). A lot of work has been done in this regard in large animals, particularly cattle, sheep, and goats (Attah *et al.,* 2004; Goe, 2007). In poultry, Oke *et al.* (2004) related body weight with some egg production traits in the guinea fowl. Teguia *et al.* (2008) reported a significant association between body weight and body measurement in the African Muscovy ducks. The use of linear body measurements to predict the live body weight of animals is perceived as more reliable compared to the use of weighing scales which could introduce biases as a result of feeding in the stomach. Moreover, weighing scales are not readily available in most rural African farming communities (Nesamvuni *et al.,* 2000).

Multiple regression analysis has been used widely to describe the quantitative association between dependent (body weight) and independent variables (heart girth, body length and wither height) in animal studies (Cankaya, 2009). Several studies on cattle, sheep, and goats (Bagui and Valdez, 2007), dogs and cats (Valdez and Recuenco, 2003), horses and donkeys (Marante *et al.,* 2007), poultry (Grona *et al.,* 2009), and grasscutters (Annor *et al.,* 2011) have been conducted to predict body weight from body measurements. The relationship existing among linear body traits provides useful information on the performance, productivity, and carcass characteristics of animals. Most of the linear measurements reflect primarily the length of the long bones of the animal and when taken sequentially over some time, they generally indicate how the animal body is changing shape and have been used as predictors of live carcass composition (Oke *et al.,* 2004). Momoh and Kershima (2008) indicated that the relationship between body weight and linear measurements is important not only in predicting body weight but also useful in genetic development policies.

According to Salako (2006), body measurements in addition to weight measurements describe more completely an individual or population than the conventional methods of weighing and assessing. These body measurements have been used at various times for the estimation of weight when live weights are measured alongside these parameters. Chineke (2005) reported that in animal breeding programs the relationship existing among body characteristics provides useful information on performance, productivity, and carcass characteristics of animals and that these quantitative measures of size and shape are necessary for estimating genetic parameters. Body dimensions have been used to indicate breed, origin, and relationship through the medium of head measurements (Itty, 1997).

Research has shown that the measure of a body part may relate significantly to body weight. Linear body measurements, therefore, have been used to predict live weight in poultry (Mbelayim, 2015). Body weight and body measurements are used to characterize rabbit breeds, contrast variation in size and shape (Shahin and Hassan, 2000), and estimate carcass and body weight (Mbelayim, 2015). This is relevant, especially in rural communities where there is evidence for the absence of conventional weighing scales. In line with this, linear body measurements have been used to characterize breeds, evaluate breed performance and predict the live body weight of animals (Ozoje and Herbert, 1997).

2.9.1 Heritability estimates of traits

Nestor *et al*. (1967) reported that the unweighted averages of published narrow-sense heritability (h^2) estimates of BW in selected populations of Turkey birds were 0.40, 0.42, 0.43, and 0.36 for birds in the age groups 0 to 8, 9 to 16, 17 to 24, and over 24 weeks, respectively. Other studies also found high heritability estimates for BW at various ages, ranging from 0.28 to 0.48 (Arthur *et al*., 1975; Nestor *et al*., 2000). Comparable outcomes were also reported by Aslam *et al*. (2011) who also observed heritability in the range of 0.23 to 0.71 and 0.32 to 0.42 respectively for BW traits at different ages.

The common environment effect had a large impact on the estimates of heritability for BW traits, especially at early ages (Aslam *et al.,* 2011). The heritability estimates are similar to results reported in other livestock species. Direct heritability of growth traits (body weight, growth rate, feed intake, and feed conversion efficiency) are moderate to high (21-50 %) whilst those of reproduction and survival are low (0-20 %) (Annor, 2011).

2.9.2 Repeatability of traits

The repeatability measures the proportion of total variation that is due the genetic and permanent environmental effects. Values of repeatability lie between 0 and 1 (or 0and 100 %) and must be larger than heritability. A repeatability of one indicates that additional measurements will not differ from early measurements. Table 2.5 shows the repeatability of shank length, keel length, breast width, and body depth of Turkey. Significant sex differences have been observed in all body measurements. Shank length, keel length, and body depth of males were greater than the corresponding measurements of females by 3.89, 2.80, and 4.82 cm, respectively. Repeatability estimate ranges for body length (BL) (0.38-0.99, 0.34-0.99, and 0.11-0.64), thigh length (TL) (0.50-0.98, 0.72-0.99, and 0.01-0.97), shank length (SL) (0.51-0.99, 0.57-0.99, and 0.72-0.93) keel length (KL) (0.44-0.98, 0.43-0.99, 0.24-0.98) were obtained for indigenous, exotic and their crossbred Turkey respectively (Lori *et al*., 2016). Repeatability estimate of a trait describes the proportion of phenotypic variance explained by additive genetic and permanent environmental effects (Annor, 2011). High repeatability means that the expression of a trait is influenced by permanent environmental effects, rather than temporal effects (Festa-Bianchet, 2003).

Table 2.5 ***Repeatability of body measurements***

Measurement	Method of measurement	Repeatability
Shank length	Caliper	0.65
Keel length	Caliper	0.31
Breast width	Caliper	0.31
Breast width	Bird’s instrument	0.44
Body depth	Caliper	0.68
Body depth	Bird’s instrument	0.98

Source*: Nestor & Chamberlin (1966).*

2.10 Relative Economic Values of Traits

The economic value of a trait is defined as the net profit when there is a unit increase in the value of the traits, whilst holding the values of all other traits constant (Sadick *et al.,* 2020). Groen and Van Arendon (1996) defined economic value as income per animal per unit improvement in the genetic merit of that trait, at constant levels of genetic merit for other traits in the breeding goal. Thus, the economic value of a trait expresses the extent to which economic efficiency of production is improved for a given unit of genetic superiority of the trait. It is useful to know the economic value of various traits relative to each other, hence the term relative value is commonly applicable (Blair, 1989) and these are needed to define breeding objectives whereby greater importance may be given to traits of higher economic merits (Morris, 1978)

2.11 Correlation among Morphometric Traits of Turkey

The results of Ogah (2011) showed that in male Turkeys all the morphometric traits were significanty correlated (P<0.001 and P<0.01) with body weight, ranging from 0.41 for keel length to 0.97 for the shank length and head length. Similarly, relationships between all the traits were positive and significant. In females, all the traits except chest circumference were positive and significantly correlated with body weight, ranging from 0.51 for keel length to 0.99 for the body length. The high and significant correlation between body measurements and body weights in both sexes suggests high predictability between the traits in both male and female Turkeys. Bachev and Lalev (1990) recorded a similar trend between body weight and principal body measurements in Turkeys. Naceur (2014) also indicated that body measurements are highly correlated (P <0.001) with body weight, ranging from 0.82 for the beak length to 0.91 for the sternum length and thigh length. This result was in agreement with the results of Ogah (2011). The results of Naceur (2014), indicates that there’s a good relationship between weight and body parameters

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Preamble

Two studies were conducted. The first study was a survey (Study one) which dealt with the determination of Turkey production systems, opportunities and constraints which are important in the design and implementation of indigenous poultry-based development programs in the Middle-belt of Ghana. The second phase of the work involved visual appraisal (Mogesse, 2007) of the appearance of the indigenous Turkey types and their typical features.

3.2 Experiment 1: A Survey on Indigenous Turkey Production systems in the Middle-Belt of Ghana

3.2.1 Location and duration of experiment

The survey was conducted from October, 2020 to April, 2021. The study took place in the Ashanti, Ahafo, Bono, and Bono East Region (Figure 3.1). These regions lie between latitude 6.7470N, 7.000N, 7.3900N, and 7.430N, and longitude -1.5208W, -1.729W, -1.8429W and -1.9268W respectively (GSS, 2019). The vegetation of these regions consist of deciduous, moist semi-deciduous forest and the soils are very fertile. The areas experience two seasons annually. The wet seasons between April and November and the dry season between December and April. The average temperatures are 23.9°C with a minimum of 20.3°C, a maximum of 37.8°C and an average rainfall of 1276mm with Humidity at 72% (WorldData, 2020).

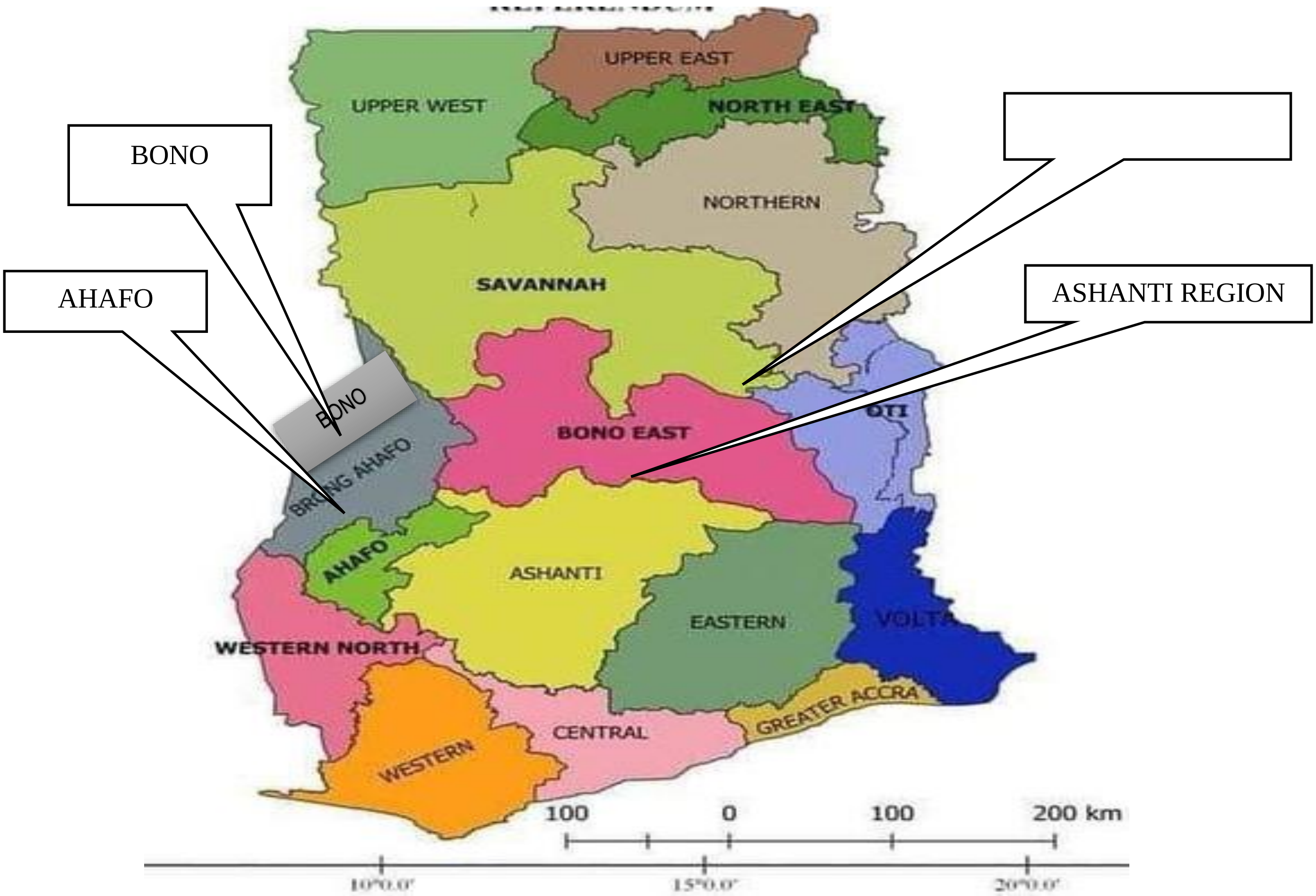

Plate 3.1 Map of Ghana indicating the study zones

Source: Map of Ghana (2020)

3.2.2 Selection of the study area

The study areas were selected from the four (4) zones found on the Map of Ghana, namely: Ashanti, Ahafo, Bono and Bono East Region (Figure 3.1). These administrative zones were chosen based on purposive sampling. A total of six (6) districts were selected from each of the four regions or study zones. Ashanti (Adansi Asokwa, Afigya Kwabre North, Ejura Sekyedumase, Ahafo Ano South West, Akrofuom District and Adansi North), Ahafo (Asunafo North Municipal, Asunafo South, Asutifi North, Tano North, Asutifi South and Tano South), Bono (Banda, Berekum West, Dorma Central, Jaman South, Sunyani and Wenchi) and Bono East Region (Atebubu Amantim, Pru East, Kintampo South, Sene East, Techiman Municipal, Nkoranza) were purposely chosen from the four zones representing the Middle-belt of Ghana. The towns selected for the study were Asokwa, Boaman, Ejura, Adugyama, Akrofuom, Fomena, Goaso, Kukuom, Kenyasi, Duayaw nkwanta, Hwidiem, Bechem, Banda Ahinkro, Jinijini, Dorma Ahinkro, Drobo, Sunyani, Wenchi, Atebubu, Yeji, Kintampo, Kajaji, Tuobodom and Busunya. The snowballing technique (Mbelayim, 2015) was used in identifying the household, thus a total of 154 households were used to carry out the survey on management practices, marketing system and production performance as well as morphological and phenotypic characteristics of indigenous Turkeys.

3.2.3 Administration of questionnaire

Questionnaire and interview schedules were used to gather information for the project. The farmers who could read were issued the questionnaire, which they answered and returned. On the other hand, farmers who could not read and write were asked the questions on the questionnaire and the answers provided. A total of 189 respondents participated in the interviews. The interviews were conducted at the farmers' residences. Information was collected on the socio-economic characteristics of the farmers, Turkey types, Turkey production systems, opportunities, constraints and farming support services provided by MOFA, feeds and feeding, number of eggs per clutch, clutches per year, average number of eggs per year, hatchability of eggs, survivability of chicks, marketing and health of birds. The responses were organized and sorted out conferring to the answers provided. These were tallied and counted according to the number of responses to each item.

3.2.4 Data analysis (Study One)

Descriptive statistics such as mean, range, frequency and percentage were used to analyse the data from the survey using Statistical Package for Social Sciences 17.0 (SPSS, 2008). The data was classified and the mean was calculated using the formula:

$$Weighted\ mean = \frac{\Sigma Xifi}{\Sigma fi}$$

Where Xi represent the observations X_1, X_2, X_3 ,…….. X_N , and f_1 the frequencies of the observations thus f_1, f_2, f_3,……..f_N.

3.3.2 Experiment 2: Measurement of phenotypic traits

Visual appraisal of the appearance of the indigenous Turkey types were collected from a total of 300 individual Turkeys using a longitudinal design. Hence, morphologically distinct indigenous Turkeys were sampled using random sampling technique to collect data on qualitative traits (plumage colour) and quantitative traits such as body weight, shank length and sternum length following the standard descriptor (FAO, 1986).

3.3.3 Morpho-biometric data collection

Three hundred (300) adult indigenous Turkeys of 6-7 months old from each of the four middle-belt regions were sampled. Data on qualitative and quantitative traits from 3 Turkeys consisting of two (2) male and one (1) female randomly selected per farmer was taken (195 males and 105 females). The following morphometric traits were measured using a 50kg capacity scale with a precision of 10g, a tape measure and a colour chart. Measurements were recorded in kilograms (kg) and centimetres (cm). The qualitative characters were determined by direct observation on each Turkey with the help of a colour chart (Au-IBAR, 2015).

The quantitative data measured include:

A. **Beak length**: distance between the ends of the upper mandible and commissure of the down and upper mandibles

B. **Body length** (BL): distance between the tip of the upper mandible and the tail.

C. **Thigh Length** (TL): distance between the hock joint and the pelvic joint

D. **Sternum length** (SL): distance between both vertices of the sternum (pocessuscarinae)

E. **Shank length** (SKL): distance between the calcaneus and the ankle and processus xiphoideus leaning the bird on its back

F. **Head Length:** end of the neck to start of beak.

G. **Body weight (BWT):** Birds were weighed using the 50kg of capacity with a precision of 10g and their weights read and recorded

Qualitative Parameters included:

Feather colours: Various feather colours were identified visually and their frequency and detailed description recorded with the aid of a colour chart.

The relationships between variables were evaluated using Pearson correlation.

The formula for computing the correlation between two traits X and Y was

$$\rho x, y = \frac{E[(X - \mu x)(Y - \mu y)]}{\sigma x \sigma y}$$

Where:

σy and σx are defined as

σy standard deviation of Y

σx standard deviation of X

µx is the mean of X

µy is the mean of Y

E is the expectation

3.3.4 Data analysis (Study Two)

The effects of variety, region and sex on body measurements. The data was subjected to least squares analysis of variance using the GLM procedure Type III of GenStat Discovery Edition 11 (2008) on the following fixed model

$Y_{ijkl} = \mu + V_i + R_j + S_k + VR_{ij} + VS_{ik} + SR_{kj} + VRS_{ijk} + e_{ijkl}$ …………… (1)

Y_{ijkl} = body weight, beak length, wing length, body length, thigh length, sternum length, shank length, head length.

μ = the overall mean

V_i = the effect of the i^{th} variety of Turkey, i = 1, 2, 3 and 4

R_j = the effect of the j^{th} region, j = 1, 2, 3 and 4

S_k = the effect of the K^{th} sex of the Turkey, k = 1 and 2

VR_{ij} = is the interaction effect between i^{th} variety and the j^{th} region

VS_{ik} = is the interaction effect between i^{th} variety and the K^{th} sex

SR_{kj} = the interaction effect between K^{th} sex and the j^{th} region

VRS_{ijk} = the interaction effect between i^{th} variety, the j^{th} region and K^{th} sex

e_{ijkl} = the random error term assumed normally and independently distributed, $(0, \sigma^2 e)$

Differences among means of significant effects were separated by probability of difference using the same software.

CHAPTER FOUR

4.0 RESULTS

This section has been separated into two (2) parts, specifically: The survey results and morphological description of the Turkeys.

4.1 Survey Results

4.1.1 Socio-economic status of farmers

A total of 154 farmers participated in the survey, with Ashanti region recording the highest (56), followed by Ahafo region (45), Bono region (30) and Bono East Region (23). The majority of the respondents were females (79.3 %) in comparison to males (20.7 %). The Bono Region had the highest respondent of females (100 %), followed by Bono East (89.0 %), Ashanti region (68.0 %) and then Ahafo region (62.5 %). The region with the highest number of males was the Ahafo region (37.5 %) followed by the Ashanti region (32.1 %), Bono East region (13.0 %) and then Bono region (0.00 %). The average age of the participant was 38.4 years, with Ahafo recording the highest (40.3 years) followed by Bono region (39.9 years) whilst Ashanti and Bono East regions recorded the least age of 37.9 and 37.5 years respectively.

About 74.0 % of the farmers were illiterate and the rest could read and write (26.0 %). The region with the highest literacy rate was Bono region (38.4 %) followed by Bono East (26.5 %), Ashanti (23.5 %) and the least being Ahafo region (15.5 %). The region with the highest illiteracy rate was Ahafo region (84.45 %) followed by Ashanti (76.5 %) then Bono East (73.5 %) and Bono region (61.6 %) (Table 4.1).

The average farm size per region was 2.61 acres. The region with the largest farm size was the Ashanti region (2.9 acres) followed by Bono region (2.7 acres) and then Bono East

(2.6 acres) and the least being Ahafo region (2.2 acres). The region with the highest family size per household was Ashanti (5.4) followed by Bono East (5.1) and then Ahafo (4.5) and the least being Bono region (1.4). Overall, the average family size was 4.1 (Table 4.1).

Table 4.1: ***Socio-economic characteristics of the respondents in village Turkey production.***

Parameter	Study zones				Mean
	Ashanti Region	**Ahafo Region**	**Bono Region**	**Bono East Region**	
Sample size(no.)	**56**	**45**	**30**	**23**	
Sex of respondent (%)					
Male	32.1	37.5	0.0	13.0	20.7
Female	67.9	62.5	100	87.0	79.3
Average age of respondent (years)	37.9	40.3	39.9	37.5	38.9
Educational level (%)					
Illiterate	76.5	84.5	61.6	73.5	74.0
Read & write	23.5	15.6	38.4	26.5	26.0
Mean land size (Acres)	2.9	2.2	2.7	2.6	2.6
Average family size per region	5.4	4.5	1.4	5.1	4.1

4.2 Husbandry Practice

4.2.1 Flock size

Ashanti region recorded the highest average flock size of 5.9 with Toms (4.1) and Hens (1.8) followed by Bono East which recorded an average flock size of 5.3 with toms (4.2) and hens (1.1), this was followed by Ahafo region which also recorded an average flock size of 4.8 with Toms (3.3) and hens (1.30). Bono region recorded the least average flock size of 4.5 with Toms (3.3) and hens (1.2). Overall average flock size per household for toms and hens were 3.7 and 1.4 respectively, with a total flock size of 5.1 (Figure 4.1).

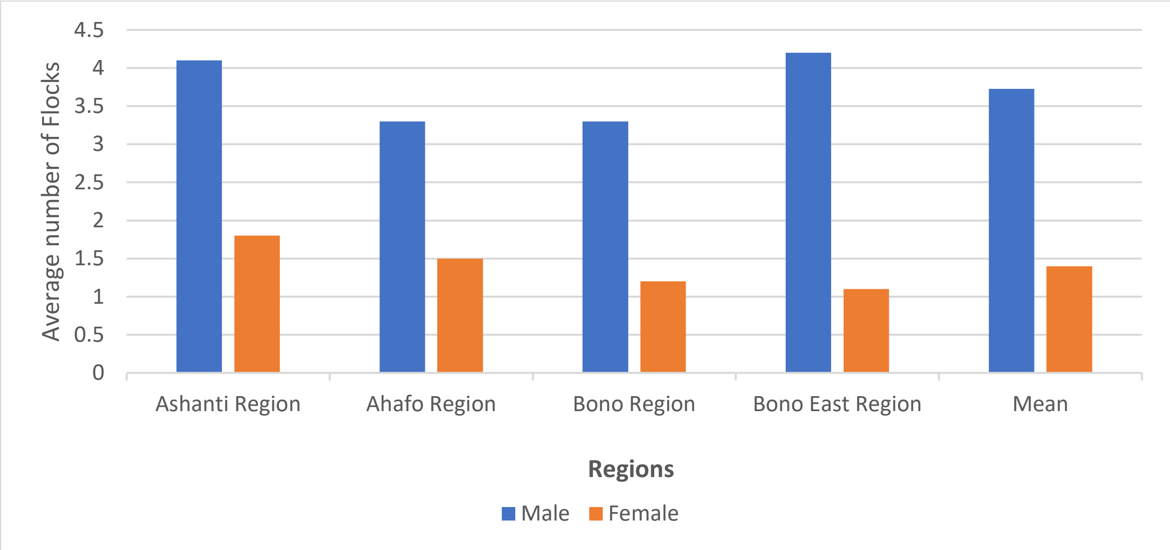

Figure 4.1: Average numbers of indigenous Turkeys per region

4.2.2 Housing and feeding

The survey indicated that majority (92.3 %) of the Turkeys in the regions were managed under a traditional or extensive system as compared to the semi- extensive (7.7 %) management system. With regards to the management system, all the farmers in Ahafo Region (100%) practised the extensive system, this was however higher than Ashanti and Bono East which recorded 94.2 and 90.0 % respectively, and the least being Bono region which recorded an average of 85.0 %. On the other hand, none of the respondent in Ahafo region kept their Turkeys under the semi-extensive system, this was however not the case in Bono region (15.0 %), Bono East (10.0 %) and the Ashanti region (5.8 %) who had few of their Turkeys managed under the semi-extensive system.

Majority (92.2 %) of the farmers in Middle-belt of Ghana provided supplementary feeding to their flocks as compared to 7.82 % who did not. Most of the respondents in Bono East (96.0 %) followed by Ashanti (94.60 %), Ahafo (90.0 %) and the Bono region (85.0 %) provided supplementary feeding to their flocks as compared to few of the respondents in Bono East (4.0 %), Ashanti (5.4 %), Ahafo (10.0 %) and Bono region (15.0 %) who did not provide any supplementary feeds. Majority of the farmers in Ahafo (97.9 %), followed by Ashanti (96.8 %), Bono (95.8 %) and Bono East (94.4 %) threw the feed on the ground whilst in Bono East (5.6 %) followed by Bono (4.2 %), Ashanti (3.2 %) and then Ahafo region (2.1 %) of the Turkey owners supplied the supplementary feed in a container or feeder (Table 4.2).

In terms of housing, few of the respondents in Bono region (2.4 %) provided some form of night shelter for their Turkeys in part of their kitchen as compared to Ashanti, Ahafo and Bono East region who did not. Majority of the farmers in Ahafo region provided shelter in the main house (62.0 %). This was however higher than Bono, Bono East and Ashanti region which had 34.5, 30.0 and 9.7 % respectively. None of the farmers in Bono East provided shelter in hand-woven baskets (0.0 %), this was not the case for Bono (14.3 %), Ashanti (12.8 %) and Ahafo region (10.8 %) which provided shelter in a hand-woven basket. Few of the farmers in Ashanti (6.5 %) and Bono region (2.4 %) provided shelter in bamboo cages, the rest of the regions however did not. Majority of the farmers in Ashanti and Bono East region (above 70.0 %) followed by Bono (46.5 %) and then Ahafo region (27.0 %) provided a separate shed purposely-made for Turkeys. It was further indicated that all the farmers in Bono region (100 %) cleaned their Turkey's housing once per week as compared to Ashanti (93.8 %), Ahafo region (90.0 %) and then Bono East region (16.7 %) which did same. Majority of the respondents in Bono East (83.3 %) as compared to Ahafo (10.0 %), Ashanti (6.2 %) and then Bono region (0.0 %) did not clean their shelter (Table 4.2).

Table 4.2: ***Turkey management systems in the Ashanti, Ahafo, Bono and Bono East Region of Ghana***

Parameters (%)	**Study zones**				**Mean**
	Ashanti Region	**Ahafo Region**	**Bono Region**	**Bono East Region**	
Type of Turkey management					
Extensive	94.2	100.0	85.0	90.0	92.3
Semi-extensive	5.8	0.0	15.0	10.0	7.7
Supplementary feeding					
Yes	96.5	97.2	85.0	90.0	92.2
No	3.5	2.8	15.0	10.0	7.8
Turkey feeding					
Supply feed in containers	3.2	2.1	4.2	5.6	3.8
Thrown on the floor	96.8	97.9	95.8	94.4	96.2
Type of shelter for overnight.					
In the kitchen	-	-	2.4	-	0.6
Perch in the main house	9.7	62.1	34.5	30.0	34.1
Hand-woven basket	12.8	10.8	14.3	-	9.5
Bamboo cages	6.5	-	2.4	-	2.3
Purposely-made house	71.0	27.0	46.5	70.0	53.6
Cleaning of the shelter					
Once per week	93.8	90.0	100.0	16.7	75.1
None	6.2	10.0	-	83.3	24.9

4.2.3.1 Provision of water

Majority (91.4 %) of the farmers in the study areas provided water for their Turkeys as compared to 8.6 % who did not. In Bono East (96.0 %) followed by Ashanti (94.6 %), Ahafo (90.0 %) and then Bono region (85.0 %) most of the farmers provided water for their Turkeys as compared to few of the farmers in Bono East (4.0 %), Ashanti (5.4 %), Ahafo (10.0 %) and Bono region (15.0 %) who did not provide water for their Turkeys (Table 4.3).

Provision of water in plastic was highest in Ahafo (75.7 %) followed by Ashanti (54.3 %), Bono East (28.2 %) and then Bono region (19.0 %). In Bono East majority (46.9 %) of the farmers as compared to Bono (35.7 %) followed by Ashanti (26.1 %) and then Ahafo region (19.0 %) provided water in woody materials. This was however different from Bono region who had majority (45.3 %) of their farmers providing water in clayey materials as compared Bono East (25.0 %), Ashanti (19.6 %) and then Ahafo region (18.9 %) which also did same.

Most of the respondents in Ahafo region (54.0 %) cleaned their troughs daily as compared to Bono (46.90 %) followed by Bono East (43.3 %) and Ashanti region (37.5 %). None of the farmers in Bono (0 %) and Bono East (0 %) cleaned their waterers at least twice per day, this was not the case in Ashanti (9.4 %) and Ahafo region (2.7 %).

24.3, 21.9, 16.3 and 3.0 % of the farmers in Bono East, Bono, and Ahafo and Ashanti region respectively, cleaned their waterers only when it was dirty. In Ahafo (8.1 %) followed by Ashanti (6.3 %) and then Bono East (2.7 %), few of the farmers as compared to Bono region (0 %) cleaned it on every provision. In many cases the troughs were not cleaned at all and this was the case in Ashanti (43.8 %) followed by Bono (31.2 %), Bono East (29.7 %) and then Ahafo region (18.9 %) (Table 4.3).

Table 4.3 ***Provision of water to Turkeys, the type and frequency of cleaning of waterers***

	Study zones				
Parameters (%)	**Ashanti Region**	**Ahafo Region**	**Bono Region**	**Bono East Region**	**Mean**
Production of waterer to Turkeys					
Yes	94.6	90.0	85.0	96.0	91.4
No	5.4	10.0	15.0	4.0	8.6
Type of waterer					
Plastic	54.3	75.7	19.0	28.1	44.3
Made from wood	26.1	5.4	35.7	46.9	28.5
Made from clay	19.6	18.9	45.3	25.0	27.20
Frequency of cleaning of the waterer					
Once per day	37.5	54.0	46.9	43.3	45.4
Twice per day	9.4	2.7	-	-	3.0
When it gets dirty	3.0	16.3	21.9	24.3	16.4
Every provision	6.3	8.1	-	2.7	4.3
None	43.8	18.9	31.2	29.7	30.9

4.2.4 *Purpose for culling of Turkeys*

The purpose for culling of the Turkeys for consumption was highest in Ashanti (13.2 %), followed by Bono (6.4 %), Ahafo (5.4 %) and then Bono East region (4.0 %). Also, the purpose for culling of the Turkeys for trade was highest in Bono East (41.9 %) followed by Ashanti (30.4 %), Ahafo (20. 9 %) and then Bono region (13.2 %). The purpose of culling of Turkeys for sacrifice was also highest in Ahafo (11.5 %) followed by Bono East (6.0 %), Ashanti (4.2 %) and then Bono region (1.0 %). In addition, the purpose for culling of the Turkeys for both sale and consumption were also highest in Bono (70.3 %) followed by Ahafo (60.2 %), Ashanti (40.6 %) and then Bono East region (8.0 %). Majority of the respondents in Bono East (40.1 %) followed by Ashanti (11.6 %), Bono (9.1 %) and then Ahafo region (2.0 %) cited the fear of disease and unable to manage large animals as major determining factors in culling and reducing the number of Turkeys (Table 4.4).

Table 4.4 ***Purpose for culling Turkeys***

Parameters (%)	Study zones				Mean
	Ashanti Region	**Ahafo Region**	**Bono Region**	**Bono East Region**	
Purpose for Culling Turkey					
Consumption	13.2	5.4	6.4	4.0	7.2
Trade	30.4	20.9	13.2	41.0	26.6
Sacrifice	4.2	11.5	1.0	6.0	5.7
Consumption and sale	40.6	60.2	70.3	8.0	44.8
Fear of disease and unable to manage large animal	11.6	2.0	9.1	40.1	15.7

4.3 Source of Replacement Stock and Finance for Indigenous Turkey Production

The region with highest purchased Turkeys as a source of replacement for their farms was Ashanti (71.6 %) followed by Ahafo (40.7 %), Bono (40.2 %) and then Bono East region (30.7 %). Farmers in Bono East (20.4 %), Ahafo (15.0 %), Ashanti (10.4 %) and then Bono region (8.4 %) all obtained their replacement stock in a form of gifts/inheritance. The region with highest hatched Turkeys as a source of replacement for their farms was Bono (51.4 %) followed by Bono East (48.9 %), Ahafo (44.3 %) and then Ashanti region (18.0 %).

The sale of culled Turkeys as the main source of capital to sustain the farm was highest in Bono East (9.0 %) followed by Ashanti (8.6 %), Bono (4.5 %) and then Ahafo region (3.1 %). Subsequently, the sale of eggs as the main source of capital to sustain the farm was highest in Bono East (30.5 %) followed by Ahafo (9.0 %), Ashanti (6.5 %) and then Bono region. Furthermore, the sale of crops as the main source of capital to sustain the Turkey farm was highest in Bono (80.3 %) followed by Ahafo (50.4 %), Bono East (41.8 %) and then Ashanti region (40.0 %). Few of the farmers in Bono East (7.7 %) followed by Ahafo (6.3 %), Ashanti (4.8 %) and then Bono region (3.3 %) obtained their capital for maintenance of their Turkey units from the sale of livestock. Most of the farmers also in Ahafo (20.10 %) followed by Ashanti (14.3 %), Bono East (8.0 %) and then Bono region (5.3 %) engaged in off farm activities to obtain capital to sustain their farms. Additionally, few of the farmers in Ashanti (25.8 %) followed by Ahafo (11.1 %), Bono East (3.0 %) and then Bono region (2.3 %) sold both crops and livestock to obtain capital to sustain their farms (Table 4.5).

Table 4.5 ***Source of replacement stock and Finance for indigenous Turkey production***

Parameters (%)	Study zones: Ashanti Region	Ahafo Region	Bono Region	Bono East Region	Mean
Source of replacement stock for layers					
Purchased	71.6	40.7	40.2	30.7	45.8
Inherited/Gift	10.4	15.0	8.4	20.4	13.6
Hatched	18.0	44.3	51.4	48.9	40.7
Source of finance for Turkey unit					
Sale of culled poultry	8.6	3.1	4.5	9.0	6.3
Sale of eggs	6.5	9.0	4.3	30.5	12.6
Sale of crops	40.0	50.4	80.3	41.8	53.1
Sale of livestock	4.8	6.3	3.3	7.7	5.5
Income from off-farm activities	14.3	20.1	5.3	8.0	11.9
Sale of both crop and livestock	25.8	11.1	2.3	3.0	10.6

4.3.1 Age at sexual maturity of female and male indigenous Turkeys

Majority of the male Turkeys in Ahafo (70.0 %) reached sexual maturity at 20-24 weeks, this was higher than those in Ashanti (64.0 %) followed by Bono East (55.7 %) and then the least being Bono region (40.0 %). At 28-32 weeks, farmers in Ashanti and Ahafo had 20.0 % of their Male Turkeys attaining sexual maturity this was however lower compared to Bono East (34.3 %) and Bono region (30.0 %).

Additionally at 32 weeks and above, Bono region had majority (30.0 %) of their Male Turkeys attaining sexual maturity, this was higher than those in Ashanti (16.0 %) which was also higher than Ahafo and Bono East which had 10.0 % of their male Turkeys reaching maturity.

At 20-24 weeks, Bono had the highest (60.5 %) followed by Ashanti (54.8 %), Ahafo (50.0 %) and Bono East region (49.0 %) of their Female Turkeys reaching the point of lay. At 28-32 weeks, Ahafo had the highest (46.8 %) followed by Bono East (40.0 %), Ashanti (46.8 %) and then Bono region (31.9 %) of their Female Turkeys reaching the point of lay. Also, at 32 weeks and above, few of the Female Turkeys in Bono East (11.0 %) followed by Ashanti (7.8 %), Bono (7.6 %) and then Ahafo region (2.7 %) of their Female Turkeys reaching the point of lay (Table 4. 6).

Generally, male Turkeys and female Turkeys reached sexual maturity at an age ranging from 20 to 24 weeks however, 39.0 % of the female Turkeys and 26.1 % of the male Turkeys in this study reached maturity at 28 to 32 weeks, indicating late maturity (Table 4.6).

Table 4.6: ***Age at sexual maturity of female and male indigenous Turkeys (%)***

Parameters (weeks)	Study zones				Mean
	Ashanti Region	Ahafo Region	Bono Region	Bono East Region	
Male reached sexual maturity					
20-24	64.0	70.0	40.0	55.7	57.4
28-32	20.0	20.0	30.0	34.3	26.1
Above 32	16.0	10.0	30.0	10.0	16.5
Jenny reached point of egg lay					
20-24	54.8	50.5	60.5	49.0	53.7
28-32	37.4	46.8	31.9	40.0	39.0
Above 32	7.8	2.7	7.6	11.5	2.3

4.3.2 Egg production and incubation practice

The average number of eggs incubated using a broody Turkey for Ashanti, Ahafo and Bono were 12, 14 and 13 respectively with Bono East recording a majority of 18 eggs. Bono East (30.0 %) followed by Bono region (27.5 %) recorded the highest number of chicks hatched per eggs set, Ashanti and Ahafo region recorded the least number of chicks hatched per egg set thus 22.5 % and 20.0 % respectively. Ashanti region recorded the highest number (29.6 %) of chicks surviving to adulthood followed by Ahafo region (25.7 %) and Bono East (24.5 %) and then Bono region (20.1 %) (Table 4.7). The number of Turkeys that clutch once per year per hen for each region varied with Bono region having the highest (21.2 %) followed by Ashanti (13.6 %), Bono East (11.1 %) and then Ahafo region (3.0 %). The number of Turkeys that clutch twice per year per hen for each region also varied with Bono East region recording the highest (77.8 %) followed by Bono (60.6 %), Ahafo (48.5 %) and then Ashanti region (27.3 %). Additionally, the number of Turkeys that clutch thrice per year per hen for each region varied with Ashanti region having the highest (54.3 %) followed by Ahafo (24.2 %), Bono (15.2 %) and then Bono East region (11.0 %). In the same way, the number of Turkeys that clutch once per year per hen for each region varied with Ahafo region having the highest (24.3 %) followed by Ashanti (4.8 %), Bono East (3.0 %) with the exception of Bono region (0.0 %) (Table 4.7).

Table 4.7: ***Egg production and incubation practice of the indigenous Turkeys***

Parameters (weeks)	**Study zones**				**Mean**
	Ashanti Region	**Ahafo Region**	**Bono Region**	**Bono East Region**	
Number of eggs used hatching (no.)	12.0 (21.1 %)	14.0 (24.6 %)	13.0 (22.8 %)	18.0 (31.6 %)	14.0
Number of chicks hatched per eggs set	9.0 (22.5 %)	8.0 (20.0 %)	11.0 (27.5 %)	12.0 (30.0 %)	13.6
Chicks surviving to adulthood	7.5 (29.6 %)	6.5 (25.7 %)	5.1 (20.2 %)	6.2 (24.5 %)	6.3
Number of clutches per hen per year					
Once	13.6	3.0	21.2	11.3	12.2
Twice	27.3	48.5	60.6	77.8	53.6
Thrice	54.3	24.2	15.2	11.1	26.2
Four Times	4.8	24.3	3.0	-	8.0

4.4 Factors Contributing to Low Production.

All (100 %) of the Turkey owners reported occurrences of poultry diseases. Most of the farmers in Bono region (18.9 %) followed by Bono East (6.9 %), Ashanti (5.3 %) and then Ahafo region (2.7 %) administered some form of medications by themselves. Few of farmers in Ashanti region (1.3 %) killed their Turkeys immediately they fell sick, this was not the case in other regions. Furthermost, some of the farmers in Bono (5.4 %) and Ashanti region (2.6 %) consumed their Turkeys immediately a disease is reported. This was moreover not the case in other regions. 9.2 % of farmers in Ashanti region sold their Turkeys once a disease is confirmed, this was similarly not the case in other regions. Majority of the farmers in Ahafo (94.6 %) followed by Ashanti (77.6 %), Bono East (75.9 %) and then Bono region (59.5 %) reported that Turkeys were not properly examined and no health management services were provided. Only 17.2 %, 16.2 %, 4.00 % and 2.7 % of the farmers in Bono East, Bono, Ashanti and Ahafo region respectively either consumed or sold their diseased Turkeys (Table 4.8).

Table 4.8: ***Factors contributing to low production and reproductive aspects of Turkeys***

Parameters (%)	Study zones				Mean
	Ashanti Region	**Ahafo Region**	**Bono Region**	**Bono East Region**	
Disease outbreak					
Yes	100	100	100	100	100
No	-	-	-	-	-
Treatment of disease Turkeys					
Treated by owner	5.3	2.7	18.9	6.9	8.5
Killed immediately	1.3	-	-	-	0.3
Consumed immediately	2.6	-	50.4	-	2.0
Sold by the owner	9.2	-	-	-	2.3
No intervention	77.6	94.6	59.5	75.9	76.9
Consumed or Sold	4.0	2.7	16.2	17.2	10.0

4.5 Marketing

Majority of the farmers in Ahafo (60.7 %) followed by Bono East (50.3 %), Bono (45.0 %) and then Ashanti region (32.9 %) reported that the marketing and price of Turkeys were largely affected by unstable price. The concerns of seasonal demand were highest in Ashanti (25.8 %) followed by Bono East (15.7 %), Ahafo (11.3 %) and then Bono region (9.0 %). A Lack of good market place was also a source of challenge to farmers mostly in Ahafo (6.8 %) followed by Bono East (5.0 %), Ashanti (2.4 %) and then Bono region (2.3 %). Poor infrastructure was also a problem in Bono (30.6 %) followed by Ashanti (5.1 %)

and then Ahafo and Bono East region which recorded 3.0 % each. Some of the farmers in Ashanti (25.6 %) followed by Bono East (20.0 %), Ahafo (13.2 %) and then Bono region (5.0 %) reported that they had no challenges in marketing their Turkeys. The sale of diseased Turkeys was also an issue in Ashanti and Bono region (above 8.0 %), however this was higher than those reported in Bono East (6.0 %) and Ahafo region (5.0 %). The price of male and female Turkeys was highest in Ashanti and Bono East as compared to those in Ahafo and Bono Region.

Generally, in the study areas, the price and marketing of live Turkeys is affected by unstable price (47.2 %), seasonal demand (15.5 %), poor infrastructure (10.4 %) plumage colour, size, age, sex, and the health status of the birds (6.8 %) and lack of market site (4.1 %). Normally the average prices of medium size Turkeys ranged from GH¢325 to 413 and GH¢ 275 to 338 for a cock and hen, respectively in all the study zones (Table 4.9).

Table 4.9: ***Factors affecting the marketing of live Turkeys and eggs***

Parameters (%)	Study zones				Mean
	Ashanti Region	Ahafo Region	Bono Region	Bono East Region	
Unstable price	32.9	60.7	45.0	50.3	47.2
Seasonal demand	25.8	11.3	9.0	15.7	15.5
Lack of good market place	2.4	6.8	2.3	5.0	4.1
Poor infrastructure	5.1	3.0	30.6	3.0	10.4
No problem	25.6	13.2	5.0	20.0	16.0
Sale of diseased Turkeys	8.2	5.0	8.1	6.0	6.8
Selling price of medium size(GH ₵)					
Male Turkeys	350-500	300-400	300-350	350-400	325-413
Female Turkeys	300-350	250-350	250-300	300-350	275-338

4.6 Provision of Extension Services

Extension services were provided to majority of the farmers (54.2 %) as compared to 45.8 % who did not receive any form of extension services. With regards to extension service majority of the farmers in Bono East (60.0 %) followed by Ashanti (55.6 %), Bono (54.0 %) and then Ahafo region (47.2 %) received some form of extension services. On the other hand, 52.8, 46.0, 44.4 and 40.0 % of the farmers in Ahafo, Bono, Ashanti and Bono East respectively, did not receive any form of extension services. Also, majority of farmers in Ashanti (70.1 %) followed by Ahafo (60.9 %), Bono East (51.2 %) and then Bono region (45.2 %) also confirmed having received information on exotic and improved breeds of Turkeys compared to Bono (54.8 %) followed by Bono East (48.8 %), Ahafo (39.1 %) and then Ashanti region (29.9 %) who did not. With regards where this information is received, few of the farmers in Bono (35.5 %) followed by Ahafo (15.4 %), Ashanti (3.4%) stated that, the information was received directly from the extension officers with the exception of Bono East region (0 %). All the farmers in Bono East (100 %) as compared to Ashanti (96.6 %), Ahafo (84.6 %) and then Bono Region (64.5 %) of the Turkey growers obtained information about exotic Turkey breeds and improved Turkey management from market places and neighbours (Table 4. 10)

Table 4.10: ***Percentage of farmers reached by extension services and source of information on improved Turkeys***

Parameters (%)	**Study zones**				**Mean**
	Ashanti Region	**Ahafo Region**	**Bono Region**	**Bono East Region**	
Provision of extension services					
Yes	55.6	47.2	54.0	60.0	54.2
No	44.4	52.8	46.0	40.0	45.8
Information for exotic Turkey breeds and improved management					
Yes	70.1	60.9	45.2	51.2	56.9
No	29.9	39.1	54.8	48.8	43.2
Source of information for improved Turkey production					
Extension officer	3.4	15.4	35.5	-	13.6
Market and Neighbours	96.6	84.6	64.5	100	86.4

4.7 Ethno-Veterinary Practices (Traditional Medication)

Majority 100 % of the respondents in all the regions confirmed that occasionally they administer some medications to their birds. The use of seeds to treat diseases was highest in Ashanti (15.9 %) followed by Bono (15.8 %), Ahafo (10.1 %) and then Bono East region (5.6 %). The use of fruits as a form of ethno-veterinary medicine was correspondingly highest in Ashanti (10.1 %) followed by Bono East (9.1 %), Ahafo (7.1 %) and then Bono region (5.5 %). Furthermore, the use of leaves as a form of ethno-veterinary medicine was highest in Bono East (29.4 %) followed by Ahafo (25.4 %), Bono (22.0 %) and then Ashanti region (20.7 %). likewise, the use of Ash as a form of ethno-veterinary medicine was highest in Ashanti (11.4 %) followed by Ahafo (11.0 %), Bono (8.0 %) and then Bono East (5.2 %). Additionally, the use of stem as a form of ethno-veterinary medicine was highest in Bono (18.5 %) followed by Ahafo (13.5 %), Bono East (10.5 %) and then Ashanti region (7.6 %). Moreover, the use of barks as a form of ethno-veterinary medicine was highest in Bono East (40.2 %) followed by Ashanti (34.3 %), Ahafo (32.2 %) and then Bono region (30.2 %). However, in Bono East (45.0 %) followed by Ahafo (40.0 %), Bono (35.0 %) and then Ashanti region (20.0 %) most of the respondent reported administering it's in powder form. Consequently, in Ashanti (70.0 %) and then Bono (55.0 %), Bono East (50.0%) and then Ahafo region (45.0 %) most of the respondent testified administering it in liquid form. Additionally, the use of paste was highest in Ahafo (15.0 %) followed by Ashanti and Bono (10.0 % each) and then Bono East region (5.0 %) as the other forms (Table 4.11).

Table 4.11 ***Percentage of farmers practicing Ethno-Veterinary services***

Parameters (%)	Study zones				Mean
	Ashanti Region	**Ahafo Region**	**Bono Region**	**Bono East Region**	
Ethno-Veterinary practices					
Yes	100	100	100	100	100
No	-	-	-	-	-
Type of Practice used					
Seed	15.9	10.8	15.8	5.6	12.0
Fruits	10.1	7.1	5.5	9.1	8.0
Leaves	20.7	25.4	22.0	29.4	24.4
Ash	11.4	11.0	8.0	5.2	8.9
Stems	7.6	13.5	18.5	10.5	12.5
Barks	34.3	32.2	30.2	40.2	34.2
Type of mixture used					
Powders	20.0	40.0	35.0	45.0	35.0
Liquids	70.0	45.0	55.0	50.0	55.0
Paste	10.0	15.0	10.0	5.0	10.0

4.8 Qualitative Traits (Colour Frequency)

From a sample of 300 adult (6-7 months old) Turkeys from the middle belt segment of Ghana, five colour varieties of Turkeys were identified. The colour varieties identified were white, black & white, black, bronze and buff varieties. The images of the colour varieties are shown in Plates 4.1, 4.2, 4.3, 4.4 and 4.5 in the study area.

Plate 4.1: WHITE

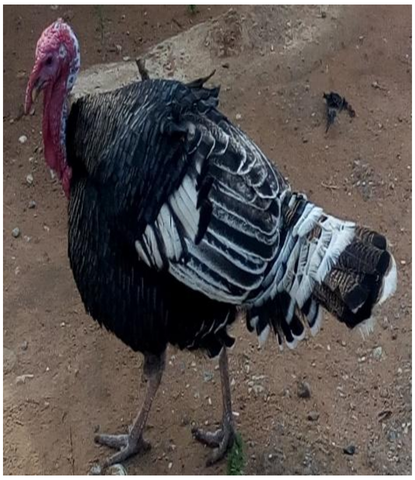

Plate 4.2: BRONZE

Plate 4.3 BLACK

Plate 4.4: BLACK& WHITE

Plate 4.5: BUFF

4.8.1 Frequencies of colour varieties

Table 4.1: ***Percentages of the five Colour Varieties of Turkey in the Ashanti, Ahafo, Bono and Bono East Region of Ghana***

Variety	Ashanti Region	Bono Region	Ahafo Region	Bono East	Total/Variety
White	36.1	22.2	30.6	11.1	100
Black	29.3	25.8	25.0	19.8	100
Bronze	38.9	16.7	27.8	16.7	100
Black& white	22.1	24.8	27.4	25.7	100
Buff	29.4	11.8	17.7	41.2	100
Totals/Region	84.0	71.0	79.0	66.0	300

The Bronze colour variety was the most popular colour in Ashanti region followed by the white colour with the least being the black and white colour (Table 4.12). This form, however, were not so for the Bono and Bono East Region. Bono region had the black and white colour as the most dominant followed by the black variety and then the white colour with the least being the bronze and buff. Across the four regions Bono East had the most Buff colour variety as compared to Ashanti region which was also higher than Ahafo and Bono region. The rest of the colours have no consistent pattern.

Table 4.13 ***Frequencies of the five colour varieties of Turkeys in the Ashanti, Ahafo, Bono and Bono East Region of Ghana***

Variety	Number	Percent %
White	36	12.00
Black	116	38.67
Bronze	17	5.66
Black & White	113	37.67
Buff	18	6.00
Total	300	100

The most common variety was the Black (38.67 %) and Black and white (37.67 %) colour followed by white (12.00 %) then the Buff (6.00 %). The least represented was the Bronze (5.66 %). The five colour varieties cut across the four regions in the middle belt.

4.8b Quantitative Traits (Body Measurement)

4.8.2 Least Square means of traits of Turkeys in the Ashanti, Ahafo, Bono and Bono East Region of Ghana

Table 4.14 Least square means and standard errors for body weight and linear body measurements of Turkeys in the middle belt of Ghana

Variable	Ashanti Region	Bono Region	Ahafo Region	Bono East Region	P-value
BWT (kg)	4.908 ± 0.08^{b}	4.997 ± 0.09^{b}	4.978 ± 0.08^{b}	5.356 ± 0.09^{a}	0.001
BKL (cm)	2.424±0.03	2.528±0.03	2.490±0.03	2.498±0.03	0.059
HL (cm)	6.393±0.20	6.408±0.23	6.278±0.22	6.303±0.24	0.968
BL (cm)	30.74 ± 0.37^{ab}	31.62 ± 0.40^{a}	29.55 ± 0.38^{b}	30.46 ± 0.41^{b}	0.002
THL (cm)	19.26 ± 0.15^{b}	20.37 ± 0.17^{a}	19.57 ± 0.15^{b}	19.40 ± 0.17^{b}	<0.001
WL (cm)	27.97 ± 0.41^{b}	30.35 ± 0.45^{a}	29.09 ± 0.43^{a}	29.24 ± 0.46^{a}	0.002
SHK (cm)	11.82 ± 0.18^{b}	12.49 ± 0.20^{a}	12.30 ± 0.19^{a}	11.91 ± 0.21^{b}	0.047
SL (cm)	12.61 ± 0.25^{b}	13.88 ± 0.26^{a}	13.26 ± 0.26^{a}	12.35 ± 0.29^{b}	<0.001

P-Value = probability value, BWT= body weight, BKL= beak length, HL = head length, BL= body length, THL= thigh length. WL= Wing length, SHK= shank length and SL= sternum length

NB: Means between regions with different superscripts are significantly different ($p \leq 0.05$).

Location had significant ($p < 0.05$) influence on body measurements of Turkeys in most of the traits. Body weight of Turkeys in the Ashanti, Bono and Ahafo region were similar ($p > 0.05$) and these were lower ($p < 0.05$) than values recorded in the Bono East region.

Beak length and Head length values were similar ($p > 0.05$) across all the regions. For body length, Ahafo and Bono East recorded similar (($p > 0.05$) values, however, these were lower ($p < 0.05$) than values recorded in Bono and Ashanti region. Thigh length for Turkeys in Ashanti, Ahafo and Bono East region were similar ($p > 0.05$) and these were lower ($p < 0.05$) than values in Bono region. Wing length for Turkeys in Bono East, Bono and Ahafo region were similar ($p > 0.05$) and these were higher ($p < 0.05$) than those in Ashanti region. Shank length of Turkeys in Ashanti and Bono East region were similar ($p > 0.05$) and these were lower ($p < 0.05$) than values in the Bono and Ahafo regions which also had similar values ($p > 0.05$). Sternum length of Turkeys in Bono and Ahafo region were similar ($p > 0.05$) and these values were higher ($p < 0.05$) than those in Ashanti and Bono East region which also recorded similar values (Table 4.14).

.

Table 4.15 ***Descriptive statistics of body weight and body measurements indigenous Turkey by colour***

	WHITE	BLACK	BRONZE	BLACK/WHITE	BUFF	P-VALUE
BWT	4.792±0.20	4.744±0.11	4.783±0.28	4.547±0.11	5.059±0.29	0.437
BKL	2.519±0.04	2.498±0.02	2.444±0.06	2.452±0.02	2.535±0.06	0.392
HL	8.914±0.09	9.009±0.05	9.161±0.13	9.112±0.05	9.035±0.13	0.304
BL	30.628±0.57	31.009±0.32	30.456±0.8	30.035±0.32	31.224±0.83	0.253
THL	19.756±0.23	19.716±0.13	19.472±0.33	19.507±0.13	19.853±0.34	0.689
WL	28.239±0.61^{a}	28.780±0.34^{a}	27.139±0.87^{b}	27.895±0.35^{b}	27.700±0.89^{b}	0.010
SHK	12.436±0.28	12.209±0.16	12.300±0.40	11.865±0.16	12.435±0.41	0.300
SL	13.511±0.40	13.185±0.22	13.250±0.56	12.646±0.2	13.194±0.58	0.275

P-Value = probability value, BWT= body weight, BKL= beak length, HL = head length, BL= body length, THL= thigh length. WL= Wing length, SHK= shank length and SL= sternum length

NB: Means between regions with different superscripts are significantly different (p ≤ 0.05).

The colour varieties of the Turkeys had significant ($p<0.05$) effect on wing length. For wing length the Black colour and White colour had similar ($P>0.05$) values and these were higher ($p<0.05$) than the values in the Bronze, Buff and Black & white colour. The Turkeys recorded similar ($p>0.05$) values for the rest of the traits (Table 4.15).

Table 4.16: ***Least square means and standard errors for linear body measurements and body weight of Turkeys based on sex in the Ashanti, Ahafo, Bono and Bono East Region of Ghana***

VARIABLE	SEX	MEAN±STANDARD ERROR	P-VALUE
BL (cm)	**Male**	32.53±0.15	0.001
	Female	26.94±0.21	
BKL (cm)	**Male**	2.60±0.013	0.512
	Female	2.25±0.018	
WL (cm)	**Male**	31.39±0.16	0.001
	Female	24.87±0.22	
THL (cm)	**Male**	20.41±0.07	0.006
	Female	18.20±0.09	
HL (cm)	**Male**	7.20±0.11	0.001
	Female	4.762±0.15	
SL (cm)	**Male**	14.38±0.11	0.001
	Female	10.50±0.15	
SKL (cm)	**Male**	13.18±0.07	0.001
	Female	10.17±0.09	
BWT (kg)	**Male**	5.521±0.03	0.003
	Female	4.182±0.04	

M± E S: Mean± Standard error.

P-Value = probability value, BWT= body weight, BL= body length, WL= Wing length, HL = head length, SL= sternum length, BKL= beak length, SHK= shank length and THL= thigh length

Both sexes had similar ($p > 0.05$) values for beak length. Sexual dimorphism was in favour of the male ($p < 0.05$) as expressed in all traits studied. With the males being significantly heavier than the females.

4.8.3 Interaction effect of fixed factors on morphometric traits

Region and Phenotype interactions effect on all the traits were not significant ($p > 0.05$). All other interactions effects on all traits were significant ($p < 0.05$) as shown in Table 4.17.

Table 4.17: Interaction effect of fixed factors on morphometric traits

Type Interaction effect	BL	BKL	WL	THL	HL	SL	SHK	BWT
Region*Colour	ns	ns	ns	ns	ns	ns	ns	ns
Region*Sex	*	*	*	*	*	*	*	*
Colour*Sex	*	*	*	*	*	*	*	*
Region*Colour*Sex	*	*	*	*	*	*	*	*

*Ns= Not significant, * = Significant*

BWT= body weight, BL= body length, WL= Wing length, HL = head length, SL=sternum length, BKL= beak length, SHK= shank length and THL= thigh length.

Table 4.18: ***Correlation coefficients of body weight and body measurements of male (above diagonal) and female (below diagonal) Turkeys***

	BWT	**BKL**	**WL**	**THL**	**SL**	**SHK**	**BL**	**HL**
BWT		0.88***	0.96*	0.95***	0.85***	0.86***	0.91***	0.69***
BKL	0.35***		0.91*	0.74***	0.78***	0.82*	0.88***	0.69***
WL	0.46***	0.61***		0.87***	0.79***	0.83***	0.90*	0.70***
THL	0.88***	0.58***	0.87***		0.79***	0.76*	0.87***	0.57***
SL	0.78**	0.51***	0.58***	0.87***		0.71***	0.71***	0.73***
SHK	0.84***	0.32***	0.75***	0.85***	0.84***		0.96***	0.74***
BL	0.79**	0.67***	0.76***	0.44**	0.36*	0.52***		0.68***
HL	0.64***	0.32***	0.56**	0.69***	0.45***	0.49***	0.40***	

**=P≤.05, **=P<0.01, ***=P<0.001. R=≤* 0.30*: Low, 50; moderate,* ≥ 51 *strong*

BWT= body weight, BL= body length, WL= Wing length, HL = head length, SL= sternum length, BKL= beak length, SHK= shank length and THL= thigh length.

The body measurement is highly correlated (P <0.05) with body weight, ranging from 0.69 for head length to 0.96 for the wing length. Similarly, relationships between all the traits were positive and significant. In females all the traits were positive and significantly correlated with body weight, ranging between 0.35 for beak length to 0.88 for the thigh length (Table 4.18).

CHAPTER FIVE

5.0 DISCUSSION

5.1 Survey Results

5.1.1 Socio-economic status of farmers

Turkey production is still at a small holder level in Ghana. However, the predominance of women in Turkey production in the study areas (Table 4.1) is in agreement with the research results reported by Okoroafor *et al*. (2020) on Constraints and prospects of turkey production in Enugu state south-eastern Nigeria. Okoroafor *et al*. (2020) found that approximately 53.0 % of the poultry flocks were kept and mainly controlled by women. However, this finding is not consistent with the report of some researchers in northern and western parts of Nigeria (Ajala *et al.,* 2007; Yakubu *et al.,* 2013) who observed that men dominated Turkey production business. The disparity recorded in these studies may be related to cultural, educational and religious differences among the people living in the various regions. The age distribution of the majority of the Turkey farmers fell within the active working age of citizens in Ghana and consistent with the report of Okoroafor *et al*. (2020).

The illiteracy rate was also quite high (Table 4.1), this confirms the results of a survey steered by Njenga (2005) on Productivity and socio-cultural aspects of local poultry phenotypes in coastal Kenya. Njenga reported that 70% of the individuals responsible for keeping of farm animals were mostly uneducated. This could be attributed to the high poverty levels and inaccessibility of some farmers within the study area to quality and affordable education (GSS, 2015). Afari (200I) also observed that human capital improvement through farmer education (both formal and informal) was essential for increasing agricultural productivity and farm income of rural farmers.

5.2 Husbandry Practices

5.2.1 Flock size

The average flock size of 5.1 per household were similar to the flock size observed by Yakubu *et al.* (2013) who both reported that the flock sizes generally ranged from 5 to 10 fowls per African village household. This disagrees with Tadelle *et al*. (2003); Njenga (2005) who both reported an average flock size of 16 birds in the central parts of Ethiopia and in the Kwale district of the South coast of Kenya. The flock size varies between seasons mainly due to the occurrence of diseases, the availability of feed, the presence of predators as well as the economic status of the owners. Luvhengo *et al*. (2017) observed that high feed and chick costs, lack of capital, poor extension support, unavailability and inconsistent supply of farm inputs were other constraints on flock size of farmers.

5.3 Housing and Feeding

Majority of the farmers provided shelter to their Turkeys. This is an indication that the owners were aware of the importance of housing. In Nigeria 56.6 % of the native Turkey farmers provided housing of some kind (Hughes and Grigor, 1996). Similar housing was also reported by Ngu *et al*. (2013) who stated that majority (70%) of Turkeys were housed purposely made hut, kitchen, trees and others (fences, cages). The significance of housing is to protect Turkeys from direct sunlight, humidity, rain, cold and windy conditions (Afari, 2001).

Most of the farmers provided supplementary feeding. However, the type and amount of feed depended on the crops grown in the area as well as the seasons. The majority of the farmers who provided supplementary feeding systems (mostly once per day) used maize, barley, wheat, millet and household waste products to feed their Turkeys. These results were comparable to the work done in Zimbabwe by Nebiyu *et al.* (2013) on Characterization of village chicken production performance under scavenging system in Halaba district of southern Ethiopia. They both stated that 96.8 % of the farmers supplied partial supplementation of feeds and 95.5 % of the feed were produced locally. Similar results on the mode of feeding (thrown on the floor) animals were also observed in local birds' population in Ethiopia (Mogesse, 2007).

At the beginning of the planting season the free roaming of Turkeys for scavenging was restricted to certain areas or they were kept in the main house in order to prevent scavenging of newly planted seeds.

5.3.1 Source of Replacement Stock and Finance for Indigenous Turkey Production

From the responses, it was found that most of the farmers purchased Turkeys as replacement stocks for their farms. Similar results with regard to the purchasing of Turkeys as replacement stock were reported by Veluw (2017). This could be attributed to the fact that there are inadequate breeding stations and selection objectives designed for Turkey production.

5*.3.2 Purpose and reason for culling Turkeys*

The respondents cited trade, sacrifice consumption and sale, old age and lack of capacity to manage large number of birds as major determining factors in culling and reducing the number of Turkeys. Similar trends were reported in other African countries. For example, in Tunisia, Djebbi *et al*. (2014) who conducted research on phenotypic characterization of indigenous Turkey (Meleagris Gallopavo) In the North West Regions of Tunisia stated that Turkeys were mainly culled for traditional purpose such as trade, sacrifices, and gifts and as a source of income. Erasmus (2017) reported that 54%, 42% and 35% Turkeys were also culled for trade, gifts and consumption respectively. Similar reports were also cited by Ngu *et al*. (2013).

5.4 Age at Sexual Maturity of Female and Male Indigenous Turkeys

The early age at which the female and male indigenous Turkeys reached sexual maturity were similar to those reported by Hale and Schein (1962) who both researched on the behaviour of Turkeys and also indicated that sexual maturity of females and males' Turkeys were between 25-28 weeks in London. The age at sexual maturity is mostly influence by the sexual hormones in each sex.

5.5 Egg Production and Incubation Practice

Egg production is one of the critical factors limiting the number of Turkeys raised in the study area. From the present study, it was confirmed that eggs/year/ Turkeys were quite high. Similar findings of the egg production in this study were reported by Badubi *et al*. (2006) who reported that on average 11 to 15 eggs were laid by indigenous Turkeys and 6 to 10 chicks were hatched. It was also reported that eggs per clutch, clutches per year and eggs laid per Turkeys per year varied between 12-13, 3 and 36 in Tanzania (Katule, 1992), 8.8, 2.1 and 35 in Mali (Wilson *et al.*, 1987), 10.9, 4.5 and 50 in Sudan (Wilson, 1979) and 8-15, 4-5 and 40-50 in Senegal (Sall, 1990) respectively. The low number of eggs and clutches per year could be attributed to improper records keeping among farmers as well poor management of broody Turkeys (Waibel, 2000).

5.6 Factors Contributing to Low Production

According to the result of this study, the occurrence and treatment of diseases was major challenge in Turkey production. It was indicated that in Africa one of the major constraints to village Turkey's production is the prevalence of various diseases during the rainy seasons (Gueye *et al*., 1998). Ngu *et al*. (2013) also observed that *Histomonas_meleagridis* infection (blackhead) and bacillary white diarrhoea are the main cause of diseases in Turkeys during rainy seasons. Similarly, Benabdeljelil and Arfaoui (2011) also reported that 77% of death in Turkeys could be attributed to disease and poor treatment. The high number of diseases reported among Turkey farmers could be attributed to occurrence of blue comb, round worm infections and also the provision of inadequate feeds to keep animals warm during the rainy season (Wilson, 1995).

5.7 Marketing

The challenges of unstable price, seasonal demand, lack of good market place, poor infrastructure, no problem, sale of diseased turkeys in marketing of Turkeys were similar to results of Bogalle (2010) who conducted a survey on characterization of village poultry production and marketing system in gomma wereda, jimma zone, Ethiopia. It was reported that unstable price and demand seasonality were the problems of egg and live poultry marketing in the study zone. The observed problems with marketing of birds and eggs are due to the fact there is no recognized price regulations systems in the study regions or using public transportation. Moreover, the live bird market in these regions is characterized by small unhygienic selling space and lack of shelter, feed and water (Bogalle, 2010)

5.8 Extension

Information on extension services were provided in areas such exotic Turkey breeds and improved management systems. The availability of extension services in the study zones was as a result of the establishment of various district offices providing extension services across the country at large. This was however in disagreement with Bogalle (2010) who reported that lack of access to credit and relevant technical extension package seems to be a limiting gap in the area of rural household poultry production. This also indicates that MOFA has given due attention to poultry production and considers it a viable enterprise towards boosting the economy (GSS, 2015).

5.9 Ethno-veterinary Practices

The result obtained is consistent with the trend of the findings reported by Bogalle (2010) in local poultry who stated that 88% of farmers provided some form of traditional treatments to their birds. These strategies have also have also been used by Fulani in Nigeria, e.g., to control CBPP outbreaks (Gabalebatse *et al.*, 2013). Maphasa *et al.* (2010) observed the use of the paste and powders to treat livestock's disease in Central Eastern Cape in South Africa. The efficacy and effectiveness of either mono or multi-purpose use of medicinal plants or "esoteric" non-medicinal treatment of Turkey diseases by the farmers in the study region was based on biological resources/natural products. There is a long-standing precedent of natural products serving as a source of novel drugs and drug-like compounds (Guantai and Chibale, 2012).

5.10 Qualitative Traits (Colour Frequency)

The wide variation of plumage colour of local population's Turkey in the Middle-belt of Ghana indicates the existence of a genetic variability. This suggests that the Ghanaian indigenous Turkey's resources are still not highly diluted by exotic breeds. These colour frequencies are in disagreement with Naceur (2014) who found a frequency of the white/black predominated (29). In second place was the bronze (26), black (22) and red/buff (20). These colour frequencies are also in disagreement to those of the study of Savage and Zakrzewska (2006) who found a frequency of 30% of bronze. The black colour belongs to the second most common type of coloration (26%), followed by the pattern of white feathers over all the body with areas of black feathers on the neck, back and wings. Turkeys are of different plumage colours: black, white/black, white, red/buff and bronze, these results are in agreement with the results of

Halbouche *et al*. (2010). When comparing the results of this study with other physiographic regions, black coloured plumage is dominant in Morocco (Benabdeljelil and Arfaoui, 2011), Dalmatian (Ekert *et al.,* 2009) in Mexico. The wide variation of plumage colour of local Turkey could be the result of the genetic variation accumulated through decades of domestication of the species (Crawford, 1992).

5.11 Quantitative Traits (Body Measurement)

The mean body weight of the indigenous Ghanaian Turkeys found in the Middle belt was 5.52±0.03 and 3.16±0.04 kg for the males and females respectively. This disagrees with López-Zavala *et al.* (2008) who stated that the weight ranged between 6.70 and 8.90 kg in males and between 2.90 and 4.35 kg in females contrast to males and females of this study. The values of this study were however higher than those reported by Ogah (2011) from Nigeria Turkey (3.38 Kg for male and 2.65 Kg for female, respectively).

This dissimilarity in size of the male and female is associated to the effect of various hormones that leads to a different growth rate (Naceur, 2014. This result does not agree with those of Ekert *et al*. (2009) and Ogah (2011) in Nigeria. However, the values (length of body, length of beak, length of shank, length of thigh and length of sternum.) of adult females were heavier than those observed by Halbouche *et al.* (2010) from Algeria in Turkeys. Environmental factors play an important role in variation of size of birds. According to Naceur (2014) the variation in the size of the bird is due to the collective effects of humidity, temperature and altitude. With the exception of beak length, sex had significant ($p < 0.05$) effect on traits such as body length, Wing length, head length, sternum length, shank length and thigh length. This means that those measurements could be considered in sexing Turkeys as sexual dimorphism.

Colour variety had a significant ($p<0.05$) effect on wing length. In this trait, the White and Black was superior ($p<0.05$). This suggest that colour is controlled by genes (Sanford, 1996). The effect of the colour on this trait could be due to heterosis, which could be traced to their origin.

5.12 Correlation Coefficient of Body Weight and Body Measurements

The high and significant phenotypic correlations between body measurements and body weights in both sexes suggest high predictableness between the traits in both male and female Turkeys. Ogah (2011) recorded similar trend between body weight and principal body measurements in Turkey, which means selection for body weight may lead to increase in other body measurements given that majority of genes influencing the body weight and body measurements of Turkey are of common attainment. The insinuation here is that, it can be helpful as a selection criterion. This also indicates that there is good relationship between weight and body parameters.

5.13 Interaction Effect of Fixed Factors on Morphometric Traits

The significant effect of sex as well as region on most measurements indicate that the measurement of the performance depends on the region in which they were assessed. This is a case of genotype-environment interaction (Mogre, 2010). This implies that selection for improvement of body weight and size should be done within regions (Mogre, 2010), provided the same genotypes exist in the regions. Colour and sex had significant ($p < 0.05$) effect on all the variables. From a morphological point of view, it is important to consider the type of colour to use in most genetic improvement programme and design of the breeding objectives. This is because body measurements can be influenced by the sexual hormones. Similar effect of sexual hormones on linear body measurement and live weight have been reported in other livestocks species, such quail, lambs, rabbit and sheep (Adedibu and Ayorinde, 2011)

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Based on results of this study, the indigenous Ghanaian Turkeys: The following conclusion are made:

- The birds are generally managed by women
- They have various major constraints such as diseases, poor housing, poor nutrition and no attention given to the improvement of indigenous Turkeys.
- This study also found that there are five (5) indigenous Turkey lines and each showed distinct physical variations for both qualitative and quantitative traits.

- Have wide range of colours and mixture of different colours. The black colour was the largest, followed by the black & white Turkey with no clear-cut difference in most of the morphological traits to the other colours.
- Small in body size with Bono East region having the heaviest birds
- Face problem of poult mortality
- Most of the body traits were highly correlated.

6.2 Recommendations

- Further research works should be steered on characterization of the indigenous Turkeys in the same regions including Genetic, molecular, and immunological characterization.
- Since the birds have already proved their ability under the Extensive rearing system in the study areas, further study should be undertaken to determine their performance under the Intensive, semi-intensive system.
- The efficacy of ethno-veterinary knowledge for preventing and treating Turkey diseases identified in this study need to be fully investigated and integrated in veterinary extension services

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