

***IN SITU* PRODUCTION ENVIRONMENT OF DOMESTICATED HELMETED
GUINEA FOWL AND PHENOTYPIC CHARACTERISATION OF DOMESTICATED
AND WILD HELMETED GUINEA FOWL IN THE SOUTHERN PART OF
BOTSWANA**

MASTER OF SCIENCE IN ANIMAL SCIENCE
(ANIMAL BREEDING AND REPRODUCTION)

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September 2024

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A dissertation submitted to the Department of Animal Sciences in partial fulfilment of the
requirements for the degree of Master of Science (MSc) in Animal Science (Animal Breeding
and Reproduction)

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DECLARATION

I, Gordon Rachaba hereby declare that this dissertation submitted by me to Botswana University of Agriculture and Natural Resources for the degree of Master of Science in Animal Science (Animal Breeding and Reproduction) is my own independent work and has not been previously submitted by me at another University to obtain any qualification. All references and assistance rendered during the production of this work have been duly acknowledged.

.....

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GENERAL ABSTRACT

The objective of the first study was to characterize guinea fowl production environment in the Southern part of Botswana. A structured questionnaire was administered to a total forty two (42) guinea fowl farmers from Kgatleng (n=10), Kweneng (n=18), South East (n=6) and Southern Districts (n=8) to gather data on demographic information of guinea fowl farmers and breeding practices, husbandry practices, feeding, flock health, and marketing channels of guinea fowl. Statistical Package for Social Sciences (SPSS, 2007) was used to generate descriptive statistics, including means, frequencies and percentages. The Chi-square (X^2) test was used to determine statistical differences of categorical data across the districts. The survey revealed that 76.2% of guinea fowl farmers were males. Majority of the respondents (73.8%) had secondary or tertiary education and the households comprised of 2-5 individuals. Most farmers (76.2%) kept guinea fowl for aesthetic value and for own consumption during special occasions. The source of foundation stock was mainly from other local guinea fowl farmers and most farmers (50%) kept less than 20 birds per farm. The most predominant guinea fowl variety was the pearl (95 %). Most farmers (78.6%) did not have any breeding strategy for their birds and did not have selection criteria for both males and females hence ignored animal traits. Guinea fowls were mostly kept on communal farms (57.1%) under an intensive management system (61.9%) and were mostly sold to individuals (57.1%) as live birds. The second study aimed to compare the body weights and linear body measurements of domesticated and wild helmeted guinea fowl varieties in the southern region of Botswana. This study employed 40 adult wild and 160 adult domesticated guinea fowl of both sexes. The collected data were analyzed using general linear models (GLM) procedures of Statistical Analysis System (SAS) and the model included fixed effects of breed and sex and the interaction between breed and sex. Results were summarized as least squares means $\pm$ standard

error and means separation were done by paired t-tests. Live birds were measured for live body weight, body length, wingspan, shank length, and chest circumference. No significant weight differences were seen across domesticated helmeted guinea fowl varieties. All domesticated helmeted guinea fowl varieties were heavier than their wild counterparts. The White guinea fowl variety was longer than other domesticated and wild varieties. The wild guinea fowl had similar shank length with the pearl grey and lavender varieties. There was no significant sex influence on guinea fowl body weight, body length and chest circumference Sexual dimorphism in favor of males was only found for shank length in pearl grey and lavender varieties of domesticated helmeted guinea fowl.

Key words: Demographic Information, Husbandry Practices, Guinea fowl Market, Body Weight, Linear Body Measurements.

DEDICATION

This work is dedicated to my wife and kids, Mrs Marilyn B. Rachaba, Rorisang Rachaba and Zoey Rachaba for the unwavering support and love they have provided throughout my academic journey. Their encouragement has been a constant source of strength, and I am truly blessed to have them by my side. I thank them for being my anchor and believing in my potential.

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CHAPTER 1

INTRODUCTION

1.1 General Introduction

The guinea fowl, an avian species indigenous to Africa, has successfully expanded its habitat to several regions around the globe, including Asia, Australia, Europe, and America (Kayang *et al.*, 2010). This widespread distribution highlights the species' remarkable capacity to thrive in diverse climatic conditions (Moreki and Seabo, 2012). The meat and eggs of guinea fowl have experienced an increase in popularity within several European countries, notably Belgium, where they have emerged as the second most significant source of white meat and eggs, behind chickens (Araujo *et al.*, 2019). The presence of wild guinea fowl in their natural habitat in Botswana persists, despite their domestication over five millennia ago (Nsoso *et al.*, 2003).

Numerous species and varieties of guinea fowl are acknowledged on a global scale. The morphological (external) traits and genetic composition of these animals exhibit significant variations. According to Moreki and Seabo (2012), the helmeted species is considered the most domesticated among all species and is exclusively found in Botswana. Botswana has successfully undertaken the domestication of various guinea fowl varieties, including but not limited to white, pearl, lavender, and royal purple. The pearl grey variety is widely prevalent in natural habitats (wild).

The production requirements of guinea fowl are comparable to those of chickens. Guinea fowls possess the ability to adapt to diverse environmental conditions, hence enabling their maintenance in various management systems. Guinea fowls are kept under intensive production systems, predominantly in nations such as France. In many developing countries, guinea fowl are raised in extensive production systems, allowing them to forage for their own feed (Moreki and Seabo, 2012). Viable alternatives for their production systems include

intensive and semi-intensive approaches, which are contingent upon the specific focus of meat or egg production, as well as the financial resources allocated for constructing facilities and providing feed for the birds.

Guinea fowl farming is not widely practiced by smallholder farmers in Botswana due to its status as an emerging poultry sector. The generation of revenue for rural communities from guinea fowl production holds considerable importance, as it possesses the capacity to mitigate poverty and enhance the overall quality of life. Guinea fowls present a viable option to commonly consumed poultry species such as chickens and turkeys and present an avenue for the diversification of the country's poultry sector. According to Ikani and Dwafang (2004), guinea fowls are characterized by their ease of management and reduced susceptibility to poultry diseases compared to other species.

The government of Botswana has implemented initiatives aimed at promoting guinea fowl production among farmers as a viable alternative to other livestock industries, through the provision of financial support. The government assumes a significant role in mitigating the risk of extinction among wild avian species through the implementation of hunting permits that are granted exclusively during designated periods. Nonetheless, the conservation efforts for these animals may not effectively maintain the genetic diversity present within guinea fowl species. There is an increasing level of apprehension regarding the current state of genetic diversity in animal populations and their conservation. This concern arises from the significant impact of intense selection processes and reduced population numbers, which have led to a decline in global genetic biodiversity among animals. Consequently, it is imperative to prioritize the preservation of genetically unique populations in the context of biological diversity conservation, rather than just focusing on preventing species extinction (Lundqvist *et al.*, 2007). Moreover, a significant gap in knowledge exists pertaining to the diverse strains or varieties, population size, and geographical distribution of these strains throughout the country.

Limited research has been undertaken in Botswana to evaluate the production environment and morphological features of both domesticated and wild guinea fowl species. Gaining a comprehensive understanding of the environmental context in which guinea fowl are raised would facilitate the formulation and execution of initiatives aimed at enhancing and promoting guinea fowl production within the local farming community. Moreover, the examination of disparities in phenotypic traits among animals offers fundamental data for making well-informed choices about conservation efforts and selective breeding practices. The variations serve to differentiate guinea fowls of different varieties as well as influence their capacity to acclimatize to dynamic environments and engage in reproductive processes (Van Dyke, 2008). Consequently, it is imperative to undertake research aimed at delineating the production environment of guinea fowl and evaluating the phenotypic variability exhibited by these avian species.

Fig 1.1 Varieties of domesticated and wild guinea fowl in Botswana.



a) Domesticated Lavender



b) Domesticated White and pearl



c) Domesticated Royal purple



d) Wild Pearl grey

1.2 Justification

The rationale for this proposition is as follows.

The essential elements that may contribute to the achievement of sustainable animal management are the characterization, inventory, and monitoring of animal genetic resources. The acquisition of knowledge pertaining to the phenotypic and genetic attributes of diverse species and varieties, along with the meticulous documenting and ongoing surveillance of their production environment, will greatly enhance the efficacy of animal genetic improvement and conservation measures. The evaluation of variations in morphological traits offers significant insights into species diversity which is crucial for making informed decisions regarding breeding and conservation efforts. Despite the importance of characterization, very limited research has been conducted on characterization of different varieties of domesticated and wild helmeted guinea fowl in their natural production environment following internationally recognized standards governing the characterization of animal genetic resources.

In theory, wild guinea fowl population should possess greater diversity in comparison to domesticated populations. This is because domesticated populations are a subset of the wild population and are subjected to artificial selection which reduces diversity. This, however, is not always the case, as natural disasters such as droughts, floods, disease outbreaks, and other adverse climatic factors can result in population bottlenecks and random genetic drift in natural environments which also reduces diversity. It is therefore crucial to conduct comprehensive characterization of both wild and domesticated guinea fowls to determine their diversity status and inform conservation and breeding strategies.

1.3 Main Objectives

The main objectives of this study were to:

- i. Assess the phenotypic diversity of domesticated and wild guinea fowl in the Southern part Botswana.
- ii. Describe the production environment for domesticated helmeted guinea fowls in the Southern part of Botswana.

1.3.1 Specific Objectives

Specific objectives of this study were to:

- i. Compare quantitative linear body measurements of different varieties of domesticated helmeted guinea fowl and wild guinea fowl in the Southern part of Botswana.
- ii. Perform demographic profiling of guinea fowl farmers and assess the production environment of guinea fowl in the Southern part of Botswana

1.4 Hypothesis

H₀: There are no significant differences in linear body measurements between different varieties of domesticated helmeted guinea fowl and wild helmeted guinea fowl in the Southern part of Botswana

H_a: There are significant differences in linear body measurements between different varieties of domesticated helmeted guinea fowl and wild helmeted guinea fowl in the Southern part of Botswana

H₀: There are no significant differences in the demographic profiles of farmers and the production environment of different varieties of domesticated helmeted guinea fowl across districts in Southern part of Botswana

H_a: There are significant differences in the demographic profiles of farmers and the production environment of different varieties of domesticated helmeted guinea fowl across districts in Southern part of Botswana

CHAPTER 2

LITERATURE REVIEW

Introduction

Guinea fowls are valued for their meat and egg production. Their hardiness allow them to thrive in diverse environments (Ikani and Dwafang, 2004). This makes them useful for small-scale farmers with limited resources. Characterisation of their morphological features and production environment is crucial as it informs decisions on production improvement, sustainable utilization and conservation. This review therefore will focus on species and distribution of guinea fowl, their origin and domestication, population overview, habitat, production systems, breeding and reproductive performance, characterization, market and challenges associated with guinea fowl production.

2.1 Guinea Fowl Species and Distribution

Guinea fowl are taxonomically classified under the order *Galliformes*, which is a lower order of the *Alectoropodes*. They belong to the family *Phasianidae* and the subfamily *Numididae*. Myers et al. (2020) identified four distinct genera of guinea fowl: *Acryllinum*, *Agelastes*, *Guttera*, and *Numida*. These genera encompass a variety of species within their respective classifications. According to Panyako (2018) different guinea fowl species encompass the helmeted species (*Numida meleagris*), which are mainly domesticated, as well as the vulturine guinea fowl (*Acryllinum vulturium*), the white-breasted guinea fowl (*Agelastes meleagrides*) found in western Africa, the plumbed guinea fowl (*Guttera plumifera*), the crested guinea fowl (*Guttera pucherani*), and the black guinea fowl (*Agelastes niger*). Botswana is home exclusively to the species of helmeted guinea fowl, as stated by Moreki (2009).

Table 2.1: Geographical Distribution of Guinea in the world

Helmeted (<i>Numida meleagris</i>)	• Found in most sub-Saharan countries • Reared commercially in Europe, America and Asia
Vulturine (<i>Acryllium vulturium</i>)	• Found in East Africa
White breasted (<i>Agelastes meleagrides</i>)	• Found in West African forests of Cote d'Ivoire, Ghana, Guinea, Liberia and Sierra Leone
Plumbed (<i>Guttera plumifera</i>) and Black (<i>Agelastes niger</i>)	• Found in humid forests of Central Africa
Crested (<i>Guttera pucherani</i>)	• Found in open forests, woodlands and savanna
<i>Source : Panyako, 2018</i>	

2.2 The Origin and Historical Development of Domestication

The guinea fowl species, known as *Numida meleagris*, is indigenous to Africa and mostly found in the hot and arid regions of tropical West Africa (Kayang *et al.*, 2010). Over time, these birds have been dispersed to many regions of the globe due to human migration patterns. Various theories abound on the original domestication of these avian species. According to a study conducted by Oakland Zoo (2001), the process of domestication was initially carried out by ancient Egyptians. According to Vignal *et al.* (2018), the process of domesticating guinea fowl is thought to have taken place approximately 2000 years ago in Mali and Sudan. This domestication was primarily motivated by the bird's potential as a food source, its ability to emit warning calls in the presence of imminent threats, and its capability to ingest parasites. According to Greek mythology, the initial instances of domestication can be traced back to the transformation of King Meleager's sisters into birds by the goddess Artemis, resulting in the birth of guinea fowl. During the ancient periods of Greece and Rome, avian species were used for sacrificial purposes and subsequently were domesticated within agricultural settings. The

presence of these birds in Europe became obscure during the Dark Ages but resurfaced in the later period known as the late Middle Ages (1300-1500) (Chantale, 2003). The practice of intensive production, accompanied by the subsequent implementation of breeding procedures, was subsequently adopted by several countries such as France, the United States, and other regions throughout the globe (Houndonougbo *et al.*, 2017). There is a prevailing belief that domesticated guinea fowl can trace their lineage back to the *Numida meleagris* strain, also known as the helmeted guinea fowl. These domesticated fowl are primarily raised for their high-quality meat and eggs. According to Kgakole *et al.* (2016), the domesticated helmeted guinea fowl varieties found in Botswana encompass pearl grey, lavender, royal purple, and white varieties.

2.3 Population Overview

Currently, there is a lack of statistical data regarding the population of wild guinea fowl in Botswana. The decline in wild populations of guinea fowl can be attributed to various factors, including habitat fragmentation and destruction and other factors such as diseases, poaching, and predation by co-inhabitants (Tamrat and Subramanian, 2013). Culling as a management practice in domesticated guinea fowls can also lead to a reduction in numbers and can occur due to advanced age, low productivity, and illness or disease (Duncan 2005; Pesti and Smith, 2011; Ferreira and Smith 2018). According to Moreki and Seabo (2012), the implementation of government-funded financial support programs for farmers in Botswana starting in 2007 has resulted in a notable expansion of guinea fowl farming. However, the lack of effective project monitoring by extension services has hindered the ability to accurately determine the precise quantity of guinea fowl being farmed. The Livestock Management and Infrastructure Development (LIMID) monitoring report of 2010 included data on the population of farmed guinea fowl in each district, as follows:

Table 2.2 : Population dynamics of Guinea fowl across the districts of Botswana			
District	No. of birds bought	No. of birds present	Percent change
Southern	751	662	-11.9
Central	1624	1875	15.5
Gantsi	64	66	3.13
Kgatleng	150	72	-52
Kgalagadi	300	260	-13.3
North East	387	1839	375
South East	250	285	14
Kweneng	485	560	15.5
North West	224	150	-33.0
Chobe	0	0	0
Totals	4235	5769	36.2
<i>Source: LIMID Report 2010</i>			

2.4 Habitat, Production Systems and feeding behaviour of guinea fowls.

The widespread presence of guinea fowl across Africa and their presence in many regions globally suggests their ability to adapt to a wide range of climatic conditions (Moreki and Seabo, 2012), hence enabling them to inhabit multiple environments and adapt to different production systems. Guinea fowls demonstrate a remarkable ability to adapt to many habitats, displaying particular preference for grasslands, thorn veld, and regions near agricultural land (Riddles, 2015). According to Ayeni (1984), guinea fowl prefer feeding habitats characterised by abundant herbaceous grasses and nesting sites situated beneath the canopies of bushes and trees. According to Crowe (2000), the extensive and intricately branching shrubs function as a form of defense for these avian species. Hence, it is imperative to prioritize the preservation of natural ecosystems when undertaking conservation efforts for guinea fowls (Linlokken, 2018).

Guinea fowl farming is prevalent among small-scale farmers in Africa (Saina, 2005). Shoyombo *et al.* (2010) identified three primary production systems employed for the rearing of Guinea fowl, namely extensive, semi-intensive, and intensive. Guinea fowls are mostly

reared using extensive system, specifically free-range method at subsistence level (Weimann *et al.*, 2016; Traoré *et al.*, 2018; Portillo-Salgado *et al.*, 2022). The extensive production system has the potential to facilitate the interaction between domesticated guinea fowls and wild ecotypes, as highlighted by Moreki and Radikara (2013). This interaction may lead to interbreeding and the subsequent exchange of genetic material. In Botswana, guinea fowl farming is at infancy stage, with the birds being raised mostly under the semi-intensive system (Moreki and Seabo, 2012).

According to Saina (2005), guinea fowl exhibit a somewhat non-selective feeding behavior, consuming a diverse range of plant and animal-based food sources. Adeyemo and Oyejola (2004) observed that in their natural habitat, guinea fowls consume a diverse range of feedstuff, including but not limited to weeds, grasses, insects, and grains. In the context of Botswana, it is common practice for farmers to utilize commercial feeds for poultry, as there is currently lack of commercially developed diets specifically formulated for guinea fowls (Moreki and Seabo, 2012).

2.5 Breeding and Reproductive Performance

To optimize productivity, farmers must consider the preferred physical and behavioral characteristics of their breeding animals (Bilcik and Estevez, 2005). Most traditional poultry breeders commonly practice unregulated breeding practices and a deficiency in structured mating procedures (Dana *et al.*, 2010). This pattern is also observed in guinea fowl production. In the context of indigenous chicken farming in Rwanda, Mahoro *et al.* (2018) highlight that poultry breeders aim to carefully choose breeding stock based on certain criteria such as body weight, size, growth rate, and disease resistance.

The strain, climate, and feed quality affect reproductive success of guinea fowl (Houndonougbo, 2017). Limited research on guinea fowl reproduction has delayed genetic

progress compared to other bird species like chickens, ducks, turkeys, and quail (Araújo *et al.*, 2019). Mallmann *et al.* (2001) report that guinea fowl have inadequate maternal capacity. Thus, domesticated hen eggs require artificial or domestic chicken incubation. These birds breed seasonally from September to April the following year (Moreki, 2009). According to Konlan *et al.* (2011), they lay their eggs during the rainy season every 40 weeks. According to Moreki and Seabo (2012) in Botswana guinea fowl lay eggs for a period of nine months starting in spring. Testicular weight, which is affected by nutrition and illumination, determines male sperm quantity and quality (LeCoz-Douin, 1992). Guinea fowl need a higher sex ratio to reproduce successfully (Houndonougbo, 2017). One male to five females is recommended to produce fertile eggs (Moreki, 2009).

2.6 Market for Guinea fowl and Products

The market pertaining to Guinea fowl and its associated products is perceived to have potential to develop into profitable enterprise, considering the investments made in production and the resulting returns (Balma and Richard, 2016). Abdul-Rahman (2019) asserts that the augmentation of guinea fowl production necessitates the fulfilment of numerous deficiencies inside the value chain. Guinea fowls are commonly reared by farmers because of their significant commercial worth and their ability to lay a substantial number of eggs (Soara *et al.*, 2020). Farmers engage in the rearing of guinea fowl primarily for personal consumption of both meat and eggs, while any surplus is sold to generate additional income for the sustenance of their households (Traore *et al.*, 2019). In several African Countries, guinea fowls are predominantly sold to farmers as live birds (Dahouda *et al.*, 2007; Moreki and Seabo, 2012; Balma and Richards, 2016; Kouassi *et al.*, 2019). According to Traore *et al.* (2018) the responsibility of marketing birds and their associated products primarily rests with men.

2.7 Demographic Information of Guinea Fowl Famers

Male dominance in guinea fowl production has been recorded in Burkina Faso (Traore *et al.*, 2018), Benin (Orounladji, 2022), the Republic of Côte d'Ivoire (Kouassi *et al.*, 2019), and Togo (Soara *et al.*, 2020). According to several research studies (Badubi *et al.*, 2004; Soara *et al.*, 2020; Anderson *et al.*, 2022), most guinea fowl farmers are 28 years of age or older. Soara *et al.* (2020) reported that 97.9 % of guinea fowl farmers in Togo were married and only 2.1 % divorced, while Kouassi *et al.* (2019) reported 84.5 % married and 15.5 % single guinea fowl farmers in Côte d'Ivoire. In Burkina Faso it was reported that 85,3% of guinea fowl farmers were married, 13.3 % cohabiting and 1.3 % single. In Togo 33 % of guinea fowl farmers had no formal education with the rest having either secondary (31%), primary (25.4%), koranic (6.1%) or University education (4%) (Soara *et al.*, 2020) while about one third (34.5%) of guinea fowl farmers in Benin were illiterate and two thirds had primary (36.4%), secondary (26.1%) and tertiary (3.0%) education, respectively (Orounladji, 2022). According to Balma and Richard (2016), there is high illiteracy level of 67 % among guinea fowl farmers in Ghana. Guinea fowl farmers' households in Northern Ghana had 15 members on average (Johnson *et al.*, 2021). Traore *et al.* (2018) and Soara *et al.* (2020) found that guinea fowl farmers also grew crops.

2.8 Challenges of Guinea Fowl Production

According to Moreki and Radikara (2013), a comprehensive report has established that guinea fowl farmers in Africa encounter various challenges. These obstacles encompass substandard housing conditions, inadequate extension services, insufficient feeding practices, elevated keet mortality rates, predation issues, inadequate health management, limited financial resources, and high input expenses. Multiple factors contribute to high mortality rates observed in guinea fowl farming and the principal factors are diseases and predation (Houndonougbo *et al.*, 2017;

Traore *et al.*, 2018; Shoyombo *et al.*, 2022). The highest keet mortality rate is primarily during the first month following hatching (Dahouda *et al.*, 2007).

2.9 Characterization

Characterization refers to the systematic procedure of discerning and delineating discrete breed populations, encompassing the analysis and depiction of their outward attributes, productive capacities, and genetic traits. According to Brown *et al.* (2017), characterization furnishes the necessary data pertaining to the utilization and conservation of animal genetic resources. The characterization of animal genetic resources in Botswana has been conducted on several species, including goats, cattle, and sheep and to a very limited extent on guinea fowl under an intensive production system (Kgakole *et al.*, 2016). Phenotypic Characterization focuses on the systematic documentation of observable (external) and production characteristics of animals in their production environment (FAO, 2012). Assessment of phenotypic characteristics is based on the following traits:

2.9.1 Qualitative Traits

Qualitative traits are discrete in nature and are often controlled by a single pair of genes or at most a few genes and are mostly unaffected by environmental factors. The presence of heterogeneity in these traits has a significant role in enhancing animal genetics, as noted by Agbolusu *et al.* (2014) and Panyako *et al.* (2016). According to Gwaza *et al.* (2018), the data gathered on morphological diversity within and among ecotypes has the potential to reveal valuable insights for the conservation and future utilization of these ecotypes. The phenotypic characteristics of chicken, such as coat plumage, skin, shank and earlobe color, and comb type, are valuable descriptors for their characterization (FAO, 2011). These descriptors are also relevant for characterizing guinea fowl due to the similarities and relatedness between these two avian species.

In a study conducted by Agbolosu *et al.* (2014), it was observed that out of a sample of 300 guinea fowls obtained from 204 farmers, nine distinct colour variations were detected. Most of the guinea fowls exhibited a pearl grey color, while the brown pied color variant was the least prevalent. Furthermore, there was a range of differences in the forms of helmets, colors of earlobes, shank color, skin pigmentation, skeletal structures, and colors of helmets. The study by Agbolosu *et al.* (2014) also indicated significant variability in the phenotypic characteristics of indigenous Ghanaian guinea fowl, suggesting the presence of a diverse genetic reservoir that might be utilized for targeted breeding to align with customer preferences. Brown *et al.* (2017) examined plumage color of guinea fowl in Northern Ghana and found that pearl grey hue was the most prevalent color, while the presence of brown, light grey, and sky blue colors was relatively rare.

2.9.2 Quantitative Traits

The primary source of phenotypic variation in animal populations arises from the multiple interacting loci, with allelic effects being influenced by environmental factors (Mackay *et al.*, 2009). These phenotypes for quantitative traits can be objectively measured. This set of traits pertains to the size and dimensions of animal anatomical structures, as well as qualities related to animal productivity, as outlined in the standards for animal production and health by the Food and Agriculture Organisation (FAO, 2012). The linear body dimensions (body length, wingspan, shank length and chest circumference) and body weight, as outlined for chickens in the FAO (2011), are the pertinent quantitative trait descriptors for guinea fowl.

Gwaza and Elkana, (2017) have noted the measurements of the broad helmeted guinea cocks to be 9.60 ± 0.12 cm for shank length, 52.78 ± 0.47 cm for wing span, 38.53 ± 0.20 cm for chest circumference, 17.12 ± 0.13 cm for neck length, and 1.49 ± 0.04 cm for helmet width versus 9.02 ± 0.10 cm for shank length, 50.54 ± 0.60 cm for wing span, 37.67 ± 0.26 cm for

chest circumference, 16.47 ± 0.16 cm for neck length, and 1.31 ± 0.05 cm for helmet width for the narrow-pointed helmeted guinea cocks in Nigeria. Kgakole *et al.* (2016) reported average body weights of male and female of pearl (1455.71 ± 31.98 g; 1503.64 ± 36.07 g), lavender (1446.14 ± 31.98 g; 1343.17 ± 34.54 g) and royal purple (1603.43 ± 45.22 g; 1494.55 ± 36.07 g) varieties under an intensive management system in Botswana. Orounladji *et al.* (2021) reported wingspan of 41.48 ± 2.70 cm, 41.43 ± 2.40 cm, 41.72 ± 1.14 cm and 41.86 ± 0.79 for the white, pearl grey, lavender and royal purple varieties, respectively. The average body weight of the wild guinea fowl in Kenya was 1538 ± 214 g (Panyako *et al.*, 2016). Guinea fowls in Nigeria were reported to have body length ranging from 32.09 cm to 37.47cm (Fajemilehin, 2014).

2.9.2.1 Effect of Genotype on Morphometric Characteristics of Guinea Fowl

Numerous research has been undertaken to examine the impact of genotype on body weight and morphometric characteristics of guinea fowl. According to Panyako *et al.* (2016), the domesticated guinea fowl varieties exhibited greater body weights in comparison to their wild counterparts. The weight of birds is influenced by the quality of their feed, with a positive correlation observed between protein content and bird weight (Seabo *et al.*, 2011). Bernacki *et al.* (2012) indicated that varieties with larger chest circumference are best suited for broiler production. The study conducted by Mróz *et al.* (2015) examined the impact of genotype on the weight of guinea fowl and determined that it was not statistically significant. Diverse morphometric characteristics have been documented among various guinea fowl varieties. According to Dudusola *et al.* (2021), the pearl variety had greater body length in comparison to the lavender, black and white varieties. Panyako (2018) observed that the wild variety exhibited greater morphometric measurements and weight values in comparison to the domesticated varieties in Kenya. According to Seabo *et al.* (2011), wild guinea fowl in Botswana have been captured and subsequently raised in captivity. Fajemilehin (2014) and Dudusola *et al.* (2021) reported significant differences in body weight between pearl, lavender,

black (royal purple) and white varieties in Northwestern (Sokoto State) and South western (Oyo and Osun States) Nigeria, respectively. Dudusola *et al.* (2021) reported average body weights of 1.33 ± 0.11 kg, 1.26 ± 0.03 kg, and 1.18 ± 0.04 kg and 1.08 ± 0.02 kg for the pearl, black, lavender and white guinea fowl, respectively in Nigeria.

2.9.2.2 Effect of Sex on Morphometric Characteristics of Guinea Fowl

When conducting an analysis of animals, irrespective of their specific breed, it is imperative to make a comparative assessment of the distinguishing traits exhibited by both males and females. In their study, Rahman *et al.* (2015) identified commonalities among the majority of parameters including head length, head width, neck length, body length, wingspan, body height and body weight. According to Panyako (2018) male guinea fowl in Kenya had considerably higher and statistically different values than their female counterparts in body length (448.70 ± 44.82 vs 432.27 ± 44.82 mm), shank length (92.35 ± 4.30 vs 89.07 ± 3.93 mm), live weight (1476.09 ± 194.58 vs 1409.09 ± 213.30 g), wing length (253.15 ± 39.24 vs 252.82 ± 27.01 mm), head size (74.35 ± 6.03 vs 72.27 ± 6.34 mm), helmet width (16.22 ± 4.8 vs 15.18 ± 4.34 mm) and helmet height (32.89 ± 6.95 vs 28.86 ± 6.07 mm). Similarly, Yakubu *et al.* (2022) reported body weight (1.49 vs 1.43 kg), head thickness (11.12 vs 10.94 cm), shank length (7.12 vs 7.06 cm), neck circumference (7.38 vs 7.35 cm), wing length (15.57 vs 15.18 cm), body length (37.11 vs 35.99 cm), chest circumference (30.31 vs 29.44 cm) and thigh length (11.07 vs 10.81 cm) for male and female guinea fowls in Nigeria. According to Brown *et al.* (2017), an analysis of the sex by variety interaction indicated that male individuals belonging to the pearl pied variety exhibited significantly smaller measurements in body weight (1.12 kg), body length (41.05 cm), and chest circumference (26.15 cm) compared to males of the pearl grey (1.25 kg, 42.45 cm and 26.85 cm) and white (1.29 kg, 43.50 cm and 27.60 cm) varieties, respectively.

2.9.2.3 Sexual dimorphism

McPherson and Chenoweth (2012) have proposed that sexual dimorphism serves the purpose of enhancing the reproductive success of individuals, particularly males. Studies by Panyako (2018), Etienne *et al.* (2021), and Nahashon *et al.* (2006) indicated the absence of sexual dimorphism across the guinea fowl species examined. Dudusola *et al.* (2021) discovered that guinea fowl exhibited sexual dimorphism in terms of body weight and several other parameters examined in their study as per Table 2.3 below:

Table 2.3 Sexual dimorphism displayed by guinea fowl in Nigeria (Dudusola *et al.*, 2021)

Parameter	Males	Females
Body weight (kg)	1.37± 0.23 ^a	1.25±0.22 ^b
Shank length (cm)	7.60±0.11 ^a	7.38±0.04 ^b
Thigh length (cm)	14.54±0.37 ^a	13.60±0.51 ^b
Body length (cm)	46.69±0.76 ^a	45.96±0.43 ^b
Neck length (cm)	14.36±0.38 ^a	14.10±0.15 ^b
Wing length (cm)	20.91±0.73 ^a	19.90±0.19 ^b
Body circumference (cm)	32.62±0.87 ^a	31.58±0.67 ^b
Wing span (cm)	47.01±0.05 ^a	42.52±1.43 ^b
Wattle length (cm)	2.63±0.07 ^a	1.77±0.04 ^b
Helmet height (cm)	2.52±0.08 ^a	1.99±0.04 ^b

SUMMARY

Guinea fowl production offers an avenue for the diversification of the country's poultry sector and an opportunity to improve food security and stimulate economic growth, particularly in rural areas. The phenotypic characterisation of guinea fowl in other countries has revealed a wide range of diversity that could be used for future genetic improvement and offers baseline information for conservation strategies. Research on the production environment and phenotypic characteristics of guinea fowl in Botswana is therefore crucial in order to tackle production challenges and understand their diversity status. This knowledge will help inform conservation and breeding strategies.

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CHAPTER 3

IN SITU CHARACTERISATION OF GUINEA FOWL PRODUCTION ENVIRONMENT IN THE SOUTHERN PART OF BOTSWANA

ABSTRACT

The objective of this study was to characterize guinea fowl production environment in the southern part of Botswana. A structured questionnaire was administered to gather data on demographic information of guinea fowl farmers and breeding practices, husbandry practices, feeding, herd health and marketing channels of guinea fowl. A total forty two (42) guinea fowl farmers from Kgatleng (n=10), Kweneng (n=18), South East (n=6) and Southern Districts (n=8) were interviewed. Statistical Package for Social Sciences (SPSS, 2007) was used to generate descriptive statistics, including means, frequencies and percentages. The Chi-square (X^2) test was used to determine statistical differences of categorical data across the districts. The survey revealed that 76.2% of respondents were males. Majority of the respondents (73.8%) had secondary or tertiary education and the households comprised of 2-5 individuals. Most farmers (76.2%) kept guinea fowl for aesthetic value and for own consumption during special occasions. The source of foundation stock was mainly from other local guinea fowl farmers and most farmers (50%) kept less than 20 birds per farm. The most predominant guinea fowl variety was the pearl (95 %). Most farmers (78.6%) did not have any mating strategy for their birds and did not have selection criteria for both males and females hence ignored animal traits. Guinea fowls were mostly kept on communal farms (57.1%) under an intensive management system (61.9%) and were mostly sold to individuals (57.1%) as live birds.

The findings of this research indicate that smallholder farmers raise guinea fowl for subsistence purposes, as there was no established market for guinea fowl products. Increasing

the scale of production could potentially be enhanced by implementing more effective management strategies and conducting market research.

Key words: Demographic Information, Husbandry Practices, Guinea Fowl Market

3.1 INTRODUCTION

Guinea fowl production enterprise is at an infancy stage in Botswana. In pursuit of the sustainable development goals, the government of Botswana implemented a strategy to encourage the rearing of guinea fowl (Moreki and Seabo, 2012.). This initiative aimed on contributing to the global objective of eradicating hunger in the face of increasing human population growth (FAO, 2015). The ever-increasing human population, urbanization coupled with income gain, and more inclination towards red meat into their food bowl continue to fuel the structural changes in the livestock sector. Guinea fowl possess a beneficial impact on human growth and development. The consumption of guinea fowl meat is advantageous due to its high protein content, low fat level, minerals, and vitamins as well as rich supply of energy (Śmiecińska *et al.*, 2022). According to Moreki (2009), guinea fowl have the potential to yield approximately 100 or more eggs per year when properly managed. This characteristic renders them suitable for the purpose of successful egg production. The utilization of guinea fowl feathers in ornamental crafts and jewelry can serve as a valuable source of money for the family. These avian species further exhibit robustness, lower susceptibility to prevalent diseases observed in other poultry species and requires less investment in terms of production inputs (Saina *et al.*, 2005). These attributes render them suitable particularly to impoverished farmers in the tropics.

Guinea fowl are reared within diverse production systems that are shaped by cultural practices, belief systems, and technological advancements. Despite the potential contributions to livelihoods, the production performance of guinea fowls remains low. According to Portillo-Salgado *et al.* (2022.), several reasons have been identified as contributing to the suboptimal productivity of guinea fowls in Africa. These issues encompass a deficient herd health programme, the presence of predators, instances of famine, incidents of theft, and lack of information pertaining to effective aviculture practices for rearing these avian species. The

nation of Botswana currently faces a lack of comprehensive data regarding the production characteristics of guinea fowl. This scarcity of information hinders the ability to develop effective and sustainable breeding programs and impairs efforts to enhance productivity in this particular species.

The characterization of the production environment in which animals are raised is a method that can be employed to get insight into the adaptation of genetic resources of any given species (FAO, 2015). It further holds significant importance in the management of animal genetic resources as well as decisions on animal improvement and conservation methods. The objective of this study was therefore to characterize the production environment of domesticated helmeted guinea fowl in the Southern part of Botswana since the majority of guinea fowl farmers are found in the Southern region of the country (LIMID report, 2010)

3.2 MATERIALS AND METHODS

3.2.1 Study area

The study was conducted in the southern region of Botswana, in the districts of Kgatleng (24° 15' 0" S, 26° 30' 0" E), Kweneng (24° 0' 0" S, 25° 0' 0" E), South East (25° 0' 0" S, 25° 45' 0" E), and Southern (25° 0' 0" S, 25° 0' 0" E) as illustrated in Figure 3.1. The region is characterized by elevated temperatures (22–38°C) between the months of August to May, and correspondingly lower temperatures (6–20°C) between May and August. The precipitation patterns exhibit a lack of consistency and demonstrate interannual variability ranging from 450mm to 550 mm with most occurring from November to May. The region is characterized by savanna vegetation which includes tall grasses, shrubs, and trees. The study area has different soil textures ranging from fine sands to fine loamy and fine sand to sandy loam.

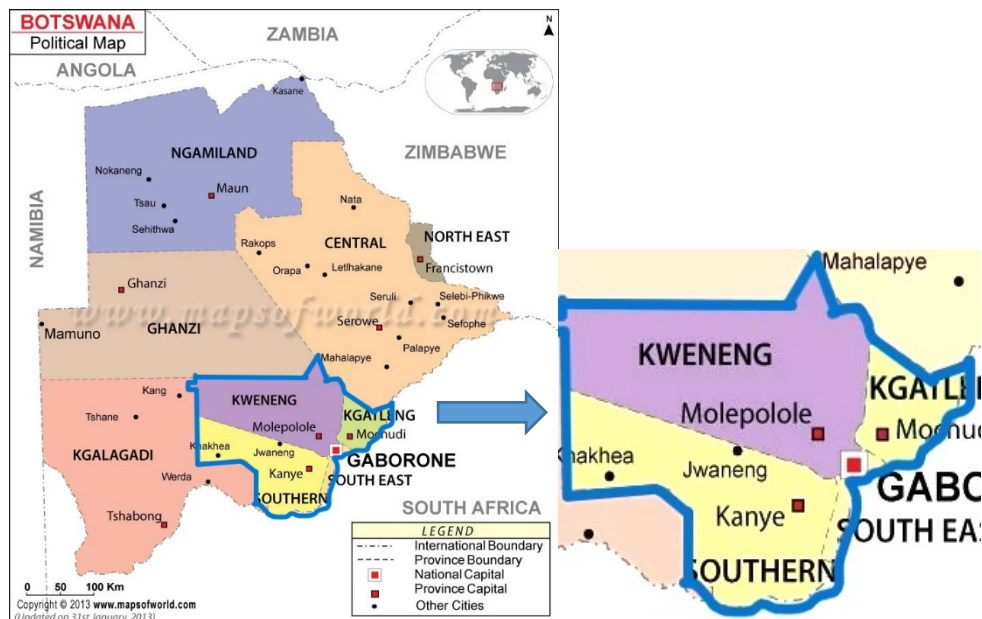


Figure 3.1 Map of Botswana depicting the Study Area

3.2.2 Study design

Four districts were purposely selected in the southern region of Botswana; Kgatleng, Kweneng, South East and Southern district. The guinea fowl farmers were selected purposely in each district based on the presence of guinea fowl on their farms. The information on the guinea fowl farms was obtained from the department of Wildlife and National Parks. A structured questionnaire (Appendix A) was administered to collect information on farmer demographic information, breeding objectives, importance of guinea fowls to the household, husbandry practices, feeding, flock health, marketing, and culling practices. The questionnaire was carried out from December 2022 to March 2023 in both official languages that is Setswana and English depending on the farmer's preference. All the interviewed farmers signed a consent form (Appendix B). Out of the already few guinea fowl farmers, a portion of them declined to participate in the interview, resulting in an even small sample size.

3.2.3 Statistical Analysis

The questionnaire data was cleaned and coded in Micro-Soft Excel (2010) and analyzed using the Statistical Package for Social Sciences (SPSS, 2007) to generate descriptive statistics,

including means, frequencies and percentages. The Chi-square (X^2) test was used to determine statistical differences of categorical data across the districts.

3.3 RESULTS

The survey attracted forty-two (42) respondents engaged in guinea fowl production in four districts of the southern part of Botswana: Kgatleng, Kweneng, South-East and Southern. The majority of the respondents were males (76.2%) with the 38.1% of guinea fowl farmers aged over 50 years of age. Most of the respondents (59.5%) were heads of households and 78.6% of these households were headed by males while female heads of household represented 21.4 % (Table 3.1). In most instances, each household comprised of 2-5 individuals. Most of the farmers were married (57.1%) and most of them had either secondary (38.1%) or tertiary (35.7%) education. The guinea fowls were mostly taken care of using family labor (28.6% by owner and other 28.6% by family members) followed hired employees at 35.7%. The targeted households/farms were mainly engaged in integrated farming (71.4%) and a few (28.6%) kept livestock only. The common livestock kept by each farm included poultry (35.7%), poultry and small stock (40.5%), small stock and cattle (16.7%), poultry and pigs 2.4 %. There were no significant differences across the districts on the demographic information of guinea fowl farmers

Table 3.1: Demographic Information of guinea fowl famers in the southern region of Botswana

Variable	Districts				Overall	X ² P-Value
	Kgatleng (n=10)	Kweneng (n=18)	Southeast (n=6)	Southern (n=8)		
Sex of respondents (%)						0.61
Male	90	72.2	50	87.5	76.2	
Females	10	27.8	50	12.5	23.8	
Age of respondent (%)						0.40
20-30	10	11.1	-	-	7.1	
31-40	20	38.9	50	25	33.3	
41-50	50	5.6	-	37.5	21.4	
more than 50	20	44.4	50	37.5	38.1	
Marital status (%)						0.10
Single	50	44.4	33.3	25	40.5	
Married	50	55.6	50	75	57.1	
Widowed	-	-	16.7	-	2.4	
Level of education (%)						0.77
None	10	11.1	-	-	7.1	
Primary	-	22.2	16.7	25	16.7	
Secondary	50	22.2	66.7	75	38.1	
Tertiary	40	38.9	16.7	-	35.7	
Non-formal	-	5.6	-	-	2.4	
Position of respondent in a Household (%)						0.48
Head of household	60	66.7	50	50	59.5	
Spouse	10	5.6	16.7	-	7.1	
Relative	10	11.2	-	12.5	9.5	
Other	20	16.7	33.3	37.5	23.8	
Head of Household (%)						0.27
Male	80	83.3	50	87.5	78.6	
Female	20	16.7	50	12.5	21.4	
No. of people in Household (%)						0.40
Less than 2	20	38.9	16.7	-	23.8	
2-5	70	44.4	83.3	87.5	64.3	
more than 5	10	16.7	-	12.5	11.1	
Who looks after GF %						0.93
Owner	30	27.8	50	12.5	28.6	
Family member	30	33.3	16.7	25	28.6	
Employee	30	27.8	33.3	62.5	35.7	
Owner and family member	10	5.6	-	-	4.8	
Family member and employee	-	5.6	-	-	2.4	
Farming activities (%)						0.93
Livestock	30	27.8	33.3	25	28.6	
Integrated	70	72.2	66.7	75	71.4	
Class of livestock (%)						0.49
Poultry	50	27.8	33.3	37.5	35.7	
Poultry and small stock	40	44.4	33.3	37.5	40.5	
Poultry, small Stock, cattle	10	22.2	16.7	12.5	16.7	
Poultry and others	-	5.6	-	12.5	4.8	
Poultry, small stock, others	-	-	16.7	-	2.4	

GF= Guinea fowl

Most of the households engaged in guinea fowl farming were mostly dependent on farming (42.9%) as source of income followed by wages/salaries (28.6%) earned from formal employment (Table 3.2). Most respondents kept guinea fowl for aesthetic value (76.2%) and as alarm against intruders followed by own meat consumption (7.1%) during special occasions. There were no significant differences across districts on the responses to the source of income and reasons for keeping guinea fowl.

Table 3.2: Source of income and reasons of keeping guinea fowls by farmers in the southern region of Botswana.

Variable	Districts				Overall %	X ² P-Value
	Kgatleng (n=10)	Kweneng (n=18)	South East (n=6)	Southern (n=8)		
Source of income (%)						0.22
Farming	50	50	50	12.5	42.9	
Home industries	-	16.7	-	25	11.9	
Salaries	50	11.1	16.7	50	28.6	
Others	-	16.7	16.7	12.5	11.9	
Farming and others	-	5.6	-	-	2.4	
Farming and home industries	-	-	16.7	-	2.4	
Reasons for keeping GF (%)						0.66
Meat	-	-	-	37.5	7.1	
Eggs	-	5.6	-	-	2.4	
Agro tourism	10	5.6	16.7	-	7.1	
Aesthetic Value	80	88.9	66.7	50	76.2	
Meat and others	10	-	-	-	2.4	
Eggs and others	-	-	16.7	-	2.4	
Meat and eggs	-	-	-	12.5	2.4	

N= sample size. %= percentage

All the households engaged in guinea fowl farming in the southern part of Botswana obtained foundation stock entirely from other local guinea fowl farmers and most households (50%) kept less than 20 birds (Table 3.3). Most of the households (52.4%) flock composition comprised adult males, adult females and keets followed by households who kept a combination of adult males and adult females at 42.9%. Comparatively higher number of households (42.9%) across the districts kept the pearl grey variety and only 2.4% of the

households across the districts kept the white variety. The population of guinea fowl comprised about 95% pearl variety, 2.5 % lavender, 1.5 % royal purple and 1 % white guinea fowl.

Table 3.3: Flock dynamics of guinea fowl

Variable	Districts				Overall %	X ² P-Value
	Kgatleng (n=10)	Kweneng (n=18)	Southeast (n=6)	Southern (n=8)		
Source of foundation						
Stock (%)						
Local farmers	100	100	100	100	100	
Number of GF kept (%)						0.42
less than 20	30	72.2	50	25	50	
20-50	-	11.1	16.7	37.5	14.3	
51-80	20	-	16.7	12.5	9.5	
81-100	10	5.6	-	-	4.8	
more than 100	40	11.1	16.7	25	21.4	
Flock composition (%)						0.20
Females	-	5.6	-	-	2.4	
Males and females	20	44.4	66.7	50	42.9	
Males, females and keets	80	-	33.3	50	52.4	
Females and keets	-	5.6	-	-	2.4	
Guinea fowl varieties (%)						0.28
Pearl	50	44.4	50	25	42.9	
White	-	5.6	-	-	2.4	
Pearl and lavender	30	27.8	-	62.5	31	
Pearl and white	20	11.1	33.3	-	14.3	
Pearl, lavender, royal purple	-	-	16.7	-	2.4	
Pearl, lavender and white	-	11.1	-	12.5	7.1	

Parameters related to breeding management of guinea fowl in the Southern part of Botswana are presented in Table 3.4. Most of the households across districts (78.9%) did not have any mating strategy for guinea fowl and therefore breeding is mostly haphazard with a few households practicing either pure breeding or crossbreeding between different guinea fowl varieties. Most of the households across districts (90.5%) had no breeding objective and there is therefore very limited effort towards genetic improvement of guinea fowl. Most of the

households across districts did not select for any traits for male (71.4% of the households) and female (90.4% of the households) guinea fowls hence the limited effort towards genetic improvement of guinea fowl. The few households that employ selective breeding mainly focus on either body size or plumage color or a combination of the two traits.

Table 3.4: Breeding management employed on guinea fowl production.

Variable	Districts				Overall (%)	X ² P-Value
	Kgatleng (n=10)	Kweneng (n=18)	South East (n=6)	Southren (n=8)		
Mating Strategy (%)						0.20
No Strategy	100	55.6	83.3	100	78.9	
Pure breeding	-	33.3	16.7		16.7	
Cross breeding	-	11.1	-		4.8	
Breeding Objective						0.31
None	90	89.9	100	87.5	90.5	
With objective	10	11.1	-	12.5	9.5	
Selection criteria for males %						0.35
None	80	55.6	83.3	87.5	71.4	
Body size	-	16.7	-	12.5	9.5	
Colour	10	-	16.7	-	4.8	
Body size and colour	10	27.8	-	-	14.3	
Selection criteria for females %						0.35
None	90	88.9	83.3	100	90.4	
Body size	-	11.1	-	-	4.8	
Colour	10	-	16.7	-	4.8	

Most of the households kept guinea fowls on a small-scale communal level (57.1%) followed by small-scale commercial (40.5) and only a few households (2.4%) kept guinea fowl on a large-scale commercial level (Table 3.5). Most of the households (61.9%) raised guinea fowls under an intensive management system in well-constructed (brick and mortar and corrugated iron roofing) modern poultry houses (81% of the households). Most of the households watered their guinea fowls with water sourced from either standpipes (42.9%) or boreholes (35.7%). Most of the households (50%) across the districts fed their guinea fowls a mixture of

commercially formulated poultry feeds and farm grown feeds such as sunflower, maize and melons followed by strictly commercial feeds in 31% of the households. Only 19% of the households across districts fed their guinea fowls traditional feeds comprising either maize or sorghum grains, sunflower, melons, sorghum bran or their combinations. In most households across districts (52.4%) mortality was prevalent among keets and was attributed to diseases, infighting, predation and inclement weather. Most of the households (73.8%) did not have any culling criteria for their guinea fowls and a few households culled birds for poor productivity (4.8%), old age (4.8%), sickness (4.8%) or combinations of the three factors.

Table 3.5: Scale of Production, Management System, Housing Type, Feed Composition, Mortality Causes, and Culling Factors.

Variable	Districts				Overall (n=42)	X ² P-Value
	Kgatleng (n=10)	Kweneng (n=18)	South East (n=6)	Southern (n=8)		
Scale of production (%)						0.31
Communal	60	55.6	50	62.5	57.1	
Small scale commercial	40	44.4	50	25	40.5	
Large scale commercial	-			12.5	2.4	
Management system (%)						0.20
Extensive	-	27.8	33.3	12.5	19	
Semi intensive	-	22.2	16.7	37.5	19	
Intensive	100	50	50	50	61.9	
Type of housing (%)						0.08
Traditional	-	27.8	33.3	-	16.7	
Cages	-	-	16.7	-	2.4	
Poultry house	100	72.2	50	100	81	
Source of water (%)						0.08
Ground water	30	-	-	-	7.1	
Borehole	20	50	16.7	37.5	35.7	
Standpipe	50	38.9	33.3	50	42.9	
Other	-	11.1	50	12.5	14.3	
Source of feed %						0.66
Local feed	-	27.8	16.7	25	19	
Commercial	40	22.2	50	25	31	
Mixed	60	50.1	33.3	50	50	
Causes of mortality (%)						0.32
None	20	33.3	-	-	19	
Diseases	10	22.2	16.7	12.5	16.7	
Fighting	50	5.6	33.3	25	23.8	
Predation	-	11.1	-	-	4.8	
Weather	-	-	33.3	12.5	7.1	
Others	20	27.8	16.7	25	23.8	
Diseases and others	-	-	-	25	4.8	
Age affected by mortality %						0.28
None	20	27.8	-	-	16.7	
Young birds	50	33.3	66.7	87.5	52.4	
Old birds	30	22.2	16.7	-	19	
Mixed	-	16.7	16.7	12.5	11.9	
Factors determining culling (%)						0.84
None	70	77.8	100	50	73.8	
Poor productivity	10	5.6	-	-	4.8	
Sickness	-	5.6	-	12.5	4.8	
Poor productivity & Sickness	-	-	-	12.5	9.5	
Old age & sickness	10	5.6	-	25	9.5	

Fifty percent (50%) and 23.8% of the households indicated the presence of good and satisfactory market demand for guinea fowls and their products and 81% of the households across districts indicated that guinea fowl production was a profitable enterprise (Table 3.6). The most lucrative market for guinea fowls and their products across districts was mostly sale to individuals (57.1%) and a combination of sale to individuals and restaurants (21.4%). About twenty one percent (21.4%) of the households across districts reported the absence of market for their guinea fowl and their products which leads to family consumption of guinea fowls and their products and lack of profitability of the guinea fowl enterprise.

Table 3.6: Market demand for Guinea fowl and profitability

Variable	Districts				Overall (n=42)	X ² P-Value
	Kgatleng (n=10)	Kweneng (n=18)	South East (n=6)	Southern (n=8)		
Market demand %						0.37
None	20	22.2	-	-	14.3	
Poor	20	5.6	16.7	12.5	11.9	
Satisfactory	40	11.1	16.7	37.5	23.8	
Good	20	61.1	66.7	50	50	
Product Market %						0.16
None existence	30	16.7	33.3	12.5	21.4	
Individuals	50	66.7	66.7	37.5	57.1	
Individuals & restaurants	20	16.7	-	50	21.4	
Enterprise profitability %						0.87
None	10	16.7	16.7	12.5	14.3	
Yes	80	77.8	83.3	87.5	81	
No	10	5.6	-	-	4.8	

3.4 DISCUSSION

The phenomenon of male dominance in guinea fowl farming found in this study has been reported in other African countries such as Burkina Faso (Traore *et al.*, 2018), Benin (Orounladji *et al.*, 2022), Côte d'Ivoire (Kouassi *et al.*, 2019), and Togo (Soara *et al.*, 2020). The observed minimal participation of the youth in guinea fowl farming reported in this study is consistent with Anderson *et al.* (2022) in Burkina Faso and Soara *et al.* (2020) in Northern Togo. The results are also similar to a study conducted on small-scale broiler production systems in Botswana (Badubi *et al.*, 2004). The less participation of the youth could be due to the absence of start-up capital (funding), lack of interest in farming and preference for formal employment in the public or private sector. This is very concerning given the high level of youth unemployment in the country. The requirement of a permit issued by the Department of wildlife and National Parks and the modern poultry house requirement to be issued a permit to go into guinea fowl production could be another discouraging factor. Similar to Soara *et al.* (2020) in Togo, Kouassi *et al.* (2019) in Côte d'Ivoire and Anderson *et al.* (2022) in Burkina Faso, most guinea fowl farmers in the current study were married. This may suggest that they adhere to societal values and conventions, enabling them to integrate into the community in which they reside hence better placed to effectively promote and sell their products.

The high literacy level of guinea fowl farmers in this study is almost similar to findings on guinea fowl farmers in Togo (Soara *et al.*, 2020) and Benin (Orounladji *et al.*, 2022). This is quite impressive as the farmers are likely to make better decisions, effectively manage resources, and adopt new technologies. Contrary to these findings, Balma and Richards (2016) reported high numbers (67%) of illiterate guinea fowl farmers in Ghana. The observed household size of guinea fowl farmers in the current study differs with the household size of guinea fowl farmers in Northern Ghana where an average household size of 15 people was reported (Nanette *et al.*, 2021). The possible explanation for smaller household sizes is that

most families in Botswana are nuclear families as opposed to extended families which are prevalent in other African countries.

Most guinea fowl enterprises in Botswana, just like in other African countries, are taken care of using family labour. In Burkina Faso, women and children provide daily care of the guinea fowls and men oversee marketing of live birds and their products (Traore *et al.*, 2018.). The integration of several farming activities in one farm is consistent with Traore *et al.* (2018) and Soara *et al.* (2020) and this is meant to spread the risk and facilitates the sharing of resources between different enterprises.

The primary sources of income of guinea fowl farmers in the Southern part of Botswana observed in this study is in agreement with Kgathi and Motsholapheko (2011). The majority of guinea fowl farmers in Botswana rear their birds primarily for their aesthetic value and consumption during special occasions, rather than for sale of meat or eggs. According to Abdul-Rahman (2019), there are still many gaps in the guinea fowl value chain that must be filled to increase the production of guinea fowl. Raising of guinea fowl mainly for their aesthetic value reported in the current study is contrary to Soara *et al.* (2020), Kouassi *et al.* (2019) and Traore *et al.* (2019) who reported that guinea fowls are raised mainly for the consumption of meat and eggs and sale of excess birds or eggs to support families.

All the foundation stock in the current study came from other local guinea fowl farmers in the region and this is of concern as it might imply less genetic diversity among the guinea fowl populations in the southern region of Botswana. According to Wilson and Primark (2019), the dispersal of few individuals to establish new populations will lead to population bottlenecks and loss of diversity and may result in extinction. Some farmers could not distinguish between male and female guinea fowls hence the observed flock compositions and unfavourable breeding ratios observed in the current study. Moreki (2009) recommended a sex ratio of one

male to five females due to the possibility of low egg fertility in higher female to male ratios. The predominance of pearl grey guinea fowl variety among households in this study has been previously noted by Moreki and Seabo (2012). The same variety has been reported to predominate in West Africa (Ikani and Dafwang, 2004). This could imply that the pearl was the first variety to be domesticated and has persisted over the years due to its superior adaptability to the environment compared to other varieties.

Lack of breeding objectives and established mating strategies for guinea fowl observed in the current study implies lack of knowledge on controlled breeding and breed improvement by local farmers. Uncontrolled breeding and inbreeding might therefore be rampant within local populations with detrimental effects on productivity. Rampant uncontrolled breeding in guinea fowl is consistent with a related study on indigenous chicken of Ethiopia where farmers practice uncontrolled breeding and lack knowledge on systematic mating of chickens (Dana *et al.*, 2010). Mahoro *et al.* (2018.) reported that in Rwanda farmers make selections based on body weight, size, growth rate, and disease tolerance which might also be extended to guinea fowl selection.

In the southern part of Botswana, guinea fowls are mostly raised in modern poultry houses under intensive production system, contrary to the semi-intensive system reported by Moreki and Seabo (2012) and extensive production systems employed in Nigeria and Burkina Faso (Shoyombo *et al.*, 2021; Traoré *et al* 2018; Portillo-Salgado *et al.*, 2022). Raising of guinea fowls under intensive production system using modern poultry houses in Botswana might be due to the issue of compliance with recommendations from the Department of Wildlife and National Parks in order to be issued a permit to engage in Guinea fowl production. According to Moreki and Seabo (2012) in most emerging nations, guinea fowls are raised under an extensive production system, allowing them the opportunity to forage for their own sustenance.

The availability of water and feed that contains all the necessary nutrients is the most important factor influencing productivity in livestock. The majority of guinea fowl farmers in the southern region of Botswana use water from either standpipes or boreholes to water their guinea fowls because they are the most prevalent water sources in the region and the birds do not require much water hence can share with the households. Most of the feeds given to guinea fowls are a blend of commercially formulated chicken feeds and feeds grown on farms such as sunflower, maize and melons. In Botswana, farmers typically use commercial feeds for chickens because there are no commercially formulated feeds specifically for guinea fowls (Moreki and Seabo, 2012). The local feed resources given to guinea fowls are similar to those given to guinea fowls in Zimbabwe which mainly comprises maize, sorghum, and other feeds produced on farm to meet dietary needs of guinea fowl (Saina *et al*, 2005).

The causes of guinea fowl mortality reported in the current study are inconsistent with Shoyombo *et al.* (2021) in Benin, Houndonougbo *et al.* (2017) in Nigeria, and Traore *et al.* (2018) in Burkina Faso where the primary causes of mortality were diseases, inclement weather and predation. Farmers who suffer setbacks as a result of high keet mortality often lose motivation to carry on with the enterprise and high keet mortality mostly occurs in the first month following hatching (Dahouda *et al.*, 2007.).

Most of the guinea fowl farmers in the Southern part of Botswana had no culling criteria in place as an effort towards improving productivity levels of their flocks. Extensive literature highlights the importance of culling to boost output which can be carried out as a result of advanced age, low productivity, and illness or disease (Ferreira and Smith 2018; Duncan 2005; Pesti and Smith, 2011). Guinea fowls and their products are mostly sold to other individuals in the southern part of Botswana, and this concurs with Moreki and Seabo (2012.), Dahouda *et al.* (2007) and Balma and Richards (2016). According to most farmers in Botswana, guinea

fowl production is a profitable enterprise, and this is in agreement with Balma and Richards (2016).

3.5 CONCLUSIONS

- Guinea fowl farmers in the southern part of Botswana are mostly men, aged between 20 and 50, married and mostly with secondary and tertiary education.
- Guinea fowl are kept under small scale communal production system, under intensive management with no controlled breeding, minimal health care, poor feeding and general husbandry practices and no organized markets for guinea fowls and their products.

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CHAPTER 4

PHENOTYPIC CHARACTERISATION OF DOMESTICATED AND WILD POPULATIONS OF HELMETED GUINEA FOWL IN BOTSWANA

ABSTRACT

This research aimed to evaluate the body weights and linear body measurements of domesticated and wild helmeted guinea fowl in southern part of Botswana. The study covered Kgatleng, Kweneng, South East, and Southern Districts. This study employed 40 adult wild and 160 domesticated guinea fowl of both sexes. The collected data were analyzed using general linear models (GLM) procedures of Statistical Analysis System (SAS) and the model included fixed effects of breed and sex and the interaction between breed and sex. Results were summarized as least squares means $\pm$ standard error and means separation were by paired t-tests. Live birds were measured for live body weight, body length, wingspan, shank length, and chest circumference. No significant weight differences were seen across domesticated helmeted guinea fowl species. All domesticated helmeted guinea fowls were heavier than wild guinea fowl. The White guinea fowl were longer than other domesticated and wild varieties. The wild guinea fowl had similar shank length with the pearl grey and lavender varieties. There was no significant sex influence on guinea fowl body weight, length, or chest circumference. Body weights of females of domesticated helmeted guinea fowl were significantly higher than those of females of wild guinea fowl and so are the males. Sexual dimorphism in favor of males was only found in shank length in pearl grey and lavender varieties of domesticated helmeted guinea fowl.

Key words: Body weight, linear body measurements

4.1 INTRODUCTION

Guinea fowl production in Botswana is at an infancy stage and provides an avenue for the diversification of the country's poultry sector. Guinea fowls have the potential to fulfil multiple roles including the provision of high protein and low fat content meat, rich in minerals, and vitamins (Śmiecińska *et al*, 2022). Guinea hens have the potential to yield approximately 100 or more eggs per year when properly managed (Moreki (2009). Guinea fowls exhibit robustness and less susceptibility to prevalent poultry diseases affecting other poultry species. Additionally, guinea fowls require less investment in terms of production inputs making them particularly suitable for impoverished small scale farmers (Saina *et al.*, 2005; Portillo-Salgado *et al.*, 2022).

The domestication of guinea fowl has been a longstanding tradition, where these avian species have successfully acclimatized to various production environments while under human supervision. However, a healthy population of wild guinea fowl still exists in Botswana demonstrating the robust ability of guinea fowl to flourish in their native environment amidst the challenges resulting from global warming and climate change. There is however lack of comprehensive phenotypic characterization of both domesticated and wild helmeted guinea fowls in their natural production environments in Botswana. Phenotypic characterization facilitates efficient conservation efforts, promotes sustainable utilisation and design of breeding programmes, and informs management interventions.

The observed diversity in phenotypic traits of domesticated and wild populations of guinea fowl is shaped by various evolutionary forces (mutation, migration, selection and random genetic drift) and environmental variables. Diversity is the raw material for evolution and for continuous adaptation to the ever-changing environment and for responding to changes in consumer demands

/tastes and specific market requirements. Understanding the diversity status of animal genetic resources is essential for sustainable utilization and conservation. To date, no studies have been carried out on *in situ* characterization of both wild and domesticated helmeted guinea fowl. The purpose of this study was therefore to compare quantitative traits of wild guinea fowl and different domesticated varieties under their natural production environment.

4.2 MATERIALS AND METHODS

4.2.1 Study area

The study was conducted in the southern region of Botswana, in the districts of Kgatleng (24° 15' 0" S, 26° 30' 0" E), Kweneng (24° 0' 0" S, 25° 0' 0" E), South East (25° 0' 0" S, 25° 45' 0" E), and Southern (25° 0' 0" S, 25° 0' 0" E) as illustrated in figure 4.1. The region is characterised by elevated temperatures (22–30°C) between the months of August to May, and correspondingly lower temperatures (6–20°C) between May and August. The precipitation patterns exhibit a lack of consistency and demonstrate interannual variability. The mean annual precipitation ranges from 450mm to 550 mm with most of the rainfall occurring from November to May. The region is characterised by the presence of Savanna vegetation, including tall grasses, shrubs, and trees. The study area has different soil textures ranging from fine sands to fine loamy and fine sand to sandy loam.

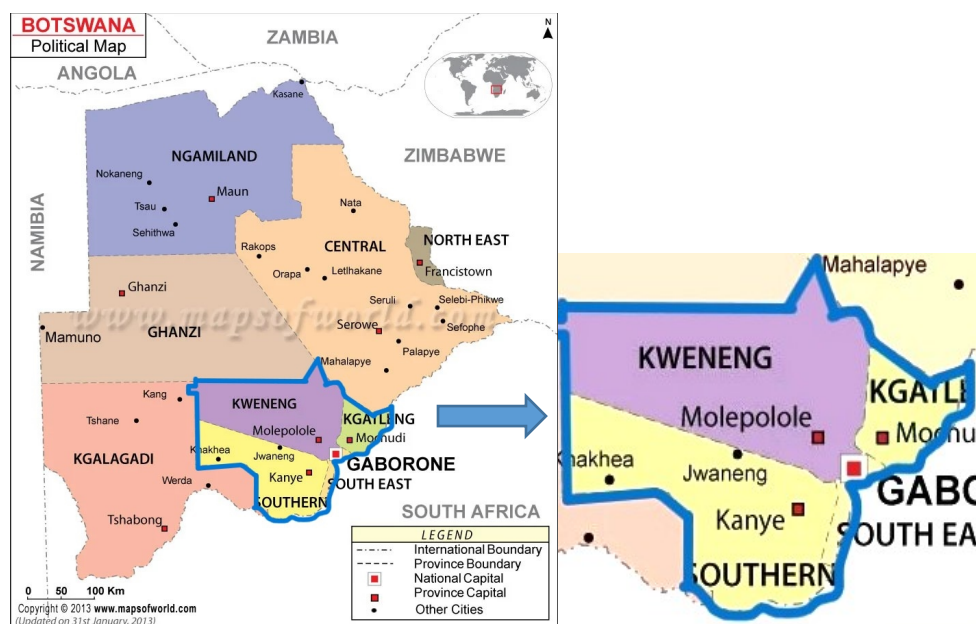


Figure 4.1 Map of Botswana depicting the Study Area

4.2.2 Sampling procedure and sample size

A sample size including 40 adult wild guinea fowl and 160 domesticated guinea fowl of both sexes was randomly selected from Kweneng, Kgatleng, South East and Southern districts. The study involved the selection of individuals, households, and villages/towns within the study area, which encompassed a broad geographical region, to sample both wild and domestic guinea fowl.

4.2.3 Ethics Statement

The present study rigorously followed the principles outlined in the worldwide code of conduct for research conducted in resource-limited settings. The Department of Wildlife and National Parks granted field approvals to capture wild guinea fowl. The guinea fowl were subjected to humane handling procedures during the data collection process. After the phenotypic measurements, the wild guinea fowl were reintroduced back into their natural habitat, whereas the domestic guinea fowl remained with their respective owners.

4.2.4 Data collection

Individual birds were weighed using an electronic balance to determine their live body weights. Measurements of body length, wingspan, shank length, and chest circumference were conducted using a flexible tape, following the recommendations established by the Food and Agriculture Organisation (FAO, 2012). The measurements were taken as follows:

Body weight, measured in kilograms, refers to the measure of live weight in guinea fowl.

Body length (cm) refers to the measurement taken from the first cervical vertebra (atlas) to the posterior end of the ischium.

The wingspan (cm) is defined as the measurement of the distance between the terminal ends of two wings when they are fully extended.

The shank length (cm) refers to the measurement of the distance between the hock joint and the foot pad.

Chest circumference (cm) refers to the measurement of the body's circumference specifically around the region encompassing the breasts.

The determination of the sex of birds in a random sample was achieved by assessing the characteristics of helmet shape, wattle size, and wattle shape. Differentiation among varieties was achieved by means of plumage colour patterns. The birds used were classified as adults based on their morphological features like helmet size.

4.2.5 Data Analysis

The collected data were analyzed using general linear models (GLM) procedures of Statistical Analysis System (SAS). The model included the fixed effect of breed/variety (Pearl grey, lavender, royal purple, white and wild guinea fowl) and sex (Male or Female) and the interaction between breed and sex). Results were summarized as least squares means $\pm$ standard error and means separation were by paired t-tests. The significance level chosen for this analysis was set at alpha 0.05. The model used in the analysis of body weight and linear body measurements was:

$$Y_{ij} = \mu + B_i + S_j + (B \times S)_{ij} + e_{ij}$$

Where; Y_{ij} = body weight and measured linear body measurements

μ = general population mean

B_i = i^{th} breed effect

S_j = j^{th} sex effect

$(B \times S)_{ij}$ = interaction effect of breed and sex

e_{ij} = random error

4.3 RESULTS

There were no significant differences in body weight between different varieties of domesticated helmeted guinea fowl (Table 4.1). However, all the domesticated helmeted guinea fowl varieties had significantly higher body weight than the wild guinea fowl. The White guinea fowl variety had significantly higher body length than other domesticated varieties and the wild guinea fowl. Similar body lengths were found between the pearl grey, lavender, white domesticated helmeted guinea fowl varieties and the wild guinea fowl. All the domesticated helmeted guinea fowl varieties had similar shank lengths. The wild guinea fowl had similar shank length with the pearl grey and lavender varieties of domesticated helmeted guinea fowl. The royal purple and white domesticated helmeted guinea fowl varieties had significantly longer shanks than the wild guinea fowl. The White guinea fowl variety had significantly higher chest circumference than the pearl grey, lavender and royal purple varieties of domesticated helmeted guinea fowl. Similar chest circumference was found between the pearl grey, lavender and royal purple domesticated helmeted guinea fowl varieties and the wild guinea fowl. The white guinea fowl variety had significantly the lowest wingspan of all the domesticated helmeted guinea fowl varieties. Similarities in wingspan were found between the royal purple and lavender and between the lavender and pearl grey domesticated varieties and between the white domesticated variety and the wild guinea fowl and between the pearl grey domesticated variety and the wild guinea fowl. Of all the guinea fowl varieties under study, the pearl grey variety had the highest wingspan, and the white variety had the lowest wingspan.

Table 4.1: Means $\pm$ SE for Main effect of Variety on body weight and linear body measurements of guinea fowl

Parameter	Variety				
	Pearl (n=117)	Lavender (n=19)	Royal Purple (n=12)	White (n=12)	Wild (n=40)
Body weight	1.48 ^a $\pm$ 0.02	1.51 ^a $\pm$ 0.06	1.45 ^a $\pm$ 0.07	1.58 ^a $\pm$ 0.07	1.15 ^b $\pm$ 0.05
Body length	24.63 ^b $\pm$ 0.23	24.57 ^b $\pm$ 0.54	24.21 ^b $\pm$ 0.69	26.75 ^a $\pm$ 0.68	24.56 ^b $\pm$ 0.43
Shank length	6.06 ^{ab} $\pm$ 0.06	6.04 ^{ab} $\pm$ 0.14	6.25 ^a $\pm$ 0.18	6.29 ^a $\pm$ 0.17	5.78 ^b $\pm$ 0.11
Chest circumference	27.21 ^b $\pm$ 0.25	26.60 ^b $\pm$ 0.61	25.93 ^b $\pm$ 0.78	30.50 ^a $\pm$ 0.76	27.18 ^b $\pm$ 0.49
Wingspan	42.10 ^{bc} $\pm$ 0.26	43.38 ^{ab} $\pm$ 0.62	43.66 ^a $\pm$ 0.78	39.08 ^d $\pm$ 0.77	40.44 ^{dc} $\pm$ 0.49

^{abcd} Row means with different superscripts are significantly different

The main effect of sex on body weight and linear body measurements of guinea fowl are shown in Table 4.2. There were no significant sex effects on body weight, body length and chest circumference in guinea fowl. Sex however had a significant influence on shank length and wingspan with males having significantly longer shanks and wingspan than females.

Table 4.2: Means $\pm$ SE for main effect of sex on body weight and linear body measurements of guinea fowl

Parameter	Male (n=82)	Female (n=118)
Body weight	1.45 $\pm$ 0.04	1.42 $\pm$ 0.04
Body length	24.93 $\pm$ 0.34	24.95 $\pm$ 0.34
Shank length	6.23 ^a $\pm$ 0.09	5.94 ^b $\pm$ 0.09
Chest circumference	27.63 $\pm$ 0.38	27.32 $\pm$ 0.39
Wingspan	42.18 ^a $\pm$ 0.39	41.29 ^b $\pm$ 0.39

^{ab} Row means with different superscripts are significantly different

There were no significant differences in body weight between males of pearl grey, lavender, royal purple and white varieties of domesticated helmeted guinea fowl (Table 4.3). All the varieties of domesticated helmeted guinea fowl were however significantly heavier than the wild guinea fowl. The white guinea variety had significantly higher body length and chest circumference than the pearl grey, lavender and royal purple varieties of domesticated helmeted guinea fowl and the wild guinea fowl. There were similarities in body length and chest circumference between the pearl grey, lavender and royal purple varieties of domesticated helmeted guinea fowl as well as the wild guinea fowl. Similar shank lengths were found between males of pearl grey, lavender, royal purple and white varieties of domesticated helmeted and between males of pearl grey domesticated variety and the wild guinea fowl. Males of lavender, royal purple and white varieties of domesticated helmeted guinea fowl had significantly longer shanks than males of the wild guinea fowl. Males of pearl grey, lavender and royal purple varieties of domesticated helmeted guinea fowl had similar wingspan which were significantly higher those of males of the white variety of domesticated helmeted guinea fowl. Only males of the white variety of domesticated helmeted guinea fowl had similar wingspan with males of wild guinea fowl.

Table 4.3. Means $\pm$ SE for body weight and linear body measurements in males of different varieties of guinea fowl

Parameter	Pearl (n=43)	Lavender (n=9)	Royal Purple (n=7)	White (n=6)	Wild (n=17)
Body weight (Kg)	1.50 ^a $\pm$ 0.03	1.47 ^a $\pm$ 0.07	1.49 ^a $\pm$ 0.08	1.66 ^a $\pm$ 0.09	1.13 ^b $\pm$ 0.06
Body length (cm)	24.36 ^b $\pm$ 0.31	24.33 ^b $\pm$ 0.69	24.43 ^b $\pm$ 0.77	27.17 ^a $\pm$ 0.83	24.35 ^b $\pm$ 0.56
Shank length (cm)	6.21 ^{ab} $\pm$ 0.11	6.33 ^a $\pm$ 0.24	6.50 ^a $\pm$ 0.27	6.50 ^a $\pm$ 0.29	5.62 ^b $\pm$ 0.20
Chest circumference(cm)	27.31 ^b $\pm$ 0.45	26.50 ^b $\pm$ 0.98	25.86 ^b $\pm$ 1.11	31.33 ^a $\pm$ 1.20	27.19 ^b $\pm$ 0.81
Wingspan (cm)	42.58 ^a $\pm$ 0.39	43.56 ^a $\pm$ 0.84	44.93 ^a $\pm$ 0.96	39.67 ^b $\pm$ 1.04	40.15 ^b $\pm$ 0.70

^{ab} Row means with different superscripts are significantly different

There were no significant differences in body weight between females of pearl grey, lavender, royal purple and white varieties of domesticated helmeted guinea fowl (Table 4.4). Body weights of females of pearl grey, lavender and white varieties of domesticated helmeted guinea fowl were significantly higher than those of females of wild guinea fowl. Only females of royal purple variety of domesticated helmeted guinea had similar body weight with females of wild guinea fowl. There were no significant differences in body length and shank length between females of all domesticated varieties and females of wild guinea fowl. Females of pearl grey, lavender and royal purple varieties of domesticated helmeted guinea fowl and females of wild guinea fowl had similar chest circumference which was significantly lower than that of females of the white variety of domesticated helmeted guinea fowl. Females of pearl grey, lavender

and royal purple varieties of domesticated helmeted guinea fowl had similar wingspan which were significantly higher those of females of the white variety of domesticated helmeted guinea fowl. Similarities in wingspan existed between females of pearl grey, lavender, royal purple varieties of domesticated helmeted guinea fowl and wild guinea and between females of the white variety of domesticated helmeted guinea fowl and females of wild guinea fowl.

Table 4.4. Means $\pm$ SE for body weight and linear body measurements in females of different varieties of guinea fowl

Parameter	Pearl (n=74)	Lavender (n=10)	Royal Purple (n=5)	White (n=6)	Wild (n=23)
Body weight (Kg)	1.45 ^a $\pm$ 0.03	1.54 ^a $\pm$ 0.08	1.40 ^{ab} $\pm$ 0.12	1.49 ^a $\pm$ 0.11	1.17 ^b $\pm$ 0.06
Body length (cm)	24.89 $\pm$ 0.30	24.80 $\pm$ 0.80	24.00 $\pm$ 1.14	26.33 $\pm$ 1.04	24.76 $\pm$ 0.62
Shank length (cm)	5.91 $\pm$ 0.06	5.75 $\pm$ 0.16	6.00 $\pm$ 0.23	6.08 $\pm$ 0.21	5.94 $\pm$ 0.13
Chest circumference(cm)	27.10 ^b $\pm$ 0.28	26.70 ^b $\pm$ 0.77	26.00 ^b $\pm$ 1.09	29.67 ^a $\pm$ 0.99	27.18 ^b $\pm$ 0.59
Wing span (cm)	41.62 ^a $\pm$ 0.32	43.20 ^a $\pm$ 0.88	42.40 ^a $\pm$ 1.24	38.50 ^b $\pm$ 1.13	40.74 ^{ab} $\pm$ 0.67

^{ab} Row means with different superscripts are significantly different

There was no sexual dimorphism in body weight, body length, chest circumference and wingspan in the wild guinea fowl and in the different varieties of domesticated helmeted guinea fowl. Sexual dimorphism in favor of males was found in shank length in pearl grey (6.21 ± 0.09 vs. 5.91 ± 0.07 cm) and lavender (6.33 ± 0.17 vs. 5.75 ± 0.16 cm) varieties of domesticated helmeted guinea fowl. There was no significant difference in shank length between males and females of royal purple and white varieties of domesticated helmeted guinea fowl and between males and females of wild guinea fowl.

4.4 DISCUSSION

Similarities in body weight between different varieties of domesticated helmeted guinea fowl found in the current study is consistent with findings of Kgakole *et al.* (2016) who reported similar body weights between pearl, lavender and royal purple varieties under an intensive management system. Contrary to the current findings, Fajemilehin (2014) and Dudusola *et al.* (2021) reported significant differences in body weights between pearl, lavender, black (royal purple) and white varieties in Northwestern (Sokoto state) and South western (Oyo and Osun States) Nigeria, respectively. The body weights of different varieties of domesticated helmeted guinea fowl in this study are higher than those reported by Dudusola *et al.* (2021) and Fajemilehin (2014). Higher body weights in domesticated varieties compared to the wild guinea fowl is consistent with Panyako *et al.* (2016). The average body weight of the wild guinea fowl in the current study is however lower than 1538 ± 214 g reported in the wild guinea fowl of Kenya (Panyako *et al.*, 2016). The observed difference in body weight between domesticated varieties and the wild helmeted guinea fowl could be due to the differences in their production environment related to feed availability and quality which tends to favor domesticated guinea fowl varieties. According to Seabo *et al.* (2011), there is evidence suggesting that the weight of guinea fowl can be altered by the quantity of protein in their diet with increases in protein intake associated with corresponding increase in body weight.

The body lengths of different varieties of domesticated helmeted guinea fowl reported in the current study are lower than those reported by Fajemilehin (2014) in domesticated guinea fowl varieties of Nigeria. In the current study the white guinea fowl variety had the highest body length contrary to the findings of Dudusola *et al.* (2021) and Fajemilehin (2014) who reported the highest body length in the pearl grey variety. The similarities in shank length between different varieties of domesticated helmeted guinea fowl in this study is consistent with Fajemilehin (2014) who reported similar shank lengths between pearl grey, lavender and black

(royal purple) varieties of domesticated helmeted guinea fowl in Nigeria. Significantly higher chest circumference in the white variety relative to other varieties of domesticated helmeted guinea fowl in the current study is consistent with Fajemilehin (2014). The chest circumference, body length and shank length of different varieties of domesticated helmeted guinea fowl found in the current study were lower than those reported by Orounladji *et.al.* (2021). The wingspan of different varieties of domesticated helmeted guinea fowl in this study are within range of the wingspan of 41.48 ± 2.70 cm, 41.43 ± 2.40 cm, 41.72 ± 1.14 cm and 41.86 ± 0.79 cm reported for the white, pearl grey, lavender and royal purple varieties, respectively, by Orounladji *et.al.* (2021). The generally lower morphometric measurements in the wild guinea fowl compared to the different varieties of domesticated helmeted guinea fowl contradicts Panyako (2018) who reported higher morphometric measurements in the wild guinea fowl compared to domesticated varieties. The observed similarities in most morphometric measurements between the domesticated pearl grey variety and the wild (pearl grey) guinea fowl might be indicative of a close relationship between the two varieties. According to Seabo *et al.* (2011), wild guinea fowl in Botswana have been captured and raised on farms suggesting possible interbreeding between the wild pearl grey and the domesticated pearl variety. The pearl grey variety of domesticated helmeted guinea fowl is by far the most numerous of all the varieties and a genomic inquiry is warranted to unravel the degree of relatedness between the wild guinea fowl and the domesticated pearl grey variety.

The body weights of male and female guinea fowl in the current study (Main effect of sex) matches the average weights of 1446.14 ± 31.98 g and 1503.64 ± 36.02 g for male and female guinea fowl, respectively, reported by Kgakole *et al.* (2016) under an intensive management system. The variations in body weight and linear body measurements between males of different varieties and between females of different varieties of domesticated helmeted guinea fowl in the current study is consistent with Gwaza and Elkana (2017). Contrary to the current

findings, Brown *et al.* (2017) reported similarities in all parameters between females of different varieties of domesticated guinea fowl. In the current study, males and females of the white variety had a greater chest circumference compared to other varieties of the same sex, an indication that the white variety possesses a higher muscle mass in the chest area, which could make it more suitable for broiler production (Bernacki *et al.*, 2012).

The lack sexual dimorphism across several traits in different varieties of domesticated helmeted guinea fowl and in the wild guinea fowl in the current study is consistent with several studies (Nahashon *et al.*, 2006; Abdhul-Rahman *et al.*, 2015; Panyako, 2018; Etienne *et al.*, 2021). Contrary to these findings several studies reported sexual dimorphism in favor of males in most morphometric parameters in guinea fowl (Gwaza and Elkana, 2017; Panyako, 2018; Dudusola *et al.*, 2021; Orounladji *et al.*, 2021; Yakubu *et al.*, 2022). In the current study sexual dimorphism in pearl and lavender varieties was observed only for shank length. McPherson and Chenoweth (2012) proposed that sexual dimorphism serves the purpose of enhancing the reproductive success of individuals, particularly males.

4.5 CONCLUSIONS

- There were no weight differences between the pearl grey, lavender, royal purple and white domesticated guinea fowl varieties.
- All domesticated helmeted guinea fowl varieties were heavier than wild guinea fowls.
- There was no sex influence on body weight, body length and chest circumference in both wild guinea fowl and domesticated guinea fowl varieties.

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CHAPTER 5

GENERAL DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 GENERAL DISCUSSION

Diversity within species is important for breed genetic improvement and for adaptation to the changing environment because of global warming and climate change. It also enables breeders to respond to changing consumer tastes and market demands of animal genetic resources within and between different breed populations. Phenotypic Characterization of different varieties of domesticated helmeted guinea fowl and the wild helmeted guinea fowl populations of Botswana will inform breed conservation and breed improvement programs and is a prerequisite for sustainable utilization of the guinea fowl resources found in Botswana. The current study aimed to investigate the production environment of domesticated helmeted guinea fowl and to analyze the morphometric properties of both domesticated and wild helmeted guinea fowl in the Southern part of Botswana.

The most common guinea fowl variety among both the wild and domesticated guinea fowl varieties was the pearl grey. The pearl grey was the sole variety in the wild and its predominance among the domesticated varieties suggest that it might be the wild ancestor of the domesticated pearl grey variety. Other varieties such as the white and lavender varieties occurred at relatively low proportions among the domesticated guinea fowl population and none in the wild population. The lavender and white varieties might have gone extinct in the wild due to high predation and their inability to camouflage in their natural habitat especially at night. Similar body weights among the different domesticated helmeted guinea fowl varieties might be due to the generally poor nutrition (unbalanced diets) which prevented the different guinea fowl varieties from reaching their growth potentials. Significantly higher body weights in the domesticated varieties compared to the wild guinea fowl might also be due to insufficient nutrition in the wild or lack of supplementation which is common in domesticated guinea fowl.

Lack of sexual dimorphism in favor of males for body weight and other linear measurements in the different varieties of domesticated helmeted guinea fowl found in the current study is consistent with Kgakole *et al.*, (2016) under an intensive management system using balanced diet. Nutrition is therefore unlikely to explain lack of sexual dimorphism for body weight and other linear measurements in guinea fowl. Sexual dimorphism is shaped by an interplay of sex genes and fluctuating amounts of sex hormones. The hormonal profiles of both male and female sex hormones in male and female guinea fowl might therefore be comparable.

5.2 GENERAL CONCLUSIONS

- Guinea fowl farmers in the southern part of Botswana are mostly men, aged between 20 and 50, married and mostly with secondary and tertiary education.
- Guinea fowl are kept under small scale communal production system, under intensive management with no controlled breeding, minimal health care, poor feeding and general husbandry practices and no organized markets for guinea fowls and their products.
- There were no weight differences between the pearl grey, lavender, royal purple and white domesticated guinea fowl varieties but all domesticated helmeted guinea fowl varieties were heavier than wild guinea fowls.

5.3 RECOMMENDATIONS

- 1) The scope of the study should be expanded to cover the remaining districts of Botswana.
- 2) Genetic diversity of the different varieties of domesticated helmeted guinea fowl and the wild guinea fowl should be assessed using modern molecular techniques such as Single Nucleotide Polymorphisms.

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Questionnaire for the phenotypic characterization of domesticated helmeted Guinea fowl populations in Botswana

Guinea fowl farming in Botswana is a growing poultry sector with greater potential to improve livelihoods of resource-poor farmers. The wild guinea fowls are equally important to the locals in the tourism sector and as source of food. Therefore, it is important to evaluate guinea fowl population diversity and trends, production environment and their importance to farmers/locals in order to facilitate effective planning for animal genetic improvement and conservation strategies. This can be achieved by engaging guinea fowl keepers who own, utilize and adopt breeds and adapt them to their needs locals benefitting from them. This survey seeks to understand varieties of guinea fowl in Botswana, their production environment, importance to farmers and locals as well as to identify challenges facing guinea fowl production in the Southern part of Botswana.

1. Interviewee name..... Region:

2. Location:

3. Enumerators name..... Date of interview.....

4. Farm type: communal () small scale commercial () large scale commercial ()

Section 1: Demographic details

5. Gender: male () female ()

6. Age in years : <20 () 20-30 () 31-40 () 41-50 () >50 ()

7. Number of people in the household: males () females () children < 15 years ()

8. Position in household: household head () spouse of head () brother () sister () son () daughter () other (specify).....

9. Household head: male () female ()

10. Marital status: single () married ()

11. Level of education: primary () secondary () tertiary () none () other (specify).....

12. Do you have any special training? If yes from whom?.....

13. Farming activities: crops () livestock () integrated ()

14. Classes of livestock kept: poultry () smallstock () cattle () others (specify).....

15. Source of income: farming () home industries () wages/salaries () others (specify).....

Section 2: Guinea fowl Production

16. How long have Guinea fowls been kept in the household?

17. Reasons for keeping guinea fowls: meat () eggs () other (specify).....

18. Source of foundation (breeding) stock.....

19. Number of guinea fowls kept: < 20 () 20-50 () 51-80 () 81- 100 () >100 ()

20. Flock composition adult males () adult females () keets ()

21. Guinea fowl varieties: pearl () lavender () white () royal purple () other (specify).....

22. Reasons for keeping guinea fowl: meat () eggs () others (specify).....

23. Who looks after the guinea fowl? Owner () family members () employee () other (specify).....

24. Do you feel the need to improve your Guinea fowl production? Yes () No ()

25. If yes to above, what needs to be improved?.....
.....
.....
.....
.....
.....

Section 3: Management Practices

26. What type of production system do you practice? Extensive () semi-intensive () intensive () others, specify.....

27. What type of housing system do you use? Traditional () cages () other (specify).....

28. What type of mating strategy do you employ in your farm? Pure breeding () cross breeding ()

29. What is your breeding objective?.....
.....
.....

30. Selection criteria for males: body size () colour () other (specify).....
.....

31. Selection criteria for females: body size () colour () other (specify).....
.....

32. Source of water for the birds: ground water () borehole () standpipe () other (specify).....
.....

33. What do you normally feed your guinea fowl?
.....
.....
.....
.....
.....

34. Source of feed for the birds: natural () local feed () commercial feed () mixed () other (specify).....

35. Do you give supplementary feed to your Guinea fowls? Yes () No (). If yes what do you supplement with?

36. Do you have access to vet services? If yes who provide the services?.....
.....
.....

37. What is the mortality rate per year in your flock?.....

38. What are the causes of mortality?.....

39. Which age group is the most affected? Young birds () old birds () mixed ()

40. What are diseases of importance in your farm and how do you treat/control them?
.....
.....
.....
.....
.....

41. During which months of the year do this diseases occur?.....
.....
.....
.....
.....

42. which parasites have your encountered in your guinea fowl?.....
.....
.....
.....
.....

43. What measures are in place to control them?.....
.....
.....

44. Ethno veterinary practices

Traditional remedy	Disease/ parasite
.....	
.....	
.....	
.....	
.....	

45. How often do you cull your birds?.....

46. Which factors determine which bird you will cull? () poor productivity () old age ()
sickness () others, specify.....

47. Have you heard about the improved poultry production practices yes () no ()

48. If yes what is your major source of information on the improved poultry production
practices.....

Section 4: Other issues

49. Do you intend to extend guinea fowl production? Yes () No ()

50. If yes to what size.....

51. How is market demand for guinea fowls? Poor () satisfactory () good ()

52. Where do you sell your
products?.....

53. Is this farming enterprise profitable? Yes () No ()

54. Prices for different categories of birds

Keets
breeding females.....
breeding males

55. What are barriers/challenges encountered in guinea fowl
production?.....
.....
.....
.....
.....

56. Any taboos related to guinea fowl
production.....
.....
.....

.....
.....

ANNEX B

Consent Form – For Participation in Research

Name:	
Sex:	
Age:	
ANIMAL/SPECIES	

DECLARATION

1. I, ... (*please print name*) certify that I am at least 18 years of age, I am the owner (or duly authorised representative of the owner) of the above animal(s), and that the animal(s) are free of any lien or claim by any other person or persons.
2. I acknowledge that I have read the attached Information sheet for the research project entitled:
.....
..... and have had the participation of my animal(s) in the research study fully explained to me by the research investigator:
..... (*please print name*)
3. I understand that the participation of my animal(s) is voluntary, and I may withdraw my animal(s) for any reason, at any time. My consent is freely given.

4. I understand that some risk always exists when animal handling and animal procedures are performed. I understand that the research investigator(s) will inform me of any new risks that may be identified, or any material changes in the way the study will be conducted.
5. I understand that all private data pertaining to me and my animal(s) will be treated in strict confidence.
6. I am aware that I should retain a copy of this Consent Form and attached Information Sheet.

PRINT NAME.....

Signature.....

Date.....

Contact Phone..... Contact
Address.....

Contact Email.....

Emergency Contact Name..... Emergency Contact
Phone.....

INVESTIGATOR DECLARATION

1. I have described to the animal owner/authorised agent the nature of the animal(s) participation in the research study. In my opinion he/she understood the explanation.

PRINT NAME.....

Signature.....

Date.....
