

UNIVERSITY OF EDUCATION, WINNEBA

**PHENOTYPIC CHARACTERIZATION OF GUINEA PIGS (*Cavia porcellus*) IN
THE MIDDLE BELT OF GHANA**

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(BSc. GENERAL AGRICULTURE)**

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UNIVERSITY OF EDUCATION, WINNEBA

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THE MIDDLE BELT OF GHANA**

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**A DISSERTATION IN THE DEPARTMENT OF ANIMAL SCIENCE
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MANAGEMENT)
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OCTOBER, 2022

DECLARATION

STUDENT’S DECLARATION

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

.....

.....

DAVID OWUSU APPAU

DATE

SUPERVISORS’ DECLARATION

We hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of thesis/dissertation/project as laid down by the University of Education, Winneba.

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ACRONYMS/ABBREVIATIONS

ACRONYM MEANING

AnGR	Animal Genetic Resources
AU-IBAR	Africa Union Inter-African Bureau for Animal Resources
BC	Before Christ
BL	body length
BW	body weight
DM	dry matter
DRC	Democratic Republic of Congo
FAO	Food and Agricultural Organisation
FLL	fore leg length
GDV	Gastric dilatation and volvulus
GH¢	Ghana Cedis
HG	heart girth
HL	head length
HLL	hind leg length
HW	height-at-weight
MoFA	Ministry of Food and Agriculture
NRC	National Research Council
R ²	coefficient of determination
SEM	Standard error means
US\$	United State Dollar

ABSTRACT

This study was conducted to investigate the phenotypic characterization of Guinea pigs in the middle belt of Ghana. The study specifically looked at the socioeconomic characteristics of Guinea pigs farmers, production systems, morphological characteristics, relationship between body weight and linear body measurements as well as cost of production. Two studies were conducted. The first study was a survey from Guinea pig farmers while the second phase of the work was a performance evaluation experiment on production of Guinea pigs. Fifty four (54) Guinea pigs farmers were interviewed using a semi-structured interview and questionnaire and 310 Guinea pigs were sampled in middle belt of Ghana using snowball sampling method. In the phase two (field experiment), fifty four (54) Guinea pigs of about four (4) weeks old were reared for four (4) months for performance traits measurements in Goaso, Ahafo region. The effects of colour, location and sex on body measurements were analyzed and phenotypic correlations among the various body measurements were measured. Simple linear regression equation was used for body weight and linear body measurements. All data analysis was carried out using R statistical software version 4.2.1 and SPSS version 21.0. The results of study one showed that Guinea pigs with two (2) eye colours were found to be black and red of which the black eye colour recorded highest (91.61 %) value. Thirteen (13) colour categories were revealed. Black-brown-white had 34.84 % as the highest presentation and greyish-brown and gold-black-white scored the same 0.32 % as the least. Four color categories formed were monochrome, dichrome, trichrome and multi-chromatic. Out of the four colour categories formed, trichrome was the largest presentation of 51.29 % and multi-chromatic scored 4.84 % out of the entire sampled population. The effect of colour categories in

Guinea pigs influenced significant ($p \leq 0.05$) variation for head length, hind leg length and fore leg length. The body measurements of Guinea pigs in the study area were highly significant in terms of hind leg length and fore leg length ($p \leq 0.01$) and the linear body measurements did have significant effect ($p > 0.05$) on cavies. Also, both sexes did not have significant different ($p > 0.05$) figure for all the linear body measurements. The highest correlation value (0.91) was between body length and heart girth, the second highest correlation figure of 0.87 was recorded between body weight and body length, also among hind leg length and fore leg length. The least correlation value (0.21) was found between body weight and fore leg length. In respect to the simple linear regression equation, body length (BL), heart girth (HG), height-at-withers (HW) and head length (HL) were the best predictor of body weight in guinea pigs with R^2 of 0.80. The best time to predict the body weight of Guinea pig was in week 2. Provision of good production systems and management practices such as pen, quality feed, watering and health care contributed positively to the growth and reproduction of cavies. The birth weights of young Guinea pigs were between 85 - 110 g and weaned at 14 days with weight between 120-200g. Matured local Guinea pigs have an average body weight of 405.19 g at 90 days old. Indigenous Guinea pigs were small in size with Ahafo region being superior in body weight and linear body measurements. The production cost of raising one cavy from birth to maturity (90 days) was GH¢ 32.16 (US\$ 5.53). However, the overall revenue from the sales of Guinea pig yielded GH¢ 66.04 (US\$ 11.35) with GH¢ 33.88 (US\$ 5.82) as the profit on each animal. It was concluded that, local Guinea pigs in the middle belt of Ghana are moderate in size, had many colour categories, females were superior to males, high growth rate and prolific, easy to produce by classes

of people, provide valuable food and income, require small capital to start and have an appreciable return on investment.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Animal production in general plays a vital socioeconomic role for people living in low-income and advanced countries. Animals are widespread and almost every rural family owns them which provide a valuable source of family protein and income (Tadele et al., 2018). Guinea pigs are animals that were first domesticated as early as 5000 BC for food by tribes in the Andean region of South America (the present-day southern part of Colombia, Ecuador, Peru, and Bolivia) (Chauca, 1995). The domestic Guinea pigs (*Cavia porcellus*) belong to monogastric herbivore which comes from the Caviidae, the rodent family (Terril et al., 1998), which belongs to the order of Caviomorpha, or Hystricomorpha (Mancinelli, 2016). Guinea pigs have historically contributed to poverty alleviation and minimized protein deficiency issues in the diets of poor people in South America, the Philippines and Sub-Saharan Africa (Bindelle et al., 2007; Lammers et al., 2009 ; Handlos, 2018).

Cavies are considered as a promising micro livestock as they require small startup capital and produce high quality meat as compared to other livestock (NRC, 1991 ; Lammers et al., 2009 ; Niba et al., 2012 ; Assan, 2013). Guinea pigs' meat contains high amount of protein (20.3 - 21%), low content of fat (7.8 - 8.0%) and minerals (0.8%) as compared with other animals such as poultry (18.2% protein and 10.2% fat), cattle (18.7% protein and 18.2% fat) and pigs (12.4% protein and 35.8% fat) (Kouakou et al., 2013).

Guinea pigs mature earlier and are prolific (Cicogna, 2000 ; Dikko et al., 2009 ; Lammers et al., 2009) with less competition with humans for food as they can be fed with a large variety of wild plants, crop residues, kitchen wastes, forages, vegetables and fruits leftovers (Kouakou et al., 2015 ; Abossede et al., 2019).

Phenotypic characterization generally refers to the process of identifying distinct breed populations and describing their external and production characteristics within a given production environment (Karnuah et al., 2018). It is used to identify and document diversity within and between distinct breeds based on their observable attributes (FAO, 2012). Phenotypic characterization describes how to conduct a study on a specific animal population and its production environment which includes; details of what to measure, how to take these measurements and how to interpret them (FAO, 2011). It provides the prerequisite information and guidelines on genetic and molecular characterization (FAO, 2011).

1.2 Problem statement

Few decades ago, Guinea pigs production was doing much better in Ghana until rabbits production took over. This has resulted to a lot of people paying less attention in Guinea pigs rearing which has led to difficulty in locating the farmers who keep Guinea pigs, inadequate data on Guinea pigs phenotypic characteristics in Ghana, limited information on Cavies production systems and poor cost determination of Guinea pigs in Ghana. Ghana has a lot of local breeds of domestic animal such as Guinea pigs that contribute to agriculture and food security but not much work has been done in respect to Cavies phenotypic characteristics and production systems (APD, 2003). In African continent, most

policy makers and farmers have given not much attention to Guinea pigs production because they think Cavies produce small meat and have poor market (AU-IBAR, 2019).

Currently, there are a handful of research works done particularly on phenotypic and genetic characterizations of indigenous animals which have been segmented in many parts of Ghana; in rabbits (Husein, 2015) ; goats (Birteeb and Lomo, 2015 ; Ofori et al., 2021) ; grasscutters (Annor, 2011 and Annor et al., 2011) ; Ghanaian local chicken (Adjei et al., 2015 and Botchway et al., 2017) ; local pigs (Ayizanga, 2016) ; sheep (Birteeb et al., 2012) ; local Chicken and Guinea fowl (Brown et al., 2017) ; domestic pigeon (Najat, 2019).

Despite these works done on characterization of indigenous breeds of animals by the researchers in Ghana, no work and publication have been done on characterization of local Guinea pigs. De Marchi et al. (2003) emphasized that characterizing indigenous breeds and their subsequent description would assist in the development of less privileged areas of every region through the evaluation of local breeds and thereby promote conservation of local breeds and preservation of biodiversity. According to MoFA (2003), characterizing indigenous breeds are very essential because they are well adapted to the local environment and require very little economic inputs for their sustenance. Characterization is essential for conservation and sustainable utilization of farm animal genetic resources, especially local breeds that are often less fancied due to their relatively low production potential (Adjei et al., 2015).

According to Ayagirwe et al. (2019), Guinea pigs can be phenotypically characterized based on their observable qualitative features such as coat colour pattern, eye colour and coat colour variation, the head shape and ear orientation and quantitative traits such as; body weight, head length, body length, heart girth and height. Hence, characterizing Guinea pigs (Cavies) populations and describing their production systems and management practices, morphological characteristics and relationship between their linear body measurements, production costs and farmers demographics are crucial in designing and implementing local Guinea pig's development programs, which will be beneficial to the small scale farmers in the rural areas as well as improve breeding strategies of Cavies in the country.

1.3.1 Main objectives of the study

The main objective of the study was to phenotypically characterize Guinea pigs (Cavies) in the middle belt of Ghana.

13.2 Specific objectives of the study

The specific objectives of the study were to;

1. assess the social characteristics of Guinea pigs farmers in the middle belt of Ghana.
2. identify the production systems and management practices of Guinea pigs rearing in the middle belt of Ghana.
3. determine the phenotypic characteristics and the relationship between body weight and linear body measurements of the Cavies in the middle belt of Ghana.
4. estimate the production cost of raising Guinea pigs in the middle belt of Ghana.

1.4 Significance of the Study

This research would provide a better understanding of biological characteristic and husbandry practices of Guinea pigs in Ghana. The findings can be used to formulate policies that would lead to sustainable use of Cavies genetic resources in Ghana. The result can be used by animal breeders to develop breeding strategies to produce fast growing Cavies in the middle belt of Ghana. The data would become Ghana's contribution to the AnGR inventory.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview of Guinea pigs Production

Animal production in general plays a vital socioeconomic role for people living in low-income countries. They are widespread and almost every rural family owns them which provide a valuable source of family protein and income (Tadele et al., 2018). Guinea pigs, widely reared for meat in Latin America, are also bred in a number of African countries, a practice that has received virtually no attention from government institutions and agricultural sector policy makers (AU-IBAR, 2019). Micro livestock are likely to become increasingly important as a result of rapid increase in human population and urbanization (Assan, 2014). Recently, there has been a growing interest in the use of mini-livestock, including Guinea pigs (*Cavia porcellus*) to increase and diversify livestock production (Manjeli et al., 1998). Domestic Cavies (*Cavia porcellus*) is one of the mini livestock which are used in Sub-Saharan Africa to provide food and nutrition security, and income (Ayagirwe et al., 2019).

According to Assan (2014), micro livestock species can be an option to meet the animal protein demand in Sub Saharan Africa. There is growing evidence that engaging in micro livestock farming has a potential to address the food insecurity in Sub Saharan Africa (Hardouin, 1995). Ghana has various breeds of domestic animal species that contribute to agriculture and food security but there is a death of knowledge about their characteristics (MoFA, 2003). In Ghana, the livestock production plays a major role in the agriculture sub-sector. Livestock species reared in Ghana are ruminants (cattle, sheep and goats),

poultry (chicken, Guinea fowl, ducks, Turkey and ostrich among others), pigs and micro livestock species (e.g. grasscutter, snail, Guinea pigs and rabbits) (MoFA, 2016). Animal production contributes significantly to the agricultural sector and serves as a major component in the livelihood of Ghanaians (Dery et al., 2020). In Ghana, livestock production contributes only about 7 % of Agricultural GDP (MoFA, 2003). Cavies are considered as a promising mini livestock as they require small startup capital and produce high quality meat as compared to other livestock (Lammers et al., 2009). The quality of Guinea pigs meat and its high levels of protein and energy contribute to improving the nutritional security of the rural people since breeding is easy and they are wide spread (Numbela and Velencia, 2003). Micro-livestock such as Guinea pigs are prolific and easy to breed (in practice and the cost of investment), appears to be cheaper and achievable solution that can be used to supplement and compensate for the insufficiency of protein in some of the rural people (Handlos, 2018).

Guinea pigs' meat contains high amount of protein content (20.3 - 21%), low content of fat (7.8 - 8.0 %) and 0.8 % minerals ; as compared with their counterpart such as poultry (18.2 % protein and 10.2 % fat), cattle (18.7 % protein and 18.2 % fat) and pigs (12.4 % protein and 35.8 % fat) hence its meat has high nutritional potential (Kouakou et al., 2013). Guinea pigs (cavies) manure is a good source of high-quality fertilizer containing relatively high amount of phosphorus and nitrogen that can be used in vegetable gardening. Their manure is rich in protein, it can be dried and added to the diets of other species (Handlos, 2018 ; Niba et al., 2012). Besides keeping them for income generation and also for the creation of manure for crops production, their meat is best served in important occasions

such as weddings; and is also used in traditional medicine to treat anaemia (Ngoupayou et al., 1995 ; Maass et al., 2014; Simtowe et al., 2017). Global poverty and food insecurity continue to remain as critical issues, especially in rural areas (Lammers et al., 2009). Cavies production are geared towards contributing significantly to nutrition security, especially catering for animal protein deficits, and income generation of more than a hundreds of thousands of poor rural and urban households in the world (Maass et al., 2013). The conservation of Animal Genetic Resources (AnGR) is essential to enable farmers to adapt to change in environmental conditions and consumer demands. This will facilitate the understanding of the status and characteristics of animal genetic resources to enable their sustainable use, development and conservation.

It is therefore in the best interest of societies to ensure that farmers and breeders have access to the widest possible range of animal genetic resources so that they can effectively respond to change (FAO, 2012). According to FAO (2007), AnGR recognizes that a good understanding of breed characteristics is necessary to guide decision-making in livestock development and breeding programme. Biodiversity is essential for the survival of species and populations, and is assuming greater importance in modern animal science because of an expanding global emphasis on only a few highly selected breeds (Notter, 1999).

2.2 Overview of Characterization in Animals

Characterization is essential for conservation and sustainable utilization of farm animal genetic resources, especially local breeds that are often less fancied due to their relatively low production potential (Adjei et al., 2015). Generally, characterization can be

phenotypic, molecular and genetic and have two parts namely primary and secondary characterization (FAO, 2011). Primary characterization refers to the activities that can be carried out in a single visit to the field such as measurement of animals' morphological features, interviews with livestock keepers, observation and measurement of some aspects of the production environment, mapping of geographical distribution and any additional information relevant to the management of these breeds (FAO, 2012). Advanced characterization could also be described as the activities that require repeated visits (FAO, 2011).

These activities include the measurement of the productive capacities (e.g. growth rate, milk production) and the adaptive capacities (e.g. resistance or tolerance to specific diseases) of breeds in specified production environments (FAO, 2012). The emphasis is on detail evaluation of production and adaptation traits to provide more comprehensive evidence-based information for AnGR management to aid decision-making on breed development and or conservation. In essence, phenotypic characterization of AnGR is used to measure and describe genetic diversity which forms basic understanding and utilizing them sustainably (FAO, 2011). Phenotypic characterization generally refers to the process of identifying distinct breed populations and describing their external and production characteristics within a given production environment (Karnuah et al., 2018). Phenotypic characterization describes how to conduct a study on a specific animal population and its production environment which includes; details of what to measure, how to take these measurements and how to interpret them (FAO, 2011). Phenotypic characterization is used to identify and document diversity within and between distinct breeds, based on their

observable attributes (FAO, 2012). It is a powerful tool to support countries to establish more complete inventories of their Animal Genetic Resources (FAO, 2012). Phenotypic characterization provides accumulation of fundamental baseline of data to enhance its national Animal Genetic Resources (FAO, 2011). Phenotypic characterization gives the prerequisite information and guidelines on genetic and molecular characterization (FAO, 2011).

2.3 Phenotypic Characterization of the Guinea pigs

Phenotypic characterization generally refers to the process of identifying distinct breed populations and describing their external and production characteristics within a given production environment (Karnuah et al., 2018). Phenotypic characterization describes how to conduct a study on a specific animal population and its production environment which includes; details of what to measure, how to take these measurements and how to interpret them (FAO, 2011). It can also be used to identify and document diversity within and between distinct breeds, based on their observable attributes (FAO, 2012). Guinea pigs can be phenotypically characterized based on observable qualitative features such as coat color pattern, eyes and coat color variegation, the head shape and ears orientation as well as quantitative traits such as; animal weight, head length, body length, heart girth, and height (Ayagirwe et al., 2019). They have four toes on each forelegs paw and three toes on each hind paw (Alderton, 1999 ; Donnelly and Brown, 2004). The total length of their forelegs is 5.5 - 6.5 cm and hind legs are 6.0 - 7.5 cm. Some literature have emphasized that adult Guinea pigs between 8 to 12 months usually comprise of heavy boars than sows. The boars weigh 900 g to 1200 g whereas sows weigh 700 g to 900 g (Meredith and Delaney, 2010 ;

Mancinelli, 2016). Adult Guinea pigs have body weight ranging from 300 to 1,203 g at maturity and a total animal length from 20 to 38.5 cm from head to rump; they do not have tails (Nowak, 1999 ; Ayagirwe et al., 2019). Their head length of 8.2 cm at the adult stage ; have a heart girth of 18.2 cm and a height at withers of 11.9 cm (Ayagirwe et al., 2019). Cavies are predominantly of three types; the long hairs, curled hairs and short hairs. The short haired type is commonly reared in Ghana whereas the curled and long haired types are the exotic breeds and can be found in the advance countries and some African countries.

Cavies with one color coat (monochromic) are usually purely white, brown or black. Usually such color- coat correlate to red or black eyes and these animals with these color coats do not have mixed color coat. Cavies with a dichromic coat color pattern have brown-white spots, grey-white, black-white or black-brown spots. Their eyes color is black, with a rounded head profile while their coat color variegation is absent. The Cavies with a trichromic coat color combinations that are, white-black-brown spots, white-brown-grey or white-black-grey spots have black eyes and have coat color variegation with their heads elongated. (Ayagirwe et al., 2019). Guinea pigs can produce a litter size between one to seven pups. Litter size of 1-2 are very common as sows only have two functional breasts; pups of larger litters are often weak and die too early (Handlos, 2018). The animals can live up to 5 to 7 years when proper care is given to them (Mancinelli, 2016).

2.4 Importance of Characterization

Characterization is essential for conservation and sustainable utilization of farm animal genetic resources, especially local breeds that are often less fancied due to their relatively low production potential (Adjei et al., 2015). It serves as an emphasis on detail evaluation of production and adaptation traits to provide more comprehensive evidence-based information for Animal Genetic Resources (AnGR) management to aid decision-making on breed development and or conservation (FAO, 2011). Characterization of Animal Genetic Resources (AnGR) can be used to measure and describe genetic diversity which form basic understanding and utilizing them sustainably (FAO, 2011). Characterization helps to identify distinct breed populations and describing their external and production characteristics within a given production environment (Karnuah et al., 2018). Phenotypic characterization also describes how to conduct a study on a specific animal population and its production environment which includes; details of what to measure, how to take these measurements and how to interpret them (FAO, 2011). Phenotypic characterization is used to identify and document diversity within and between distinct breeds, based on their observable attributes (FAO, 2012). It is a powerful tool to support countries to establish more complete inventories of their AnGR (FAO, 2012). Phenotypic characterization provides accumulation of fundamental baseline of data to enhance its national AnGR (FAO, 2011). Phenotypic characterization gives the prerequisite information and guidelines on genetic and molecular characterization (FAO, 2011).

2.5 Animals that have been Characterized in Ghana

According to De Marchi et al., (2003) characterizing indigenous breeds and their subsequent description would assist in the development of economically marginalized

areas of every region through the evaluation of local breeds and thereby promote conservation of local breeds and preservation of biodiversity. But now there are a handful research works done particularly on phenotypic or morphological and genetic characterizations of indigenous animals which have been segmented in many parts of Ghana ; in rabbits (Husein, 2015) ; in goats (Birteeb and Lomo, 2015 ; Ofori et al., 2021) ; in grasscutters (Annor, 2011 and Annor et al., 2011); in Ghanaian local chicken (Adjei et al., 2015 ; Botchway et al., 2017) ; in local pigs (Ayizanga, 2016) ; in sheep (Birteeb et al., 2012) ; in local chicken and Guinea fowl (Brown et al., 2017) ; in domestic pigeon (Najat, 2019).

2.6 Origin, History and Distribution of the Guinea pigs

The domestic Guinea pigs (*Cavia porcellus*) comes from the Caviidae, the rodent family and not the family of pigs (Terril et al., 1998), which belongs to the order of Caviomorpha, or Hystricomorpha (Mancinelli, 2016). They were first domesticated as early as 5000 BC where many poor families keep them primarily for meat production and also use as a food source in the Andean region of South America mountains (the present day southern part of Colombia, Ecuador, Peru, and Bolivia), they have been domesticated some thousands of years by the South Americans (Chauca, 1995). The breeding of Guinea pigs have been well known worldwide, as a source of pets and laboratory animals (Sachser and Lick, 1991 ; Chauca, 1995). The scientific name of Cavies, the common species (*Cavia porcellus*) which porcellus is a Latin word for "little pig". *Cavia* is a new Latin word which is derived from *cabiai*, the animal's name in the language of the Galibi tribes once native to French Guiana (Chauca, 1995) indicated that about 36 million Guinea pigs in the Andean

countries are used as the traditional food. About two million Guinea pigs are consumed each year in Peru alone. The rearing of Guinea pigs on small scale farms in Latin America has shown to be more profitable than rearing other conventional livestock. This species occupies a special place in animal production in Latin America (Hardouin et al., 2003 ; Morales, 1994) and Sub-Saharan Africa (Ngoupayou et al., 1995). In Sub-Saharan Africa, cavies have been popularly and widely raised to address food insecurity in Benin, Cameroon, Côte d'Ivoire, Democratic Republic of Congo (DRC), Ghana, Guinea (Conakry), Mali, Nigeria, Senegal, Sierra Leone, Tanzania, and Togo (Morales, 1995 ; Ngoupayou et al., 1995).

2.6.1 General description of Guinea pigs

Although Guinea pigs do not relate to the pigs family, they resemble piglets when they are skinned and dressed for cooking. Also, some of their vocalizations sound somewhat like piglets vocalizations (Alderton, 1999). These species give birth to precocious young ones being mobile, with fully developed furs, with their eyes open, teeth present therefore, able to consume solid food within a few hours and open eyes after a long gestation period of 68 days and can still suckle for two to three weeks (Meredith and Delaney, 2010; Hubrecht and Kirkwood, 2010 ; Quesenberry et al., 2012). They have four toes on each forelegs paw and three toes on each hind paw (Alderton, 1999; Donnelly and Brown 2004). Adult Guinea pigs have body weight ranging from 300 to 1,203 g at maturity (Ayagirwe et al., 2019; Nowak, 1999). The boars weigh 900 g to 1200 g whereas sows weigh 700 g to 900 g (Meredith and Delaney, 2010 ; Mancinelli, 2016). They are social animals. One mature male (boar) can service 1 to 10 females (sows) which can be in groups (Keeble, 2009;

Mancinelli, 2016). Guinea pigs are monogastric grazing herbivores with hindgut fermenter and practices coprophagy, consuming its own pellets (Terril et al., 1998 ; Alderton, 1999 ; Mancinelli, 2016 ; Meredith and Delaney, 2010). They do not consume all the faeces but the soft portion which makes the caecotrophs. This is to ensure the efficient utilization of nutrients re-absorption from the caecal digesta, particularly vitamins K and B12 produced by the bacterial flora in the gut (Kaliste, 2004 ; Alderton, 1999). The Guinea pig gastrointestinal tract is dominated by a large caecum which breaks down the cellulose content of the diet (Richardson, 2000).

2.6.2 Guinea pigs scientific classification

Domain: Eukarya

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Rodentia

Suborder: Hystricomorpha

Family: Caviidae

Subfamily: Caviinae

Genus: Cavia

Species: Cavia porcellus

Source: ([Benton](#), 2016 ; Monique, 2021)

2.7 Morphological Features of Guinea pigs (Cavies)

Sow pups reach sexual maturity earlier than boars. They reach puberty as early as six weeks of age and nine to ten weeks of age in boars (Harkness et al., 2010). Because the sows reach sexual maturity early, females come on heat approximately every 16 days (Hubrecht and Kirkwood, 2010). They have four toes on each forelegs paw and three toes on each hind paw (Alderton, 1999 ; Donnelly and Brown 2004). The total length of their forelegs is 5.5 - 6.5 cm and hind legs are 6.0 - 7.5 cm. Some literature have emphasized that adult Guinea pigs between 8 to 12 months, usually have heavier boars than sows. The boars weigh 900 g to 1200 g whereas sows weigh 700 g to 900 g (Meredith and Delaney, 2010 ; Mancinelli, 2016). Adult Guinea pigs have body weight ranging from 300 to 1,203

g at maturity and a total animal length from 20 to 38.5 cm from head to rump; they do not have tails (Ayagirwe et al., 2019 ; Nowak, 1999). Their head length of 8.2 cm at the adult stage ; have a heart girth of 18.2 cm and a height at withers of 11.9 cm (Ayagirwe et al., 2019). Cavies are predominantly of three types ; the long hairs, curled hairs and short hairs. The short haired type is commonly reared in Ghana whereas the curled and long haired types are the exotic breeds and can be found in the advance countries and some African countries.

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2.7.1 List of breeds of Guinea pigs

1. Hairless breeds of Guinea pigs

The response to hairless Guinea pig breeds is the most polarized. People consider hairless breeds to be easy to care for and have low tendencies of infestation and do not need hair management. However, some people do not love this kind of breed. They have a lifespan of 5 to 6 years. Hairless breeds have the greatest number of color variations in terms of their hair coat. They stay in warmer climate because of lack of insulation of their body and should therefore be provided with enough bedding and insulation during the cold seasons. Kids prefer this breed because hairless Guinea pigs do not cause allergic reactions to them ([Benton](#), 2016 ; Monique, 2021).

Breed characteristics of Baldwin Guinea pig

This breed comes from California; it is normally said that they cannot withstand hot temperatures. They have a lifetime of just over four (4) years and cannot withstand warm regions because of their vulnerabilities and this requires them been kept indoors under a shade. This breed grows fast, quite obese and looks cute. They have appreciable body length between 8 to 10 inches in size than other Guinea pigs. Baldwin Guinea pigs are hard to distinguish them from other breeds especially at birth for the first few weeks of their life. Their hair is just like other breeds of Guinea pigs and with time the hairs are peeled off. Most often this breed has skin colour of two contrasting shades in large spots- like brown and peach ([Benton](#), 2016 ; Monique, 2021).



Plate 2.1: Baldwin Guinea pig

Breed characteristics of Skinny Guinea pigs

This particular skinny breed is originated from Canada. They can live longer than 4 years and has body size of about 8 to 11 inches in length ([Benton](#), 2016 ; Monique, 2021). Skinny Guinea pigs cannot withstand warm regions because of their vulnerabilities and this requires them been kept indoors under a shade. To keep them in a moderate temperature, good bedding materials could be used as an insulation to avoid rains, heat and high humidity. If not properly cared for, they have high tendencies of infestation due to very low and high temperatures. The Skinny Guinea pig is a hybrid of both hairless and short-haired breeds.



Plate 2.2: Skinny Guinea pig

Short haired breeds of Guinea pigs

Short haired Guinea pigs are the most preferred breeds of all. Not only are they quite easy to care for, but the chances of infestation are also quite minimal. Moreover, their hair is neither too long to get messed up, nor too short to make them cold. One common trait for the short-haired breeds is their lifespan of 4 to 7 years.

Breed characteristics of American Guinea pig

This breed hails from Peruvian Andes in South America and they belong to the short-haired type of Guinea pigs. American Guinea pigs live between 4 to 6 years as compared to other breeds. An adult American Guinea pig have cute round nose with body length between 7 - 9 inches. This kind of breed can be commonly found in Ghana because of good temperance.



Plate 2.3: American Guinea pig

Breed Characteristics of American Crest Guinea pig

This breed hails from Peruvian Andes in South America and they belong to the short-haired type of guinea pigs. American Crest Guinea pigs live between 4 to 6 years as its lifespan. An adult American Crest Guinea pig have cute round nose with body length between 7 - 9 inches. American Crest Guinea pigs are noticed with a crest on top of their head, in a different color of their body but can also vary. They look like they have a bow on their head all the time (Monique, 2021).



Plate 2.4: American Crest Guinea pig

Breed characteristics of Himalayan Guinea pig

Himalayan Guinea pigs come from Himalayas in the South-Eastern part of Asia. This breed has a lifespan of 5 to 7 years. This breed is an exception to the easy to care rule of short-haired breeds. These breeds do response well to direct sunlight. They do not grow beyond 12 inches in length, and they have white hair with dark spots around their ears and feet. These spots could fade as result of exposure and depression and this requires that they should be kept indoors ([Benton](#), 2016).



Plate 2.5: Himalayan Guinea pig

Breed characteristics of Ridges Guinea pig

Ridges Guinea pigs are originated from America. Their lifespan is in the range of 4 to 7 years. This breed is the best choice for aesthetics purposes. They have a very common ridge of hairline running down their back. Their hair grows in the reverse direction near their feet. Some adult ridge Guinea pigs are as small as 5 inches whereas others grow as long as 12 inches ([Benton](#), 2016 and Monique, 2021).



Plate 2.6: Ridges Guinea pig

Long haired breeds of Guinea pigs

Most breeds of Guinea pigs fall under this category. They have long hair that make a great show companionship with humans. They are sociable and emotionally receptive. Since

they are well-insulated, they are better off in areas where the weather is humid or cold. With the long-haired, breeds have been seen to have the longest lifespan as compared to other short-haired and hairless breeds. However, longer hair comes with more investment in grooming and anti-infestation measures

Breed characteristics of Silkie Guinea pig

The Silkie breeds are very satisfying to people than hunger for aesthetic value. There is another common name for the silkie breed of Guinea pigs: sheltie. They have an average lifespan of 5 - 7 years; their lifespan depends on administering proper health care of the animals. The silkies stay shy for a longer duration than the other breeds. With their gentle personality, they make great pets for kids to play with. But they need regular grooming, extensive care and love from an adult who understands their needs. With silky smooth hair, they look like the rulers of the Guinea pig kingdom. Their long hair does look great, especially because of the shiny, lustrous and elegant colors. With a teardrop shaped body, their hairline is spectacular in itself. It has a perfect wave of hair falling behind the face, with no hair growing in opposite directions anywhere in the body (Monique, 2021).



Plate 2.7: Silkie Guinea pig

Breed characteristics Texel Guinea pig

It is originated from England and also known as the prettiest breeds among Guinea pigs that came from England. They have multiple combinations of colours with aesthetic nature. They are known as affection breeds among Guinea pigs. Their lifespan is between 5 to 7 years. The Texel breed has an alternative name as Curlies. They have attractive curly hair. Their hair is straight towards their top, but gets gradually towards exclusive curliness towards the bottom and difficult to manage ([Benton](#), 2016 ; Monique, 2021).



Plate 2.8: Texel Guinea pig

Breed characteristics of Coronet Guinea pig

It is a long-haired breed which originates from England. This breed has proved to be the longest living of all other breeds of Guinea pigs up to 6 to 8 years. They are the most playful and affectionate breeds among all. Their hair coat normally grows backward right from the face, which is common among silkies and cornets breeds. The difference between the two breeds lies in the presence of a coronet or rosette in the middle of the heads in cornets. They are multichromatic (many) color in their hair. The most adored combination

is where the rosette is white, the majority of the coat is brown with black strands in between ([Benton](#), 2016 ; Monique, 2021).



Plate 2.9: Coronet Guinea pig

Breed characteristics of Peruvian Guinea pig

They are pretty and impressive breeds from Paris. They are very cooperative with outdoor relaxing sessions and make great playmates. With probably the longest hair of 24 inches longer than all the Guinea pig breeds, it is safe to say that it is also the toughest to groom and maintain. Their body length cannot grow longer than 12 or 13 inches. Their lifespan is, on an average in the range of 4 to 7 years ([Benton](#), 2016 ; Monique, 2021).



Plate 2.10: Peruvian Guinea pig

Breed characteristics of Alpaca Guinea pig

They originated from English Peruvian Guinea pigs in England. The alternative breed names include Boucle, English Peruvian and Curly Coronet. This breed also has an excellent record for the longest lifespan in Guinea pigs, with about 5 to 8 years at best. The Alpaca Guinea pigs are probably the ideal choices for Guinea pig seekers. Alpaca Guinea pig portraits all the qualities with all the traits that Guinea pigs' seekers want such as furry, fuzzy, playful, cute, hairy, even though not all these adjectives are fitting for all breeds. They have wonderful thick and wavy hair and come in many different colours ([Benton, 2016](#)).



Plate 2.11 Alpaca Guinea pig

iv. Breed characteristics of Merino Guinea pig

The Merino Guinea pig is also known as English Merino and Merino Peruvian with a proven life span of a minimum of 5 years with proper care. The maximum lifespan depends on a number of factors. The Merino Guinea pig is known for its friendly temperament. They have a varied body length as short as 4 inches and as long as 12 inches. Usually its appearance is similar to Texel Guinea pig, with curly coats short hair on the head are the differences. They are visually appealing than the rest of the breeds of Guinea pigs ([Benton](#), 2016 ; [Monique](#), 2021).



Plate 2.12 Merino Guinea pig

Breed characteristics of Lunkarya Guinea pig

They have common name as “Lunk”. It hails from Sweden. Their breeding practices have led to this elegant and gorgeous breed of Guinea pigs. They are proven to have strong immune system than the rest of the breeds and with lifespan of between 5 to 8 years. The most common colour combination of this breed is that of grey with white, a brilliant

combination that accounts for a long, rough and curly nature. Their corkscrew-like curls filled coat is a great appeal to our eyes but also difficult to combed and maintained.



Plate 2.13: Lunkarya Guinea pig

Coarse coat breeds of Guinea pigs

These are intermediate in terms of lifespans, grooming and easier to maintain than most other breeds. They make a good preference for people with moderate benefits in terms of everything.

Breed characteristics of Teddy Guinea pig

Most people choose Teddy Guinea pigs for a number of reasons such as fun, social, mellow, fuzzy and curious in nature. They look more like soft toys than real animals ([Benton](#), 2016 ; [Monique](#), 2021).



Plate 2.14: Teddy Guinea pig

Breed characteristics of Rex Guinea pig

This type of the Latin American breeds is friendly. They grow as long as 17 inches in length with an appreciable lifespan of 5 to 6 years. Their hair length grow not more than 1 cm in length. Their unique traits such as wholly hair, dense coat and curly hair on their underbelly make them fuzzier in appearance and in texture.



Plate 2.15: Rex Guinea pig

Breed characteristics of Abyssinian Guinea pig

This breed emerged from Latin America, with a lifespan of 5 to 8 years. They are one of the most reliable breeds of Guinea pigs. They are among the most beautiful, intelligent,

emotionally connecting and adorable of all Guinea pigs. Their body length is between 8 to 12 inches that grows up to 4 cm. The hair coat can grow up to 4 cm in length. Abyssinians guinea pigs are noticed for their multiple colour variations ([Benton, 2016](#)).



Plate 2.16: Abyssinian Guinea pig

Breed characteristics of Sheba Guinea pig

Sheba Guinea pigs are alternatively called Sheba Mini Yak. They have a common resemblance as that of wild yaks of the Himalayan range. Sheba Guinea pigs have a lifespan of between 4 to 7 years. Their body can grow 7 to 12 inches in length. The nature of their cool hairstyle requires regular management ([Benton, 2016](#) ; [Monique, 2021](#)).



Plate 2.17: Sheba Guinea pig

Breed characteristics of Satin Guinea pig

Satin Guinea pigs are well known for their glossy coats which make them very distinctive. The breed of this kind of coat could emerge from many varieties of cavy including Abyssinian, Rex and even hairless types. Satin breed of Guinea pigs are prone to osteodystrophy. If found early can be treated using calcium supplements and painkillers. Osteodystrophy in Guinea pigs is a painful disease and a decision to curb it may need to be taken to prevent suffering. Symptoms can occur as early as 12 - 18 months old with signs being staggered or unbalanced gait, change in eating habits and temperament (Monique, 2021).



Plate 2.18: Satin Guinea pig

2.8 Production Systems of Guinea pigs

2.8.1 Housing of Guinea pigs

Adhering to good husbandry practices of caviae are paramount to improve their performance, increase productivity and thus brings good returns on investment. Better housing of Guinea pigs make management easier. The provision of pens make management of the animals easier and allows them to grow slightly faster in more secure environment, but had little effect on the productivity or profitability of the enterprise (Paterson and Rojas, 2004). Either pens, cages or hutches can all be used to house Guinea pigs. Metal cages and wire mesh flooring has the advantage of allowing urine, faeces and water to fall through but however can cause alopecia, pododermatitis and leg injuries (Brian and Fish, 2015). Soft woods are not good materials for constructing pens for caviae because they end up chewing it and also gets soaked easily with their urine which cannot be cleaned and can get rotten too fast (Mancinelli, 2016).

Housing units of caviae must be adequately spacious to allow all the Guinea pigs to express their welfare by enabling them to lie down, run, play, tunnel and stand without touching the roof of the enclosure. Where Guinea pigs are housed in hutches, they must have a permanent secured place in the pen. Guinea pigs must be provided with a suitable litter materials which includes dust-free wood shavings and can be supplemented with hay

(DEFRA, 2018). Some people also allows them to run freely in the kitchen building of their house, although on some farms, they are confined in a separate, small shed (Paterson and Rojas, 2004).

Guinea pigs should not be exposed to high temperatures (i.e. stay away from direct sun radiations), humidity, rains and droughts/wind (Keeble, 2009 ; Handlos, 2018) as these conditions may easily predispose them to health problems. The optimum temperature required for Cavies must be 20 °C to 22 °C and humidity should be 40 % to 70 % (Keeble, 2009). Too high temperatures above 27 °C, will lead to heat stress in Guinea pigs and can be fatal. Suitable designs for pens should be made available, and raised to keep the animals 90 - 100 cm above the ground level. The cages, hutches and pens must be well ventilated whereas protecting them from dogs, cats and snakes because these are predators of cavies (Paterson and Rojas, 2004 ; Handlos, 2018). Housing of cavies in open cages must have dimensions from 60 x 120 cm to 120 x 220 cm. The ideal space for the animals should be at least 600 cm² (Stoffels and Hermans, 2014).

The standard floor space is 700 cm² per adult animal with 40 cm high lateral cage walls. And in a large hutch (at least 100 cm long × 50 cm wide × 40 cm high) above the ground level), the outdoor must be (150 cm × 100 cm at minimum), is preferable for Guinea pigs. Guinea pigs cannot jump or climb, so do not require much vertical space (Mancinelli, 2016). Plenty of suitable dust-free with good absorbing bedding materials should be provided such as shredded papers, newspapers, recycled paper pellets, wood shavings (not sawdust) and hay/straws (free from pricking). This will allow for natural nesting and hiding behavioural expression (Johnson-Delaney, 2008 ; Keeble, 2009 ; Mancinelli, 2016).

Bedding materials should be monitored daily and changed at least two times in a week. Because of predators, cavies will want to hide and secure themselves in tunnels, cardboard boxes, pipes or plastic tubes and would want to screen themselves from windy places, if their pen is located outside (Mancinelli, 2016). They are social animals where one male (boar) and 1 to 10 females (sows) can be grouped together for breeding (Keeble, 2009 ; Mancinelli, 2016). Guinea pigs (cavies) should be separated by sex and age. In a situation where two or more males are housed together with one or more females, it brings about fighting and one male may be injured or die. However, boars without females can be put together. Internal cage separation standards - to house young males, young females, pregnant females and females and their young must be adhere to (Paterson and Rojas, 2004 ; Handlos, 2018). Guinea pigs and rabbits should not be put together as the rabbits tend to bully them. These two have different dietary requirements and rabbits can also transmit infections such as *Bordetella bronchiseptica* that causes death among Guinea pigs (Brian and Fish, 2015 ; Mancinelli, 2016).

2.8.2 Diet/nutrition of Guinea pigs

Cavies are animals that require less intensification as compared to their counterparts; chickens, rabbits, pigs and goats. Guinea pigs virtually eat a wide range of herbs, roots, fruit and vegetables and they also eat fresh hay and grass as part of their diet. At times, they can be fed with grains but not seeds and nuts (Jessica, 2017). When there is availability of feed in the pen, cavies can eat throughout the day, this keeps their digestive system more functional. This helps to prevent malocclusion among guinea pigs, by preventing their teeth from continuous overgrowth (Jessica, 2017). Some feed materials

that can be fed with guinea pigs are as indicated below; Capsicum, celery, carrot, spinach, silver beet, kale, tomatoes, bok choy, pakchoi, wombok, cucumber, lettuce, corn and the silks/husk, string beans, sweet potato, pumpkin, broccoli, cauliflower, squash, cabbage. Types of herbs: parsley, endive, fennel, coriander, chicory, basil, mint. Types of fruit to be fed with animals; Banana, apple, choko, berries, citrus fruits, honeydew melon, rock melon, watermelon, grapes, pawpaw, dragon fruit, pear, peach, apricot and many others (Jessica, 2017). Types of plant to be used as feed for the cavies; Milk thistle, banana and plantain leaves, some fruit tree leaves, dandelion, edible flowers, clover, Bamboo leaves, banana tree leaves, types of hay such as wheat, oats, barley, fresh grass. Below is a brief list of what guinea pigs should not eat. Feed materials that should not be given to Guinea pigs are -garlic, onion, bulb vegetables, some types of beans, potato or potato skins, dairy, meat, nuts, eggs, seeds, spices, eschallots, leek, avocado, coconut, lollies/sweets, rice (Jessica, 2017).

Daily feeding regime guide indicate that they need feed components such as fresh fruits, vegetables and herbage, about 200 g per animal per day, hay and potable water daily at ad libitum (Stoffels and Hermans, 2014). Drinkable water should be provided daily through the use of a dropper bottle and heavy ceramic bowl which should be slightly raised in other to avoid soiling the water with their droppings and tipping (Mancinelli, 2016). The average food intake is 60 g/kg to 70 g/kg per day in adult animals and the average water intake is 100 ml/kg to 200 ml/kg (Keeble, 2009). Guinea pigs' feed can also be obtained from wastes harvest produce, household scraps and sometimes supplemented with vegetables, fruits, forages and roots. Watering is not considered as a challenge because they rely on the

forages to meet their requirements (Manjeli et al., 1998 ; Noubissi et al., 2014). Guinea pig feed is hocked on to the use of forages rich in protein sources such as Panicum maximum to improve the herbivores nutritional requirement of Guinea pigs (Porkellus and Emile, 2018). In other for Guinea pigs to obtain proper daily requirement feed for normal growth and maintenance, they require commercial pellets feed with 65.8 % of dry matter (DM), crude protein 15%, crude fibre 10 %, crude oils 3 %, crude ash 5 %, Ca 0.6 %, P 0.5 %, vitamin C 250 mg/kg, vitamin D 1500 IU/kg, per animal per day (Stoffels and Hermans, 2014). Guinea pigs are monogastric, grazing herbivores. They subscribe to their dietary preferences at a very early stage of their life and changing in feed type, food and water should not be done too easily (Quesenberry et al., 2012). It is therefore required to expose them to it a bit by bit in smaller amounts of different types of commercial pellets and vegetables for young ones. They mainly eat at night and perform coprophagy in the morning. Their diet should be high in fibre (12 % to 16 %), which they digest more efficiently than in rabbits. High fibre intake is necessary to ensure adequate chewing activity and promote tooth wear and gastrointestinal health.

They must therefore have ad libitum access to good quality hay (Keeble, 2009). Clover and alfalfa hay should not be given to adults because their high calcium content predisposes them to renal calcification (Yarto-Jaramillo, 2011). Commercial pelleted diets are preferred over mixes because they provide more fibre and nutrients, ensuring a better quality and balanced diet and prevent them from selective feeding. Feeding pellets ad libitum is not prescribed for Guinea pigs because the animals will tend to prefer them to hay (Hollamby, 2009). Guinea pigs are like humans which cannot synthesis vitamin C or ascorbic acid on

their own and must be supplemented through feed and water, because they lack the hepatic enzyme L-gulonolactone oxidase that is necessary to synthesize ascorbic acid (Richardson, 2000). Their inability to synthesize vitamin C is responsible for their absolute dietary requirement. Hypovitaminosis C, also known as scurvy, usually shows signs and symptoms of deficiencies in two to three weeks leading to lameness or pain due to subcutaneous hemorrhage, reduce immune function, anorexia, diarrhoea, weakness, pneumonia, acute enteritis, weight loss, stiffness, skin infections, teeth problems and if left untreated can lead to death (Terril et al., 1998 ; Richardson, 2000 ; Gad, 2006 ; Hollamby, 2009). Guinea pigs need to consume 10 mg/kg to 30 mg/kg of vitamin C daily, which can be achieved through a balanced diet (with many commercial guinea pig complete pellet diets containing plentiful vitamin C). Vitamin C is unstable in the presence of light, so the water bottle should be covered and/or changed daily. Excess vitamin C is harmless and can be excreted in the urine. Sources of dietary vitamin C can be obtained from fresh fruits and vegetable matter that is supplemented through to their feed and drinking water (Richardson, 2000 ; Keeble, 2009 ; Jenkins, 2010 ; Quesenberry et al., 2012).

NAS (1995) ideal intake of 5 mg/day of a Cavy with vitamin C provides adequate amounts of ascorbic acid will be appropriate for growth and reproduction. Guinea pigs require vitamin C daily, they can acquire it from specific fruits, vegetables and wild herbs; cabbage, kale, dandelions, parsley, spinach, chicory, asparagus, green peppers, beet greens, broccoli, tomatoes, kiwi, red berries and oranges contain high levels of vitamin C, although may not be sufficient to daily requirements. Some of the vegetables, such as kale, cabbage, whole green pepper and parsley, also have high levels of calcium and oxalate; therefore,

they should be fed in small amounts (Jenkins, 2010 ; Quesenberry et al., 2012). A handful of a variety of leafy green vegetables twice a day and a small amount of fruit, without a high sugar content, should also be given and they will enjoy it very well. These feed items are important to provide a good quality and balanced diet for Guinea pigs (Jenkins, 2010 ; Quesenberry et al., 2012).

2.8.3 Growth performance of Guinea pigs

Growth can be the changes in stature and weight of an animal. It is influenced by exogenous factors related to the environment of the animal and endogenous factors specific to the animal. Generally, it is assumed that the male has a higher growth rate than the female, as is the case with young animals as compared to adults. An animal's growth curve is also influenced by the rearing system. This curve of a sigmoidal form in an intensive production system becomes highly variable in the extensive production system as a result of variable feed availability (McDonald et al., 2010). Growth rate is also a function of the breed type used. Guinea pigs normally gain as much as 5 to 7 g/day during the rapid growth period when allowed to eat commercial natural-ingredient or purified diets ad libitum (Quesenberry et al., 2012). These gains occur routinely and are greater than those obtained with some of the diets used earlier.

Growth slows after 2 months and maturity is reached at about 5 months. Weight gain can continue until 12 to 15 months of age and levels off at 700 to 850 g for females and 950 to 1,200 g for males (Quesenberry et al., 2012). It has been found in a South Kivu cavy population that, on average, the length is 9.5 cm at birth, 12.0 cm at weaning, and 25.0 cm

at the age of 34 weeks. The mean daily linear growth for both sexes is about 0.06 cm. Egena et al. (2010b) recorded 25.7 cm and 24.6 cm body length for adult male and female animals respectively of unknown age after twelve weeks under controlled conditions. The cavies have 27.6 cm at 15 weeks of age on station in Cameroon. Over decades of research and development in Peru since the mid-1960s, adult body size has been substantially increased by selection (Chauca, 1995).

2.8.4 Reproduction of Guinea pigs

Guinea pigs are capable of breeding throughout the year which their birth basically occurs in spring season. Cavy can bear litter size from 1 - 6 pups, but litter size of 1 - 2 or 3 are mostly common ; seven to nine litters can be estimated in a year (Quesenberry et al., 2012) Sex determination is more visible in the adult animals. In males, the scrotal sacs are visible with palpable and large testicles. The inguinal canal remains open. The preputial opening is rounded and gentle press allows extrusion of the penis (can be detected in young males). Guinea pigs have an os penis (Quesenberry et al., 2012 ; Mancinelli, 2016). In females, the anogenital area is Y-shaped, which can be seen in young females with the urethral opening forming the Y-branch of the vagina, there is a thin membrane which covers the vagina and can only open at the time of oestrus and before parturition representing the vertical tail (Keeble, 2009 ; Quesenberry et al., 2012).

Both males and females have one pair of inguinal mammary glands (Mancinelli, 2016). The oestrous cycle has an average length of 16 days (Quesenberry et al., 2012). Oestrous is realized by behavioural changes such as the receptive posture of the female in the presence

of the male (Mancinelli, 2016), rupture of the vaginal membrane and mucus secretion. During oestrous, which usually occurs in the evening and lasts six to eleven hours, the female is receptive to the male. Ovulation happens on its own, normally 10 hours after the onset of oestrous. Usually, two to four ova are produced (Quesenberry et al., 2012 ; Mancinelli, 2016). However, litters of up to eight will be recorded. After mating, the sperm transport time from vagina to oviduct is 15 minutes. A copulatory plug forms in the vagina within minutes of mating, and is retained for one to two days (Quesenberry et al., 2012). Their gestation period ranges from 59 – 72 days, with an average of 63 – 68 days (Quesenberry et al., 2012). Due to their long gestation period and the large size of the pups, it can make pregnant females look large and bloated. Pregnancy can be felt by palpation of foetus at four to five weeks. The weight of the female can double during gestation period. Just prior to parturition, the pubic symphysis separates to a gap of 15 mm (Quesenberry et al., 2012). On average, sows can bear 3 to 4 (range from 1 to 7) offspring weighing an average of 75 to 100 g each (Quesenberry et al., 2012). Guinea pigs born weighing less than 50 g have a low probability of survival (Quesenberry et al., 2012) indicated that stillbirth could account for 8.5 % whereas the preweaning mortality of liveborn can also be high as 9.6 %.

The sow usually consumes the placenta and membranes. Postpartum estrous occurs at six to eight hours of delivery (Quesenberry et al., 2012). Unlike the offspring of most rodents who are unable to move and feed themselves, Guinea pigs newly born pups are precocious fully developed with hair coat, teeth, claws, eyes open and with body length up to 310 mm. They are mobile, and are capable of eating semi-solid foods immediately or some few

hours after birth and can be weaned within a few days. Live birth weight ranges from 75 - 100 g. Ideally, weaning occurs and is better managed when they are at about 14 - 21 days old when body weight is approximately 180 - 250 g (Quesenberry et al., 2012). Milk production by the sow peaks at about seven days postpartum, and declines by about four weeks (Quesenberry et al., 2012). The sow will often accept suckling by young ones other than her own, especially in the case of larger litter sizes and group housing (Quesenberry et al., 2012). They can also continue to suckle up to 1 month old. Young female reach puberty very early and may come on heat (oestrous) at least four weeks of age, therefore they should be weaned at 180 g when they are three weeks old (Quesenberry et al., 2012). Males attain puberty at 68 - 70 days. Mating is most often successful when females weigh 400 - 600 g (two to three months old) and the male weighs 450 - 650 g (three to four months old) (Quesenberry et al., 2012).

Guinea pigs are bred in a polygamous way. In this system, one male is used to service 1 to 20 females (Quesenberry et al., 2012). The size of the group could be characterized by a combination of production systems and the facilities which are available. More than one male is used to cross larger groups of females in order to ensure that the females that come on heat are serviced. The males are substituted at frequent intervals (every three or four months), and the pen of females has an economic breeding life of about two years. Productivity of the group is monitored rather than the individual animal. Inbred strains of Guinea pigs are produced using monogamous pairs. This is a more labour intensive and costly breeding system. The record keeping required is more involving. Reproduction of Guinea pig can be successful if the producer carefully adhering to the following breeding

indicators; puberty, matching, gestation, birth, breast-feeding, weaning, breeding, and selection of repositioning nurseries.

2.8.4.1 Puberty of Guinea pigs

Guinea pigs are able to reproduce when they reach puberty stage. In females, it is a stage whereby the reproduction organs become functional and is ready to be crossed by male.

Females (sows) can reach puberty when they are between 6 to 8 weeks old. Puberty can be triggered by ancestral record and nutrition. The males (boars) can also attain puberty stage close to 7 - 8 weeks old (Quesenberry et al., 2012).

2.8.4.2 Matching/Crossing of Guinea pigs

Matching/crossing can be done by putting the male and the female together to start the reproduction process. Guinea pigs stocking density should be carefully managed, ideally one (1) male is to five (5) females. The weight and age by which Guinea pigs can reach sexual maturity when they are 6 to 8 weeks old with average body weight of about 180 - 200 g can reproduce for both male and female. The female has its ovulation cycle every 16 days or even more (Numbela and Valencia, 2003 ; Quesenberry et al., 2012). Crossing or matching can be ; continuous crossing and discontinuous matching;

In continuous crossing, this is done by matching the sexual mature females and males for at least one year in the same pen or cage. This facilitate the male to cross the females within 2 - 3 hours after birth and their chances for conception is so high, about 80 to 85 % success. Birthing interval is between 68 to 70 days and this can make females have 4 - 5 reproductive cycle in a year which does not give the female any birthing rest at all. To aid continuous reproduction, good nutrition should be provided (Numbela and Valencia, 2003 ; Quesenberry et al., 2012).

Discontinuous crossing can also be done by separating the males from the females one week before birth and return them in three weeks after birth. This practice helps the females to have sexual rest and allows them to recover in order to reproduce. Under this system, the sows are able to space their births and promote maternal health (Numbela and Valencia, 2003 ; Quesenberry et al., 2012).

2.8.4.3 Gestation of Guinea pigs

Guinea pigs are capable of reproducing many pups within a short time. The sows (females) after giving birth about three to four hours later can still be crossed and conceived coupled with one ovulation. The gestation period is approximately 67 days (9 weeks). The pregnant sow should be kept in cool dry place to make it more relaxed. Noxious noisy and distractions could trigger miscarriages in Guinea pigs. Pregnant Guinea pig should be handled with care. Poor nutrition, improper feeding and water provision can also lead to abortion (miscarriages) and loss of weight among pups of Guinea pigs (Numbela and Valencia, 2003; Quesenberry et al., 2012).

2.8.4.4 Birth of Guinea pigs

During delivery the mother does not need special care. It usually happens at night within 10 to 30 minutes. At birth, Guinea pigs can produce 1 to 7 young ones at a time.

The mother consumes the placenta rightly after birth and cleans the young ones. The mother gives to precocious ones born fully furred, eyes open, and start to feed on soft forages and mobile after some few hours that precedes giving birth. Guinea pigs noted with

higher litter size are recorded and use for next multiplication (Numbela and Valencia, 2003 ; Quesenberry et al., 2012).

2.8.4.5 Lactation of Guinea pigs

Lactation is the way by which the mother provides nourishment for the young animals through breast milk. In Guinea pigs, breastfeeding is done for two (2) weeks (14 days), from the day of delivery up to 14 days. Unlike other mammals, Guinea pigs do not feed on their mothers breast milk for quiet long. As the litter size increases young Guinea pigs receive small amount of breast milk that impede their growth and must be supplemented with quality feed. The mother Guinea pigs (Sow) are good producers of breast milk in the first two weeks after parturition. After fourteen (14) days the amount of breast milk from the mother may go down due to post parturition pregnancy and the young animals must be weaned immediately. After weaning, Guinea pigs will show signs of growth when they are fed well and provided right nutrition and vice versa (Numbela and Valencia, 2003 ; Quesenberry et al., 2012).

2.8.4.6 Weaning of Guinea pigs

Weaning is the separation of the young Guinea pigs from their mother, after 14 days of breastfeeding. During weaning, the sexes of animals should be characterized for easy identification. Guinea pig sexes can be identified by carefully holding the animals back and observing their external genital areas critically. Sows (females) reproductive organ is identified in the form of a “Y” sign on their external genitalia whereas the boars (males) sex organ is in the form of a “i.” (Numbela and Valencia, 2003 ; Quesenberry et al., 2012).

2.8.4.7 Breeding of Guinea pigs

Breeding it is the transition between weaning to adult stage. Guinea pigs weaners should be kept in very hygienic pens in groups of 8 to 10. The pens should be free from insects and pathogenic attacks. The animals should be housed in cool dry place. They should be stocked with the same sex and age categories in a pen. Healthy food and water must be provided to the Guinea pigs at regular intervals to aid their growth. Provision of quality feed helps the animals to obtain good weight, reach sexual maturity very early and it also reduce birth complications like abortion and infertility in cavies. The breeding phase should be 45 to 60 days depending on the breed and their feeding regime. It is always prudent not to exceed this period in other to prevent competition for space, food, and superiority among the males. During breeding, both males and females Guinea pigs proven with an outstanding qualities such as long body length, good body weight, grow very fast and animals from large litter size are selected to reproduce for 5 to 6 times and curled.

In breeding, animals with close relatives should not be paired (i.e. parents and offspring, or with Siblings) should be discouraged because it can lead to genetic erosion such as high mortality, births defects and reduce genetic vigor. In selection of Guinea pigs for breeding, you should make that the animals have good body conformation and look healthy. The sows (females) can be sexually matured when they are about 2 to 3 months old with a body weight of about 400 to 500 g whiles males should be 3 months old ideally and weigh between 500 to 600 g (Numbela and Valencia, 2003 ; Quesenberry et al., 2012).

2.9 Health Care of Guinea pigs

The best health management for your guinea pig is to practice preventive health care. This happens by way of preventing problems from occurring and also by adhering to good management practices, well balanced diet and checking on them very often for any abnormalities and signs of illness or diseases and parasites. Continuous provision of Vitamin C has not only been found to curb Scurvy in Guinea pigs but could be used to create acidic condition (acidophiles) to promote the growth of beneficial bacteria and also suppressing the harmful ones and thereby boosting the immune system of these animals.

Good animal husbandry, combined with knowledge and understanding of the biology and behaviour of the Guinea pigs, are the keys to the prevention of most animal health problems. Animal care staff must be adequately trained, observant, and follow good animal husbandry practices (Noonan, 2014) so that they can better advise Guinea pigs farmers on what to do and not to do.

Good management is crucial in the prevention and control of diseases in the Guinea pig, as in all laboratory animals. Proper housing, adequate ventilation, sanitation, and temperature, humidity, natural lights control, provision of well-balanced diets are all important in maintaining good health in Cavies (Terrill, 1998). Cavies are very resistant to disease, reproduce quickly and at all year round (can be put to reproduction at 2 months of age) (Numbela and Valencia, 2003 ; Quesenberry et al., 2012). Normal temperature for young animals is more than 12 0C. Adults can endure cooler temperatures better beyond high extreme ones, the optimum for breeding animals being 18 0C. Temperatures exceeding 30 - 34 0C can badly affect breeding or lactating females (Mwalukasa, 2009). Cavies at different age categories are usually affected by different temperature regimes for their

physiological activity. Mortality from diseases, trampling and predators are major constraints to the development of cavy culture in Africa (Manjeli et al., 1998). Predators of cavies are found to be cats and dogs, snakes, mice, silkworm, ants and chickens which attack young cavies. Mortality caused by trampling of cavies may be posed by some people allowing their cavies to move freely about in the kitchen (Ngoupayou et al., 1995). Mortality is reported up to 40 %, particularly at birth and before weaning in Cameroon (Ngoupayou et al., 1995 ; Manjeli et al., 1998). The most challenging diseases remain unknown to African cavy keepers due to weak knowledge of diagnosis. Non-infectious and infectious diseases cause of mortality in Cavies such as bacterial, viral or parasitic; acting alone or in combination in the genesis of pathogens in cavies.

Other factors contributing to diseases that are found to be in the husbandry environment includes transporting, overcrowding, unfavourable environmental conditions, lack of hygiene and feeding (Kouam et al., 2017). In Congo, Central province of DRC, the most frequent diseases identified are coccidiosis, pneumonia, salmonellosis and ecto-parasites. In Cameroon, helminthes and arthropods (40.3 %) as well as ecto parasites and myiasis (30.6 %) were the most common (Kouam et al., 2015). Among the arthropods, identified mites (*Sarcoptes scabiei* and *Demodex* spp.) were more prevalent among females and older animals in South Kivu; this suggest that inadequate hygiene and possible vitamin deficiencies can increase the animals' susceptibility for ectoparasites and many diseases. From studies in South America, it is known that lack of hygiene is one of the most important causes identified that predisposes domestic cavies to ill health (Numbela and Valencia, 2003). Manjeli et al (1998) identified the rainy season for peak incidences of

pneumonia. Susceptibility to any disease increases when animals lack adequate feeding. Notwithstanding, cavies are susceptible to respiratory illnesses, being more tolerant to cold than to heat, sudden environmental changes regarding temperature in addition to high humidity. Also draft and overcrowding of animals are known as important causes for diseases such as pneumonia (Numbela and Valencia, 2003 ; Quesenberry et al., 2012).

However, there is a need to improve record-keeping, for better diagnostic procedures and understanding of the epidemiology and pathogenesis of agents such as *Streptococcus zooepidemicus*, *Diplococcus pneumoniae* and others.

The appropriate knowledge, combined with frequent surveillance, will provide early detection and diagnosis of infection. Then specific measures can immediately be taken to ensure that animal losses due to infectious disease are minimal (Numbela and Valencia, 2003 ; Quesenberry et al., 2012). In apparent infections pose different types of problem, because they are more difficult to resolve and to detect. Such infections are likely to become more important because of their deleterious effects on experimental animals, such problems in human medicine, and possible zoonotic significance (Mancinelli, 2016). The knowledge about tumours in Guinea pigs is increasingly significant for both clinical practice and comparative pathology (Jelínek, 2003). Percy and Barthold (1993) ascertained that the pulmonary tumours form 35 %, and tumours of reproductive organs forms about 25 % of all spontaneous tumours in Guinea pigs. Guinea pigs are predisposed to dental diseases. Malocclusion is very common in Guinea pigs when left unchecked and controlled at the early stage. This can be treated regularly by tooth trimming (Dudley and Boivin, 2011). Gastric dilatation and volvulus (GDV) is a life threatening condition with a high

morbidity and high mortality rate in Cavies (Nógrádi et al., 2017). Fluid and gas gets trapped in the lumen and bacterial fermentation in the stomach causing further gastric distension leading to increased abdominal pressure and death. This in turn can lead to cardiogenic shock (Hedlund and Fossum, 2007 ; Cornell, 2012). The probable causes of gastric torsion in Guinea pigs are based on many factors. Feeding fewer meals per day, eating rapidly, decreased food particle size, exercise, stress after a meal, competition, age, and an aggressive or fearful temperament, are all likely and potentially risk factors for Gastric dilation and volvulus (GDV) development in Guinea pigs with similar effects on dogs. Sex, breeding, dental diseases, anatomical abnormalities, pain and pregnancy may also be contributing factors (Nógrádi et al., 2017).

Overeating dry foods, followed by excessive drinking of water, were listed as a possible cause of gastric torsion in Guinea pigs (Quesenberry et al., 2012 ; Mancinelli, 2016). Bloating and hypo motility of the intestines can lead to gastric torsion in Guinea pigs and can also be caused by various factors. The real cause is usually unknown, but poor-quality feed, bacterial infections, various drugs, pain and dental disease can all lead to anorexia and bloating (Michelle, 2009 ; Dudley and Boivin, 2011). Children can also be considered as a stress factor leading to development of gastric torsion among Guinea pigs, which often occurs when the children reach home after school, by way of feeding, picking up and playing with them, children rotate the animals without considering holding the animals in their normal anatomical position (Nógrádi et al., 2017).

2.10 Socioeconomic Importance of Guinea pigs (Cavies)

Guinea pigs are small rodents, very popular and have been used in the entire continent for many years for meat production and research. Guinea pigs have historically contributed to the poverty alleviation, albeit indirectly, of protein deficiency in the diets of poor people in South America, the Philippines and Sub-Saharan Africa (Morales, 1995 ; Ngoupayou et al., 1995 ; Morrow, 1997 ; Bindelle et al., 2007 ; Lammers et al., 2009). However, the breeding of Guinea pigs have been well known worldwide, as a source of pets and laboratory animals (Sachser and Lick, 1991 ; Chazan, 2008). In Sub-Saharan Africa, cavies have been popular and widely raised to address food insecurity in Benin, Cameroon, Côte d'Ivoire, Democratic Republic of Congo (DRC), Ghana, Guinea (Conakry), Mali, Nigeria, Senegal, Sierra Leone, Tanzania, and Togo (Morales, 1995 ; Ngoupayou et al., 1995).

Guinea pigs appear to be cheaper and achievable solution that can be used to supplement and compensate for protein insufficiency in rural areas for many reasons (Handlos, 2018). Chauca (1995) indicated that about 36 million Guinea pigs in the Andean countries are used as the traditional food. About two million Guinea pigs are consumed each year in Peru alone. The rearing of Guinea pigs on small scale farms in Latin America has shown to be more profitable than rearing other conventional livestock. They mature earlier and are prolific (Dikko et al., 2009 ; Lammers et al., 2009) with less competition with human for food as their diet is mainly made from crop residues, kitchen wastes and forages (Kouakou et al., 2015 and Abossede et al., 2019). At some point in time they are easily reared together with other species such as rabbits, though not a good practice (Lammers et al., 2009). Cavies require less care if kept in absolutely clean and good environment (Lammers et al., 2009). For most farmers, cavy rearing however is relatively cheaper and easier as

compared to the other livestock species as the animal requires little space, its feeding is cheap, besides it can be fed with a large variety of wild plants, kitchen wastes, vegetables, and fruit leftovers. Guinea pigs are very resistant to disease, reproduce quickly and at all year round (can be put to reproduction at 2 months of age) (Numbela and Valencia, 2003). Domestic cavies have immensely contributed to scientific research as they have been and are still used today as laboratory animals and pets worldwide (Terril et al., 1998 ; Sachser and Lick, 1991 ; Chazan, 2008 ; Pritt, 2012), where they have contributed greatly to the progress in research on health issues like tuberculosis, juvenile diabetes, cholera, vaccine standardization, pharmacology, and research on scurvy (Terril et al., 1998 ; Pritt 2012).

Cavies are considered as a promising mini livestock as they require small startup capital and produce high quality meat as compared to other livestock (Lammers et al., 2009). Guinea pigs' meat contains high amount of protein content (20.3 - 21 %), low content of fat of (7.8 - 8.0 %) and 0.8 % minerals ; as compared with their counterpart such as poultry (18.2 % protein and 10.2 % fat), cattle (18.7 % protein and 18.2 % fat) and pigs (12.4 % protein and 35.8 % fat) hence its meat has high nutritional potential (Kouakou et al., 2013). Guinea pigs (cavies) manure is a good source of high quality fertilizer containing relatively high amount of phosphorus and nitrogen that can be used in vegetable gardening because their manure does not burn the roots of the crops. Their manure is rich in protein which can also be dried and added to the diets of other species (Handlos, 2018). Besides keeping them for income generation and also for the creation of manure for crops production, their meat is best served in important occasions such as weddings; and is also used in traditional medicine to treat anaemia (Ngoupayou et al., 1995 ; Maass et al., 2014 ;

Simtowe et al., 2017). Cavies require small startup capital and produce high quality meat as compared to other livestock (Lammers et al., 2009). Guinea pigs contain Oregano essential oil which is a natural product that have anti-microbial and antioxidant properties that is used on the preservation of the conventional meats (Moreno and Arteaga-Miñano, 2018).

2.11 Correlations and Prediction of Body Weight using Linear Body Measurements

The phenotypic characteristics such as body weight and litter size are key for breeding of Guinea pigs. The improvement of these traits would be beneficial when selection is done. Correlations of body traits are crucial in the morphometric character study of animals which are useful projections of the magnitude and direction of change on how one trait could affect the other (Husein, 2015 ; Najat, 2019). A study conducted by Husein (2015) show that the pearson correlation coefficient among most traits of the Ghana indigenous rabbits were highly correlated. According to Egena (2020) the high and significant correlation coefficients among body weight and body length, body weight and heart girth and body weight and trunk length indicate that body length, heart girth and trunk length are useful for predicting live body weights in Guinea pigs. The high positive correlation values of Guinea pigs suggest that as the live body weight increases, the linear body measurements will also increase respectively. According to Egena et al. (2010), body weight is highly correlated between all the linear body measurements and significant in male Guinea pigs. Notwithstanding, the correlation with the fore leg length and trunk length were shown to be negative in females. The high and significant correlation among body weight and body length, heart girth, trunk length and length of ear shows that they

could be very useful in predicting live body weight in male Guinea pigs (Egena et al., 2010). Husein (2015) had similar recordings on Ghanaian indigenous rabbits. Najat (2019) obtained similar data in pigeons which the highest correlation was between body weight and body length (0.467), body weight and wing length (0.299) respectively. The live body weight of the animal is the valuable factor to determine the growth and economic traits for farmers, breeders and butchers (Husein, 2015). Adequate and precise knowledge about live weight is the best predictor to determine income generation by farmers and livestock processors.

The coefficient of determination (R^2) value, show that live body weight increases with age (Egena, 2020). Egena et al., (2010) suggested that predictive regression equations were significant as linear body measurements of body weight in male Guinea pigs were high whereas in females Guinea pigs body lengths were low. The R^2 value varied between 0.24 to 0.64 in males and 0.01 to 0.56 in females respectively. The phenotypic characteristics such as heart girth (0.64), body length (0.53) and length of ear (0.44) were good predictors of weight in males whereas in females, the best predictors of body weight were trunk length (0.56), length of ear (0.49) and hind leg length (0.46) in that order. The expression of high R^2 value as seen in males for heart girth, HG and Body length, BL show these traits are capable to estimate live body weight for the animal because they represent 64 % and 53 % of the variation in live body weight (Egena et al., 2010). Again, trunk length, TL and length of ear, LE could be used to determine live body weight in females because they indicate 56 % and 49 % of the variation. The magnitude and direction of the R^2 value to predict animal body weight and highly correlated in all sexes in Guinea pigs. It is therefore

imperative that selection of one or more of the traits indicate increase in body weight of Guinea pigs (Egena et al., 2010). The use of measuring tapes, weighing scales and calibrated sticks to determine linear body measurements for livestock weight are found to be economically viable, time saving and sustainable. Moreover, the use of body traits to estimate body weight of livestock will enable farmers to avoid uncertainties of determining the weights of their animals and also save cost of procuring weighing tapes and scales (Husein, 2015). The measurements of body morphometric give a useful data to predict performance, productivity and carcass characteristics of animals (Oni et al., 2001 ; Adenowo and Omoniyi, 2004 ; Ige et al., 2006).

Table 2.1. : Mean values for linear body measurements

Traits	Males Mean \pm SEM	Females Mean \pm SEM	Significance
Body weight (g)	454.00 \pm 14.69 ^a	436.67 \pm 6.52 ^b	*
Body measurements (cm)			
Body length (BL)	25.73 \pm 0.30 ^a	24.67 \pm 0.17 ^b	*
Heart girth (HG)	17.20 \pm 0.19 ^a	16.53 \pm 0.19 ^b	*
Trunk length (TL)	5.44 \pm 0.14 ^a	5.27 \pm 0.07 ^b	*
Fore leg length (FLL)	2.53 \pm 0.03	2.53 \pm 0.02	ns
Hind leg length (HLL)	4.70 \pm 0.06 ^a	4.41 \pm 0.06 ^b	*
Length of ear (LE)	2.60 \pm 0.05 ^a	2.36 \pm 0.05 ^b	*

Legend: *Significant difference ($p < 0.05$) ; ns: Not significant ($p > 0.05$) ab: Means denoted by different alphabets across row differ ($p < 0.05$) significantly ; SEM: Standard error of mean. Source: (Egena et al., 2010).

Table 2.2. : Correlation coefficients between linear body measurements.

	BW	BL	HG	TL	FLL	HLL	LE
BW	-	0.735**	0.799**	0.582**	0.491*	0.575**	0.661**
BL	-0.091*	-	0.671**	0.700**	0.415*	0.414*	0.630**
HG	0.368*	0.738**	-	0.598**	0.304*	0.715**	0.688**
TL	0.748**	0.446*	0.695**	-	0.578**	0.737**	0.584**
FLL	-0.268	0.201	0.255	-0.419*	-	0.427*	0.535**
HLL	0.674**	0.155	0.396*	0.443*	0.350*	-	0.685**
LE	0.703**	0.473*	0.776**	0.776**	0.267	0.878**	-

Legend: *Significant difference ($p < 0.05$) ; **Significant difference ($p < 0.01$) ; BW: Body weight. Values for males are above the diagonal while those for females are below the diagonal. Source: Egena et al., (2010).

Table 2.3. : Predictive equations between linear body measurements.

Sex	Regression equation	R^2	SEM
Male	BW= -448+35.0BL	0.53*	10.50
	BW= -622+62.6HG	0.64*	9.17
	BW= 129+59.7TL	0.34*	12.40
	BW= -230+271FLL	0.24*	13.29
	BW= -225+144HLL	0.33*	12.47
	BW= -18+182LE	0.44*	11.49
Female	BW= 521-3.4BL	0.01ns	6.74
	BW= 230+12.5HG	0.14*	6.29
	BW= 51+73.2TL	0.56*	4.49
	BW= 680-96.2FLL	0.07*	6.52
	BW= 90+78.6HLL	0.46*	4.99
	BW= 240+83.3LE	0.49*	4.81

Legend: *Significant difference ($p < 0.05$) ; ns: Not significant ($p > 0.05$) ; R^2 = Coefficient of determination; SEM: Standard error of mean. Source: (Egena et al., 2010).

Table 2.4. : Predictive equations for live body weight in Guinea pigs

Week	Equation	SEM	R2	Significance
4	$Y = -169 + 16.4BL + 8.9HG - 10.5TL$	11.86	0.29	*
6	$Y = -207 + 8.28BL + 5.90HG + 52.3TL$	8.88	0.62	*
8	$Y = -372 + 24.9BL + 4.75HG + 16.6TL$	6.22	0.79	*
10	$Y = -401 + 18.3BL + 20.8HG + 7.2TL$	4.89	0.84	*
12	$Y = -259 - 2.9BL + 38.2HG + 24.5TL$	8.26	0.49	*

Y=live body weight

BL=body length

HG=heart girth

TL=trunk length

*Significant ($p < 0.05$). Source: (Egena, 2010)

Table 2.5: Vital biological facts about Guinea pigs

Vital Biological Facts	Values	Remarks
Adult male body weight (Bwt)	900 - 1200 g	up to 1200 g
Adult female body weight (Bwt)	700 - 900g	
Birth weight	70 - 100 g	
Body Surface area	$9.5 - 10.1 \times (\text{Bwt in g})^{2/3} \text{ cm}^2$	
Chromosome number. (diploid)	64	
Life span	4 - 6 years	up to 7 years
Food consumption	6 g/100 g/d	
Water consumption	10 - 40 ml/100 g/d	
Body Temperature	37 - 39.5 oC	
Gut transit time	13 - 30 h	
Breeding onset: male and female	700 g (3 - 4 months) 350 - 450 g (2 - 3 months)	
Duration of breeding (not age)	18 months - 4 y	
Commercial breeding	4 - 5 litters	
Respiratory rate	42 - 104 breath/min	
Cycle length	15 - 17 d	
Gestation	59 - 72 d	
Pseudo pregnancy (rare)	17 d	
Postpartum estrus conception	fertile, 60 - 80%	
Heartbeat rate	280 - 380 beats /min	

Blood pressure	80 - 94/55 - 58 mm Hg	
Blood volume	69 - 75 ml/kg	
Puberty	♂ 3 - 4 months, ♀ 2 - 3 months	♂ 400 - 500 g, ♀ 300 - 400 g*
Gestation	68 days	68 - 72 days*
Litter size	2 - 5	1 - 5
Weaning age (lactation duration)	150 - 200 g (14 - 21 d)	
Milk composition	fat 4%, protein 8%, lactose 3%	
Peak milk production	65 ml/kg (days 5 - 8)	
Weaning	21 days	21 - 28 days*
Reproductive performance	0.7 - 1.4	
young/female/month		

Source : Normative values for Guinea pigs (Hrapkiewicz and Medina, 2007 ; Suckow et al., 2012 ; Noonan, 2014 ; Stoffels-adamowicz and Hermans, 2014 ; Handlos, 2018 ; Quesenberry et al., 2012).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Preamble

Two studies were conducted. The first study was a survey on the determination of social characteristics of Guinea pig farmers and phenotypic characteristics of Guinea pigs breeds in the middle belt of Ghana. The second phase of the work was a performance evaluation

experiment on production systems and management practices and production cost of raising Guinea pigs in the middle belt of Ghana.

3.2 STUDY ONE (SURVEY / ON FARM)

The objectives were to:

assess the demographic characteristics of Guinea pigs farmers in the middle belt of Ghana.
determine the relationship between body weight and linear body measurements of the cavies.

3.2.1 Location and duration of study

The survey was conducted from 20th September, 2019 to 19th November, 2020 in Ahafo, Ashanti, Bono and Bono East regions of Ghana. These regions were selected because of their enormous contributions to the food security in Ghana and unavailability of Guinea pigs keepers. Ashanti region lies between longitudes 0.15 – 2.25 oW and latitudes 5.50 – 7.46 oN and Bono Ahafo region is located within longitude 0.15 oE and latitudes 8.45 oN and 7.30 oS of Ghana. These regions have annual rainfall between 1,088 mm – 1,800 mm from the beginning of March to end of September and a mean temperature range of 23.9 oC to 32 oC and humidity between 65 % - 85 % throughout the year MOFA (2021)ab.

3.2.2 Experimental design

Primary characterization and cross-sectional and longitudinal survey research were used for this study. was used for this work.

3.2.3 Sampling procedure and Sample Size Study one (1)

Non-probability sampling technique such as snowball sampling procedure was used to randomly select unavailability fifty four (54) Guinea pigs farmers; 48 males and 6 females from the sixteen (16) districts (Ashanti Region; Ejura Sekyedumase and Ahafo Ano South West), (Ahafo Region; Asunafo North, Asunafo South, Asutifi North, Asutifi South, Tano North and Tano South), (Bono Region; Berekum West, Dorma Central, Jaman South, Sunyani and Wenchi) and (Bono East Region; Kintampo North, Techiman North and Techiman South) within the four (4) regions where Guinea pigs farmers were kept. These regions were selected because of their enormous contributions to the food security in Ghana. Semi-structural questionnaires were used to contact fifty four (54) farmers in their various homes that covers farmers social characteristics and phenotypic characteristics of Guinea pigs (AnGR-CIM, 2015). Overall, three hundred and ten (310) Guinea pigs; 120 males and 190 females of the same breed and age were used for Study one (1). The phenotypic measurements were recorded using a handy electronic LCD digital weighing scale with 5 kg capacity and 1 g accuracy, a tape measure and an Infinix phone (X650B, android version 9) and colour chart. Measurements were read in grams (g) and centimetres (cm).



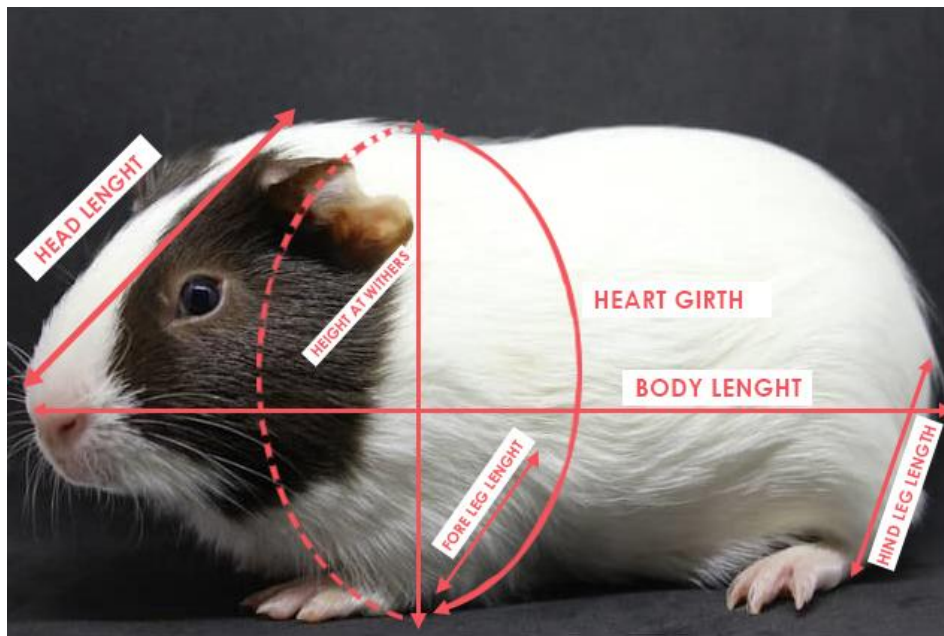


Plate 3.1: Linear body measurements in Guinea pigs

Body weight (WT): The animals were weighed on a scale and their weights read and recorded.

Body length (BL): It was measured from the rump to the end of pelvic bone as shown in Plate 3.1.

Height at withers (HW): Measured from ground to the highest point of the withers. This was done by keeping the tape measure tight, straight and perpendicular to the ground.

Heart girth (HG): Measured the circumference around the chest. It was done by placing the tape measure immediately behind the forelegs and pull the tape to fit snugly.

Head length (HL): It was measured from the nose to the neck bone.

Hind Leg length (HLL): It was measured from the socket joint to the highest point of the rump.

Fore Leg length (FLL): It was measured from the shoulder joint to the foot.

3.2.3.2 Qualitative traits as perceived by owner

Visual appraisals were assessed for all the 310 Guinea pigs used for the study such as hair texture, coat colour, profile (head, back and rump), body colour combinations and sex (Plate 3.2).



Plate 3.2: Qualitative traits of guinea pigs

Table 3.1. : Quality of Traits as perceived by owners

Trait	Quality Code a
Size	
Conformation/shape	

October to early March, each year. The region has annual rainfall between 1,088 mm – 1,800 mm from the beginning of March to end of September and a mean temperature range of 23.9 oC to 32 oC and humidity between 65 % - 85 % throughout the year MOFA (2021)ab. The experiment was carried out from 22 nd October, 2020 to 23 rd February, 2021 at Goaso in the Ahafo region of Ghana.

3.3.1.1 Experimental design

Intensive system and primary characterization were used for the purpose of this study.

3.3.1.2 Sampling procedure and Sample Size Study two (2)

Fifty-four (54) Guinea pigs four (4) weeks old were procured from farmers in Ahafo, Ashanti and Bono regions for the Study two (2). Morphological measurements were also performed on fifty-four (54) Guinea pigs that were obtained from farmers at different stages of the experiment; week zero (0), two (2), four (4) and eight (8) respectively.

3.3.2 Production System and Management Practices of Cavies.

3.3.2.1 Housing of Guinea pigs

Fifty four (54) Guinea pigs of about four (4) weeks old were reared over a period of four (4) months in the intensive system. The animals were confined in a pen partitioned into 12 compartments with two (2) males and four (4) females in each compartment to give a total of 20 males and 34 females. The cavies were developed through a reciprocal crossing between males (boars) and females (soars) Guinea pigs. Wooden pen with iron sheets roof was used to house the cavies (Plate 3.3). Each chamber was 86 cm x 81 cm x 58 cm and it

was raised 30 cm above the ground. Wood shavings were spread in the corrals as a bedding material to absorb their urine, faeces and water spills. The bedding materials were changed every week in order to minimize bad odour from the cages.



Plate 3.3: Three (3) tier housing unit

3.3.2.2 Feeding and watering of Guinea pigs

Animals were fed with forages (basal feed) such as Guinea grass (*Panicum maximum*), etc. Kitchen scraps and supplementation of concentrate (15 % crude protein) were given as well (Plate 3.4). Water was offered ad libitum. Feeding and watering troughs were washed every two days. Drinking water was changed every twenty four (24) hours to make sure the Guinea pigs had clean cool water to drink (Plate 3.5).



Plate 3.4: Concentrate supplementation



Plate 3.5: Water provision

Table 3.2 : Composition of concentrated feed for Guinea pigs

COMPOSITION	STAGES	
	Normal/reproduction	Growers
Wheat Bran	17	15
Maize	60	60

Soya Bean	21		23
Common Salt		0.5	0.5
Premix	1.5		1.5
TOTAL	100		100

3.3.2.3 Health care of Guinea pigs

Guinea pigs used for this experiment were quarantined for five (5) days to check for visible signs of any ailments (Plate 3.6). Cleaning feed and water troughs were done daily. Wood shavings were changed every week to avoid making the animals feel uncomfortable. Routine deworming was also carried out by using 0.1 ml injection of Ivermectin every month to control both endo and ecto-parasites. 50 ml of Dettol was used to disinfect the Cavies pen every week to discourage the growth of microorganisms. 50 to 150 mg of vitamin C (Ascorbic Acid) was diluted in 1000 ml of water to boost Cavies immune system (Mancinelli, 2016; Handlos, 2018). Animals were vaccinated routinely to boost their immune system (Plate 3.7).



Plate 3.6: Assessing the health status of cavies



Plate 3.7: Vaccination of cavies

3.3.2.4 Sex determination/differentiation of Guinea pigs

The females became sexually mature when they were 3 months of age while the males attained sexual maturity at about 2 - 3 months. Females' sexes were detected by holding back Guinea pigs gently and observing their external genitalia area where 'Y' signs were

seen for the sows (females) (Plate 3.8) whereas males' sexes were detected by observing 'i' at their external genitalia area with prominent penis and testis (Plate 3.9). Sex determination/differentiation is quite laborious and time consuming but it is also good in order to segregate the males from females to avoid poor breeding performance among the animals.



Plate 3.8: Sex determination of female



Plate 3.9: Sex determination of female

3.3.2.5 Reproduction performance of Guinea pigs

Reproductive performance data of the following were taken during this phase.

Litter size at birth: the total number of kids born per doe at parturition.

Litter size at weaning: the measure of the mothering ability and the impact of maternal genes until the kid's own genes for growth are switched on.

Survival: the livability of adult Guinea pigs over four months.

4. Offspring characteristics: birth weight and weaning weight.

5. Littering interval: how frequent a doe litters in every three (3) months.

3.3.3 Determination of Production Costs of Guinea pigs

Guinea pigs cost were determined on how much goes into the inputs such as their pen construction (standard pen), nutrition, purchase of starter stock, transportation and the sales or revenue. The operative stage entailed proper management in which an index of productivity and cost of production was calculated;

$$P = I - C$$

Where; P is the profit margin, I is the income from cavies production and C is the cost of production.

3.3.3.1 Productivity index of Guinea pigs

The productivity index of Guinea pig was expressed through the female factor (FF) that can be produced by a female Guinea pig in one year (Numbela and Valencia, 2003).

$$FF = F \times B/Y \times SL \times LS \times BS$$

Where:

FF represents the female factor;

F was the effort or fertility rate of the female;

SL was the effort of size of litter of the female;

B/Y was the effort of birth per year of the female;

BS was the effort of breeding survival of the female;

LS was the effort of lactating survival of the female;

Example: Using a good starter stock of 35 reproducing females with the following indexes:

Fertility:	96%
Number of birth per year	4.8%
Size of litter	2.8%

Lactation survival	85%
Breeding survival	90%

To determine the number of animals that will be sold in one production period (one year), the Female Factor (FF) needs to be considered.

The values obtained are replaced in the formula:

$$FF = F \times B/Y \times SL \times LS \times BS$$

$$FF = 0.96 \times 4.8 \times 2.8 \times 0.85 \times 0.9$$

$$FF = 9.9$$

This means that a female Guinea pig was estimated to produce 9.9 animals in a productive period of one year. Therefore, 34 females for instance will produce approximately 347 animals in one year if all other things are equal.

3.4 Statistical Analyses

The frequencies of social characteristics of cavies farmers, phenotypic characteristics, production systems and production costs were assessed using descriptive statistics of Statistical Package for Social Sciences (SPSS, 2021, version 21.0).

The data was classified and the mean was calculated using the formula:

$$\text{Weighted mean} = \frac{\sum X_i f_i}{\sum f_i}$$

where X_i represent the observations $X_1, X_2, X_3, \dots, X_N$, and f_i the frequencies of the observations thus $f_1, f_2, f_3, \dots, f_N$.

The frequencies of the various colour varieties were determined using descriptive statistics of SPSS 21.0 (SPSS, 2021).

Evaluation of the effects of colour variety, location (regions), sex and their interaction on the body measurements from both Survey and On Station studies were analyzed by least squares difference of variance using the General Linear Model (GLM) of R Statistical Software version 4.0.2 (R Core Team, 2021).

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

where Y_{ijk} = dependent variable of body weight, body length, heart girth, height-at-weight, head length, hind leg length and fore leg length, μ = the overall mean, V_i = the effect of the i th colour variety of Guinea pigs, $i = 1 \dots 4$ (1=Monochrome, 2=Dichrome, 3=Trichrome and 4=Multichrome), R_j = the effect of the j th regions location, $j = 1 \dots 4$ (1=Ashanti, 2=Ahafo, 3=Bono and 4=Bono East), S_k = the effect of the k th sex of Guinea pigs, $k = 1, 2$ (1=male, 2=female), VR_{ij} = is the interaction effect between i th colour variety and the j th regions location, VS_{ik} = is the interaction effect between i th colour variety and the k th sex, SR_{kj} = is the interaction effect between k th sex and the j th regions location, VRS_{ijk} = is the interaction effect between i th colour variety and the j th regions location and the k th sex and e_{ijkl} = the random error and independently distributed, $(0, \sigma^2 e)$. The analysis of variance and means were separated using LSD under the Post Hoc Multiple comparison.

Correlation coefficients among the various linear body measurements for the Survey and On Station studies were estimated using the Pearson's correlation of SPSS 21.0 (SPSS, 2021).

Prediction equation of the linear body measurements of Guinea pigs was analyzed using simple linear regression analysis of SPSS 21.0 (SPSS, 2021). The simple linear regression equation was:

$$Y_i = \alpha + \beta X_i + e_i \dots\dots\dots(3)$$

Where Y_i is body weight or dependent variable; α is the intercept or the value of Y_i Where $X_i = 0$; β is the coefficient of regression or slope defined as the change in Y_i resulting from a unit change in X_i ; X_i independent variable represented by BL, HW, HG, HL, HLL, FLL; and e_i is the random residual associated with Y_i .

CHAPTER FOUR

4.0 RESULTS

4.1 Survey Results

4.1.1 Social Characteristics of Guinea pig farmers

The study revealed that majority of Guinea pigs' producers were males (88.89 %) with the remaining (11.11 %) being females as indicated in Table 4.1. Again, the study revealed that, respondents aged between 31 and 49 recorded the highest (51.85 %) proportion of individuals involved in raising Guinea pigs. Respondents below 17 and between 50 - 75 obtained the same percentage (11.11 %) as age 18 to 30 recorded 25.93 % as respondents who were into Guinea pigs production. The study revealed that, most (62.96 %) of the respondents had completed Junior High School, as 16.67 % , 12.96 % and 7.41 % represented farmers who had received tertiary, middle school leaving certificate and senior high school education in the middle belt of Ghana.

Majority (66.66%) of the respondents received below Gh¢ 190.84 as revenue from the sales of Guinea pig business in one production cycle. Again, 12.96 % of the farmers had between Gh¢ 200.38 - 381.62 , 5.56 % receive Gh¢ 391.16 - 572.46, 772.84 - 954.07 and above Gh¢ 954.07 whereas 3.70 % of cavies' farmers got between Gh¢ 582 - 763.29 from the Guinea pigs' enterprise in the middle belt of Ghana. Most (66.67 %) of the farmers mentioned that they rear Guinea pigs for food and income whereas 33.33 % of farmers produce cavies for many reasons (food, income and multiplication).

Table 4.1: Socioeconomic characteristics of Guinea pigs farmers

Social characteristics	Total number (n)	Percentage (%)
Sex of farmers:		
Males	48	88.89
Females	6	11.11
Age of farmers:		
< 17	6	11.11
18 - 30	14	25.93
31 - 49	28	51.85
50 - 75	6	11.11
Farmers educational level:		
Tertiary	9	16.67
Senior High School	4	7.41
Junior High School	34	62.96
Middle School Leaving Certificate	7	12.96
Monies received from Guinea pigs production (Gh¢) in one production cycle:		
< 190.84	36	66.66
200.38 - 381.62	7	12.96
391.16 - 572.46	3	5.56
582 - 763.29	2	3.70
772.84 - 954.07	3	5.56

> 954.07	3	5.56
Purpose of rearing:		
Food and Income	36	66.67
Food, Income and Multiplication	18	33.33

Conversion rate of Ghana Cedis (¢) to US Dollar (\$) was GH¢ 5.82 to USD\$ 1.00 during Survey in October 22, 2020.

4.1.2 Qualitative characteristics of Guinea pigs in the middle belt of Ghana

Results on qualitative characteristics of the Guinea pigs of the households visited are presented as follow;

4.1.2.1 Color varieties in all the four regions

In the middle belt of Ghana, there were thirteen colour varieties as showed in Table 4.2. The colour varieties and their respective percentages; greyish-brown and gold-black-white scored the same percentage (0.32 %), black-brown, greyish-black-white and gold-brown-greyish-white got the same percentage (0.65 %), gold-brown-white were 1.94 %, greyish-white recorded 2.90 %, gold-black-brown-white had 4.19 %, pure white obtained 10.32 %, brown-white were 12.26%, greyish-brown-white were 13.55 %, black-white receive 17.42 % and black-brown-white represented 34.84 % in the four regions in the study areas. Further, the thirteen colour varieties sampled from the four regions were grouped into four color categories as shown below in Table 4.3. Out of these four color categories formed, trichrome (three colors) were the highest 51.29 %, dichromic (two colours) had 33.55 %,

monochromic (one colour) had 10.32 % and whereas multi-chromatic (four colours) were 4.84 % of the entire sampled population in Table 4.3.

Table 4.2 : Thirteen color varieties of Guinea pigs

Variety	Total number (n)	Percentage (%)
All white	32	10.32
Black-white	54	17.42
Black-Brown	2	0.65
Brown-White	38	12.26
Greyish-Brown	1	0.32
Greyish-White	9	2.90
Black-Brown-White	108	34.84
Gold-Black-White	1	0.32
Gold-Brown-White	6	1.94
Greyish-Black-White	2	0.65
Greyish-Brown-White	42	13.55
Gold-Black-Brown-White	13	4.19
Gold-Brown-Greyish-White	2	0.65
Total	310	100

Table 4.3 : Four colour categories of Guinea pigs

Color Category	Number (n)	Percentage (%)
Monochromic (one colour)	32	10.32
Dichromic (two colours)	104	33.55
Trichromic (three colours)	159	51.29

Multi-chromatic (four colours)	15	4.84
Total	310	100

4.1.2.2 Sex, eye colour, hair texture, hair type, animal head profile, breed source/origin and perception about traits of Guinea pigs

Results on these qualitative characteristics of the Guinea pigs from households' survey are presented in Table 4.4. Out of 310 Guinea pigs used for this study, 63.55 % were females as 36.45 % were males in the middle belt of Ghana. About 91.61 % of the animals had black eyes as red eyed Guinea pigs obtained 8.39 %. Cavies with course hair texture were 70.65 % as soft hair represented 29.35 %. Majority of the Guinea pigs (242) had medium hair as 54 of the pigs had short hair. Long haired Guinea pigs were 14. All the Cavies used for this study appeared to have convex, hollow and sloping profile. Moreover, most of the respondents 83.33 % purchased their breed stock from their neighbors, through gifts (11.11 %) while 1.85 % acquired their animals through market centres, family members and inheritance. About 64.81 % of the respondents were moved by some good attributes of Guinea pigs while 35.19 % respondents recorded average. Over 85.48 % of the household respondents interviewed have the flock size between 1 and 9. The respondents that keep 10 - 15 animals represented 11.29 % and those that rear above 15 animals were 3.23 %.

Table 4.4 : Sex, eye colour, hair texture, hair type, animal head profile, breed source/origin and perception about traits of Guinea pigs from survey

Varieties	Total number (n)	Percentage (%)
Sex:		
Males	113	36.45
Females	197	63.55
Eye color:		
Black	284	91.61
Red	26	8.39
Hair texture:		
Course	91	29.35
Soft	219	70.65
Hair type:		
Short	54	17.42
Medium	242	78.06
Long	14	4.52
Animal head profile:		
Convex, Hollow and Sloping	310	100
Breed source/origin:		
Neighbor	45	83.33
Gift	6	11.11
Market	1	1.85

Family	1	1.85
Inherited	1	1.85
Interest about physical appearance:		
Good	35	64.81
Average	19	35.19
Flock size		
1 - 9	265	85.48
10 - 15	35	11.29
> 15	10	3.23

4.1.3 Least square means of traits of Guinea pigs in the middle belt of Ghana (survey)

4.1.3.1 Body weight and linear body measurement base on location (regions)

The mean body measurements for local Guinea pigs based on regions are indicated in Table 4.5. The regions were highly significant ($p < 0.01$) on body measurements (BL, HG, HL, HLL and FLL) of Guinea pigs except for the body weight ($p > 0.05$) and height-at-withers ($p > 0.05$) that did not have significance effect on the location (regions).

Table 4.5 : Effects of location (regions) on body weight and linear body measurements of Guinea pigs in the middle belt Ghana

Variable	Region				Mean	P Value
	Ashanti	Bono	Ahafo	Bono East		
BW (g)	378.88 ±20.5	429.84±23.3	418.65 ±12.9	357.86 ±35.5	405.19±151.9	0.061
	8	5	3	7	0	
BL (cm)	21.68±0.48b	23.02 ±0.55	23.67 ±0.30	21.76 ±0.83	22.83±3.55	0.000
		ab	a	ab		
HG (cm)	17.01±0.35b	18.58 ±0.39	17.05 ±0.22	16.81 ±0.60	17.32±2.55	0.000
		a	b	b		
HW (cm)	7.24±0.16	7.71±0.18	7.47±0.10	7.24±0.28	7.43±1.19	0.095
HL (cm)	6.77±0.15c	7.73 ±0.17	8.08±0.09a	7.33 ±0.25	7.58±1.09	0.000
		ab		bc		
HLL (cm)	6.19±0.12b	6.41 ±0.14	6.95±0.08a		6.59±0.91	0.000
		b		6.42±0.21ab		
FLL (cm)	5.31±0.13b	5.44 ±0.15	6.41±0.08a	5.41 ±0.22	5.83±0.96	0.000
		b		b		

abc Means bearing different superscripts in the same row are different at $p < 0.05$.

SEM= standard error of means p = probability of main effects of BW= body weight,
BL=body length, HG=heart girth, HW=height-at-weight, HL=head length, HLL=hind leg
length, FLL=fore leg length

4.1.3.2 Body weight and linear body measurement base on sex

Mean body measurements for Guinea pigs based on sexes are found in Table 4.6. Both sexes had no influence ($p > 0.05$) on BW, BL, HG, HW, HL, HLL and FLL.

Table 4.6 : Effects of sex on body weight and linear body measurements of Guinea pigs in the middle belt Ghana

Variable	Sex		Mean	P Value
	Male	Female		
BW (g)	399.76±17.97	408.43±10.99	405.19±153.10	0.630
BL (cm)	22.85±0.43	22.82±0.26	22.83±3.64	0.952
HG (cm)	17.29±0.31	17.34±0.19	17.32±2.62	0.850
HW (cm)	7.41±0.14	7.45±0.09	7.43±1.21	0.826
HL (cm)	7.64±0.14	7.54±0.09	7.58±1.22	0.510
HLL (cm)	6.56±0.11	6.60±0.07	6.59±0.96	0.677
FLL (cm)	5.77±0.13	5.87±0.09	5.83±1.09	0.461

ab Means

bearing different superscripts in the same row are different at $p < 0.05$.

SEM= standard error of means p = probability of main effects of BW= body weight, BL=body length, HG=heart girth, HW=height-at-weight, HL=head length, HLL=hind leg length, FLL=fore leg length

4.1.3.3 Body weight and linear body measurement base on colour

In Table 4.7, the mean body measurements for guinea pigs based on colour category are found below. The various colour categories did not have influence ($p > 0.05$) on body measurements (BW, BL, HG, HW, HL and FLL) of Guinea pigs except for HLL which was significant ($p < 0.05$).

Table 4.7 : Effects of colour on body weight and linear body measurements of Guinea pigs in the middle belt of Ghana

Variable	Colour				Mean	P Value
	Monochrome	Dichrome	Trichrome	Multichrome		
BW (g)	370.55±31.09	418.27±14.73	409.29±19.11	340.40±42.02	405.19±152.40	0.163
BL (cm)	22.29±0.74	23.04±0.35	22.92±0.46	21.60±1.00	22.83±3.64	0.420
HG (cm)	17.15±0.53	17.36±0.25	17.44±0.33	16.23±0.72	17.32±2.61	0.381
HW (cm)	7.11±0.24	7.59±0.12	7.43±0.15	7.00±0.33	7.43±1.19	0.112
HL (cm)	7.27±0.25	7.62±0.12	7.66±0.15	7.03±0.33	7.58±1.21	0.123
HLL (cm)	6.32±0.19ab	6.64±0.09ab	6.66±0.12a	5.96±0.26b	6.59±0.95	0.011
FLL (cm)	5.53±0.22	5.88±0.10	5.92±0.14	5.27±0.29	5.83±1.08	0.050

ab Means bearing different superscripts in the same row are different at $p < 0.05$. SEM= standard error of means p = probability of main effects of BW= body weight, BL=body length, HG=heart girth, HW=height-at-weight, HL=head length, HLL=hind leg length, FLL=fore leg length

4.1.4 Interaction effects of fixed factors on Phenotypic traits

Table 4.8 shows the interaction effects of fixed factors on phenotypic traits. Region and colour had significant effects ($p < 0.05$) on body weight, body length, heart girth, heart-at-height and fore leg length. Sex and colour significantly interacted with body length ($p < 0.05$). There were no interaction between regions and sex and also between regions, sex and colour on the body measurements.

Table 4.8 : Interaction effects of fixed factors on phenotypic traits

Interaction	BW (g)	BL (cm)	HG (cm)	HW (cm)	HL (cm)	HLL (cm)	FLL (cm)
Region*sex	0.639	0.980	0.748	0.992	0.995	0.310	0.648
Region*colour	0.043	0.051	0.015	0.036	0.072	0.102	0.045
Sex*colour	0.217	0.012	0.363	0.669	0.682	0.560	0.432
Region*sex*colour	0.979	0.936	0.756	0.939	0.844	0.955	0.915

NB: significant ($p < 0.05$); not significant ($p > 0.05$), BW= body weight, BL=body length, HG=heart girth, HW=height-at-weight, HL=head length, HLL=hind leg length, FLL=fore leg length

4.1.5 Correlation between body measurements of Guinea pigs from survey

The correlations coefficient between body weight and linear body measurements ranged from low (0.334) to high (0.874) are indicated in Table 4.9. The correlation was highly positive and significant ($p < 0.01$) between body measurements. The highest correlation figure was recorded between body weight and body length (0.874), hind leg length and fore leg length (0.872). The body weight and height-at-weight had the second highest correlation figure (0.793). The least correlation value was found between heart-at-withers and fore leg length (0.334). There was no negative correlation among body measurements.

Table 4.9 : Correlation of body weight among linear body measurements of Guinea pigs from survey

	BW (g)	BL (cm)	HG (cm)	HW	HL (cm)	HLL (cm)	FLL (cm)
				(cm)			
BW (g)	-						
BL (cm)	0.874**	-					
HG (cm)	0.639**	0.658**	-				
HW (cm)	0.793**	0.777**	0.506**	-			
HL (cm)	0.674**	0.725**	0.533**	0.548**	-		
HLL (cm)	0.599**	0.688**	0.507**	0.543**	0.707**	-	
FLL (cm)	0.449**	0.594**	0.490**	0.334**	0.668**	0.872**	-

** significant $p < 0.01$, BW= body weight, BL=body length, HG=heart girth, HW=height-at-weight, HL=head length, HLL=hind leg length, FLL=fore leg length

4.2 On Station Results

4.2.1 Least square means of traits of Guinea pigs in the middle belt of Ghana from On Station study

4.2.1.1. Body weight and linear body measurement base on location (regions)

Mean body measurements for Guinea pigs based on location (region) are presented in Table 4.10. The location did not have effects on most of the body measurements of Guinea pigs. The Guinea pigs had similar values ($p > 0.05$) for all the body measurements except for hind leg length that had some differences ($p < 0.01$) and fore leg length was highly significant ($p < 0.01$).

Variable	Region			Mean	P Value
	Ashanti	Bono	Ahafo		
BW (g)	281.58±22.17	253.80±19.09	272.36±13.17	267.54±61.78	0.424
BL (cm)	22.83±0.99	21.60±0.85	21.91±0.59	22.00±2.75	0.467
HG (cm)	18.33±0.83	16.55±0.72	17.55±0.49	17.35±2.31	0.105
HW (cm)	6.96±0.26	7.08±0.22	7.30± 0.15	7.14±0.71	0.373
HL (cm)	7.13±0.28	7.28±0.24	7.16±0.17	7.19±0.78	0.838
HLL (cm)		6.80±0.25a	6.02±0.17b	6.41±0.79	0.010

Table 4.10 : Effects of Location (regions) on body weight and linear body

6.46±0.29ab

FLL (cm) 6.50±0.28a 6.93±0.24a 5.52±0.17b 6.26±0.79 0.000

ab Means bearing different superscripts in the same row are different at $p < 0.05$.

SEM= standard error of means p = probability of main effects of BW= body weight, BL=body length, HG=heart girth, HW=height-at-weight, HL=head length, HLL=hind leg length, FLL=fore leg length

4.2.1.2 Body weight and linear body measurement based on sex

The mean body measurements for Guinea pigs based on sex has been presented in Table.

4.11. Both sexes had no influence ($p > 0.05$) on BW, BL, HG, HW, HL, HLL and FLL.

Table 4.11 : Effects of sex on body weight and linear body measurements of Guinea pigs in the middle belt of Ghana

ab Means bearing different superscripts in the same row are different at $p < 0.05$. SEM= standard error of means, p = probability of main effects of BW= body weight, BL=body

Variable	Sex		Mean	P value
	Male	Female		
BW (g)	272.18±17.19	264.34±10.98	267.54±62.10	0.651
BL (cm)	21.55±0.76	22.31±0.48	22.00±2.74	0.317
HG (cm)	16.91±0.66	17.66±0.42	17.35±2.37	0.259
HW (cm)	7.16±0.21	7.22±0.14	7.19±0.77	0.782
HL (cm)	7.23±0.19	7.08±0.13	7.14±0.71	0.453
HLL (cm)	6.48±0.24	6.36±0.15	6.41±0.86	0.622
FLL (cm)	6.21±0.28	6.29±0.1896	6.26±1.01	0.743

length, HG=heart girth, HW=height-at-weight, HL=head length, HLL=hind leg length, FLL=fore leg length

4.2.1.3 Body weight and linear body measurement based on colour

Table 4.12 shows the mean body measurements for Guinea pigs based on colour. Guinea pigs colours were not significant ($p > 0.05$) on body measurements (BW, BL, HG and HW) of Guinea pigs except for HL which was highly significant ($p < 0.01$) on cavies. HL and FLL had influence ($p < 0.05$) on the experiment animals.

Table 4.12 : Effects of colour on body weight and linear body measurements of Guinea pigs in the middle belt of Ghana

Variable	Colour				Mean	P Value
	Monochrome	Dichrome	Trichrome	Multichrome		
BW (g)	267.40±31.23	272.68±14.25	254.77±19.46	290.50±26.19	267.54±62.13	0.556
BL (cm)	22.80±1.34	21.68±0.61	21.41±0.84	23.88±1.13	22.00±2.67	0.142
HG (cm)	18.60±1.16	17.53±0.53	16.55±0.72	18.38±0.97	17.35±2.31	0.141
HW (cm)	7.70±0.38	7.13±0.18	7.07±0.24	7.38±0.32	7.19±0.77	0.354
HL (cm)	7.00±0.31b	6.89±0.14b	7.05±0.19b	8.06±0.26a	7.14±0.61	0.001
HLL (cm)	6.80±0.40ab	6.39±0.18ab	6.09±0.25b	7.06±0.34a	6.41±0.80	0.027
FLL (cm)	7.00±0.48	6.29± 0.22	5.86±0.29	6.81±0.39	6.26±0.95	0.032

ab Means bearing different superscripts in the same row are different at $p < 0.05$.

SEM= standard error of means p = probability of main effects of BW= body weight, BL=body length, HG=heart girth, HW=height-at-weight, HL=head length, HLL=hind leg length, FLL=fore leg length

4.2.2 Interaction effects of fixed factors on phenotypic traits

The interaction effects of fixed factors on phenotypic traits are presented in Table 4.13. The result reveals an interaction between region and sex with body length and heart girth ($p < 0.05$). Sex and colour significantly interacted between hind leg length and fore leg length ($p < 0.05$). There were no interaction between regions and colour and also between regions, sex and colour on the body measurements.

Table 4.13 Interaction effects of fixed factors on phenotypic traits

Interaction	BW (g)	BL (cm)	HG (cm)	HW (cm)	HL (cm)	HLL (cm)	FLL (cm)
Region*sex	0.639	0.030	0.018	0.316	0.229	0.534	0.217
Region*colour	0.895	0.506	0.965	0.995	0.273	0.438	0.246
Sex*colour	0.939	0.784	0.939	0.731	0.152	0.021	0.020
Region*sex*colour	0.149	0.071	0.285	0.590	0.652	0.360	0.222

NB: significant ($p < 0.05$); not significant ($p > 0.05$), BW= body weight, BL=body length, HG=heart girth, HW=height-at-weight, HL=head length, HLL=hind leg length, FLL=fore leg length

4.2.3 Correlation between body measurements from On Station study

Table 4.14 to 4.17 shows the degree of correlation between body weight and linear body dimensions for the On station animals in week; 0, 2, 4 and 8 respectively which ranged from low (0.205) to high (0.907). The correlation coefficients were highly positive and significant ($p < 0.01$: 0.05) between body measurements such as body length, heart girth, height-at-weight and head length. The body length highly correlated with heart girth (0.907) as in Table 4.15. The second high correlation was found between body length and heart girth (0.884) (Table 4.16). Body weight and fore leg length (0.205) had the least correlation value as indicated in Table 4.17. From Table 4.16 to 4.17 reveals that as Guinea pigs grow older their body weight became highly correlated with hind leg length whereas the body weight did not correlate with fore leg length in the On station study. There was no negative correlation among body measurements.

Table 4.14 : Correlation coefficients between body weight and linear body measurements in week 0.

	BW (g)	BL (cm)	HG (cm)	HW (cm)	HL (cm)	HLL (cm)	FLL (cm)
BW (g)	-						
BL (cm)	0.837**	-					
HG (cm)	0.776**	0.764**	-				
HW (cm)	0.687**	0.690**	0.760**	-			

HL (cm)	0.677**	0.716**	0.728**	0.659**	-		
HLL	0.264	0.346*	0.543**	0.457**	0.509**	-	
(cm)							
FLL	0.232	0.324*	0.507**	0.389**	0.506**	0.828**	-
(cm)							

*Significant ($p < 0.05$), ** significant ($p < 0.01$), BW= body weight, BL=body length, HG=heart girth, HW=height-at-weight, HL=head length, HLL=hind leg length, FLL=fore leg length.

Table 4.15 : Correlation coefficients between body weight and linear body measurements in week 2.

	HW						
	BW (g)	BL (cm)	HG (cm)	(cm)	HL (cm)	HLL (cm)	FLL (cm)
BW (g)	-						
BL (cm)	0.819*						
	*	-					
HG (cm)	0.853*						
	*	0.907**	-				
HW (cm)	0.684*						
	*	0.559**	0.668**	-			
HL (cm)	0.673*						
	*	0.587**	0.623**	0.659**	-		
HLL (cm)	0.263	0.299*	0.354**	0.457**	0.509**	-	
FLL (cm)	0.229	0.246	0.321*	0.389**	0.506**	0.828**	-

*Significant $p < 0.05$, **significant $p < 0.01$, BW= body weight, BL=body length, HG=heart girth, HW=height-at-weight, HL=head length, HLL=hind leg length, FLL=fore leg length

Table 4.16 : Correlation coefficients between body weight and linear body measurements in week 4.

	BW (g)	BL (cm)	HG (cm)	HW (cm)	HL (cm)	HLL (cm)	FLL (cm)
BW (g)	-						

BL (cm)	0.750**	-					
HG (cm)	0.833**	0.884**	-				
HW (cm)	0.550**	0.550**	0.603**	-			
HL (cm)	0.561**	0.593**	0.689**	0.621**	-		
HLL (cm)	0.485**	0.468**	0.464**	0.640**	0.531**	-	
FLL (cm)	0.245	0.423**	0.354**	0.574**	0.487**	0.811**	-

** Significant $p < 0.01$, BW= body weight, BL=body length, HG=heart girth, HW=height-at-weight, HL=head length, HLL=hind leg length, FLL=fore leg length

Table 4.17 : Correlation coefficients between body weight and linear body measurements in week 8

	BW (g)	BL (cm)	HG (cm)	HW (cm)	HL (cm)	HLL (cm)	FLL (cm)
BW (g)	-						
BL (cm)	0.714**	-					
HG (cm)	0.806**	0.792**	-				
HW (cm)	0.410**	0.533**	0.465**	-			
HL (cm)	0.376**	0.325*	0.400**	0.273*	-		
HLL (cm)	0.391**	0.456**	0.378**	0.313*	0.454**	-	
FLL (cm)	0.205	0.321*	0.217	0.263	0.324*	0.818**	-

* Significant $p < 0.05$, ** significant $p < 0.01$, BW= body weight, BL=body length, HG=heart girth, HW=height-at-weight, HL=head length, HLL=hind leg length, FLL=fore leg length

4.2.4 Prediction of Body Weight of Guinea pigs

4.2.4.1 Prediction of body weight from linear body measurements using simple regression

Simple linear regression equation among body weight and linear body measurements (BW, BL, HG, HW, HL, HLL and FLL) of Guinea pigs were presented in week; 0, 2, 4 and 8 respectively was significant ($p < 0.05$) as found in Table 4.18. The study revealed that the best time to predict cavies body weight was in week 2. The best predictor of body weight in Guinea pigs were body length (BL), heart girth (HG), height-at-withers (HW) and head length (HL) with R^2 of 0.80 which shows that there was 80 % of variations in live body weight and linear body measurements of the experimental Guinea pigs. The highest coefficient of determination figure ($R^2 = 0.80$) was seen in week which recorded low value of Standard error of means (SEM = 28.93).

This shows that there was 80 % influences of body weight (BW) of Guinea pigs between BL, HG, HW, HL, HLL and FLL in week 2 of the experiment. Week 0, reveals second highest coefficient of determination value (R2 = 0.78 or 78 %, SEM = 31.02) which begun with high in magnitude and direction. But the strength in coefficient of determination started declining in week 4 (R2 = 0.76 or 76 %, SEM = 29.65) and week 8 (R2 = 0.68 or 68 %, SEM = 37.60) in direction of the predictive equation. The best predictive equation to determine live body weight in Guinea pigs was:

$$Y = -214.69 + 5.51BL + 10.11HG + 15.74HW + 18.16HL - 7.74HLL - 5.34FLL$$

Where Y= live body weight (BW), BL= body length, HG= heart girth, HW=height-at-weight, HL=head length, HLL=hind leg length and FLL=fore leg length respectively.

Table 4.18 : Prediction of body weight from linear body measurements using simple regression

Week	Equation	SEM	R2	Sig
0	Y= -281.99+15.99BL+11.68HG+7.60HW+8.96HL-7.99HLL-9.01FLL	31.02	0.780	*
2	Y= -214.69+5.51BL+10.11HG+15.74HW+18.16HL-7.74HLL-5.34FLL	28.93	0.803	*
4	Y= -104.52+3.01BL+15.06HG+5.21HW-2.27HL+27.98HLL-25.99FLL	29.65	0.761	*
8	Y= -151.87+4.21BL+15.85HG+0.01HW+3.47HL+12.69HLL-8.74FLL	37.60	0.683	*

*Significant $p < 0.05$, Y= live body weight, BL=body length, HG=heart girth, HW=height-at-weight, HL=head length, HLL=hind leg length, FLL=fore leg length, R2 = Coefficient of determination, SEM=Standard error of mean.

4.3 Production System of Cavies in the Middle Belt of Ghana

Table 4.19 shows the growth and performance characteristics of Guinea pigs (survey and on-station) in the middle belt of Ghana. The results from survey indicated that birth weights of young Guinea pigs were between 85 - 110 g and weaned at 14 days with weight between 120 - 200 g. Guinea pigs can be considered matured when they are about 90 days old and more with an average body weight of 405.19 g and above. Further, farmers reported that they do not administer ecto and endo-parasitic medications on their animals.

Table 4.19 : Average values on production system of Guinea pigs in the middle belt of Ghana

Growth/Performance Characteristic	Units/Duration
Birth weight	85 - 110 g
Age at weaning	14 days
Weight at weaning	120 - 200 g
Age at maturity	90 days
Weight at maturity	> 405.19 g
Feed requirement (forages and concentrates) for covies per day	75 - 130 g/animal

4.4 Production Costs of Guinea pigs

The production costs for 54 experimental Guinea pigs have been presented below in Table 4.20 to 4.23. Revenue generated from the sales of 40 Guinea pigs as in Table 4.23.

4.4.1 Determination of the cost of concentrate feed

Table 4.20 shows how the cost of 100 kg of concentrate feed used to feed the experimental animals.

Table 4.20 : Costs of concentrate feed (kg) in (GH¢)

Concentrate feed	Quantity (kg)	Unit price (GH¢)	Total amount (GH¢)
Normal/reproduction formula			
Wheat Bran	24 kg	$25.78 \times 1 = 25.78$	25.78
Maize	50 kg	$47.72 \times 1 = 47.72$	47.72
Soya Bean	25 kg	$76.53 \times 1 = 76.53$	76.53
Premix (Minerals and Vitamins)	1 kg	$4.77 \times 2 = 9.54$	9.54
Total			159.57

Conversion rate of Ghana Cedis (¢) to US Dollar (\$) was GH¢ 5.82 to USD\$ 1.00 during On Station study in October 22, 2020.

4.4.2 Cost of labour (Caretaker of the animals)

The motivation for the caretaker for harvesting of forages for the experimental Guinea pigs (four months duration) are presented in Table 4.21.

Table 4.21 : Cost of labour (Caretaker of the animals) in (GH¢)

Labour of the animals	Number	Unit	Unit cost (GH¢)	Total amount (GH¢)
Motivation for Labour	1	Person	$190.84 \times 1 = 190.84$	
(four months)			190.84	
Total				190.84

Conversion rate of Ghana Cedis (¢) to US Dollar (\$) was GH¢ 5.82 to USD\$ 1.00 during On Station study in October 22, 2020.

4.4.3 Summary of the total costs incurred on experimental Guinea pigs for four months

Table 4.22 showed how to calculate total cost on experimental animals.

Table 4.22 : Summary of the total costs incurred on Guinea pigs for four months in (GH¢)

Cost description	Quantity	Unit price (GH¢)	Total amount (GH¢)
Construction of Guinea pigs pen	1	858.68	858.68
Purchase of starter stocks of Guinea pigs (Weaners)	54	9.55 × 54	515.70
Feed (Concentrate)		159.58	159.58
Veterinary care cost		76.36	76.36
Labour (Caretaker of the Animals)	1	190.84 × 1	190.84
Total Cost			1,801.16

Conversion rate of Ghana Cedis (¢) to US Dollar (\$) was GH¢ 5.82 to USD\$ 1.00 during

On Station study in October 22, 2020.

4.4.4 Revenue/income from sales of experimental Guinea pigs

Table 4.23 presents the revenue/income received from the sales of experimental Guinea pigs in the middle belt of Ghana. The costs of feed for the experimental animals were found to be GH¢ 350.42 which represented 19.46 % costs of production for the four (4) months. Other related costs include pen construction, labour, veterinary care and Guinea pigs' stocks sum up to GH¢ 1,450.46, which scored 80.54 % of the total cost of production. Total income obtained from Guinea pigs ventures in four months was GH¢

3,698.12. An amount of GH¢ 1,896.96 was realized as profit from the business as shown above.

Profit = Income - Expenditure, Profit = GH¢ 3,698.12 – GH¢ 1,801.16 = GH¢ 1,896.96

The income from Guinea pigs business exclude manure that was considered as a secondary tangible fertilizer, which support crops and forage production in the middle belt of Ghana.

Table 4.23 : Revenue/income from sales of On Station Guinea pigs in (GH¢)

Revenue/income detail	Quantity	Unit price (GH¢)	Total amount (GH¢)
Sale of Guinea pigs (Weaners/young ones)	40	14.32 × 40	572.80
Breeders			
Sale of Guinea pig (adults)	54	52.32 × 54	2,825.32
Manure (organic fertilizer)	50 kg	300 × 1	300.00
Total Income			3,698.12

Conversion rate of Ghana Cedis (¢) to US Dollar (\$) was GH¢ 5.82 to USD\$ 1.00 during

On Station study in October 22, 2020.

CHAPTER FIVE

5.0 DISCUSSION

5.1 Survey

5.1.1 Social Characteristics of Guinea pig Farmers in the middle belt of Ghana

The Guinea production in the middle belt of Ghana can be characterized as a small scale.

The study revealed that Guinea pigs farmers were mainly males (88.89 %). The findings agrees with Adomah (2009) who recorded that 84 % of the grasscutter farmers were males in the Brong Ahafo of Ghana. The present result was lower than Kouakou et al. (2011) who observed that men were 96.3 % more than the women in Guinea pigs rearing in the urban and peri-urban areas in central and southern Côte d'Ivoire but disagrees with Herman et al. (2014) who revealed that women were 54 % in cavies production in the Western Highlands of Cameroon. This shows that men are main owners of the local Guinea pigs in the households certain in the middle belt of Ghana. However, in some African societies (Côte d'Ivoire, Cameroon, Ghana, etc) men are in charge of preoccupation and household properties.

The highest age range of the Guinea pigs producers was between 31 and 49 years. The results contradicts with the findings by Kouakou et al. (2011) who pointed out that Guinea pigs farmers were children between 7 to 13 years old in Côte d'Ivoire. This implies that Guinea pig rearing is not restricted by age. However, Guinea pigs keepers include both elderly and youth (Herman et al., 2014). Education levels of the respondents range from no education to tertiary education. The respondents who have received formal education was 62.96 %. Mwalukasa (2009) indicated in his report that 73.6 % of the Guinea pigs respondents have acquired primary education in Tanzania. This means that cavies farmers

who could read and write is a good indication that they could obtain opportunities in life. Hence, the ability to read and write is very paramount in livestock production simply because farmers who are literate can adopt technology very fast (Zipora et al., 2011). Over sixty six percent (66.66 %) of the cavies farmers received below GH¢ 190.84 (US\$ 32.79) as a revenue from the sales of Guinea pig in one month. This result is not consistent with Herman et al. (2014) who noted that Guinea pig keepers obtained US\$ 100 from the sales of Cavies in a month. This can be attributed to the fact that the farmers used Guinea pigs mostly for food and the surplus are sold. However, Cavies production serve as a valuable protein source and some form of income for less privileged families in Sub Sahara Africa (Manjeli et al., 1998; Komwihangilo et al., 2016).

5.1.2 Qualitative Traits of Guinea pigs

5.1.2.1 Flock size of Guinea pigs

The result showed that a lot of the respondents have a flock size between 1 and 9. This finding is in consonance with Kouakou et al. (2011) who indicated that an average flock size of the respondents range from 1 to 10 Guinea pigs per household was found in the central and southern part of Côte d'Ivoire. The study contradicted with Herman et al. (2014) who found that the flock size of Guinea pigs per household range from 1 to 30. Farmers keeping an average number of Guinea pigs might have accounted for them to sustain cavies production. The result indicated that female Guinea pigs were higher (63.55 %). The relatively smaller number of male animals in the livestock production can be ascribed to the fact that most farmers normally cull male animals from the flock by killing for meat or selling them while leaving the females to continue reproducing (Najat, 2019).

5.2.2 Breed Sources of Guinea pigs

The breed source is importance factor breeder to trace the origin of the animals. Most (83.33%) respondents purchased their cavies from their neighbors. The results was higher than what Komwihangilo et al. (2016) had in Central part of Tanzania who pointed out that 66.7 % farmers obtained their starting stock from friends and neighbors by traditional batter system in an exchange cavies for chicken, dogs, food and sugarcane. This means that farmers purchased the starting stock from their acquaintances because of trust and also get the animals relatively cheap. Hence the breed source is a good indicator for breeders to trace the ancestral record and also to carry out further investigations on the animals.

5.2.3 Physical Characteristics of Guinea pigs

Eye colour form part of the qualitative traits of cavies. Ninety one percent (91.61 %) of the Guinea pigs used in this study had black eyes. The result agrees with these researchers Mwangomb et al. (2021) and Ayagirwe et al. (2019) who found in their report that many Guinea pigs have black eyes; 99.46% and 88.65 % respectively in the Democratic Republic of Congo. This means that Guinea pigs with black eyes are very common in Africa. The research findings indicated that there were many (70.65 %) cavies have soft hair texture. Guinea pigs that have medium hair type recorded 78.06 %. Mwangomb et al. (2021) mentioned in his report that Guinea pigs have soft coat and medium type which he attributed to them as English type cavies. The cavies used in the study area have convex, hollow and sloping head profile. Much cannot be said about this result because of limited literature. There were several colors and their combinations among Guinea pigs in this

study such as monochromic (one color), dichromic (two colours) and trichromic (three colors). Black-brown-white (trichrome) three colors combination among Guinea pigs were the highest 51.29 %. The research findings compares with the following researchers; Mwangomb et al. (2021), Ayagirwe et al. (2019), Husein (2015) and Warren et al. (2008) made similar observations in rabbits and cavies respectively had many colours categories. Further, the results revealed that some Guinea pigs have four color combinations which agreed with Kouakou et al. (2015) mentioned that there are four color combinations (multi-chromic) among Guinea pigs in Côte d'Ivoire. According to Warren et al. (2008) combination of several colors on the same cavy were as a result of expression of several genes and their interactions such as the extension locus (E), the Agouti locus (A), the Brown locus (B), the Color locus (Albino), the Roan locus (Ro) and the locus responsible for white traces in the coat (S).

5.3 Body Measurements of Guinea pigs

Morphometrics readings are very useful in the phenotypic characteristics of livestock production. The study indicated that the mean body weight of the adult Ghanaian local Guinea pigs was 405.19 g and notably males were heavier 408.43 g as compared with females (399.76 g). The finding did not compare with Ayagirwe et al. (2019) report which shows that adult average body weight of Guinea pig was 562.77 g and obviously females were heavier (600.50 g) than males (525.04 g) but also agrees with Egena et al. (2010) who revealed that mean weight of adult male and female Guinea pigs were 454.00 g and 436.67 g respectively in Nigeria. The implication is that cavies from Africa origin have similar body weights. The average body weight of the local cavy that was three months old from

the on-station was 267.54 g where the mean body weights for males and females were 272.18 g and 264.34 g respectively. The result was similar with Abossede et al. (2019) observation that live weight of male and female cavy was 310.19 g and 285.54 g, respectively in the southern part of Benin. However, the adult males and females Guinea pigs have live body weight ranging from 900 - 1200 g and 700 - 900 g for the exotic breeds of cavies (Quesenberry et al., 2012). Variations in body measurements in different locations may be attributed to genetic and environmental interactions expose to the animals (Beffa et al., 2009).

The average body length, heart girth, height-at-weight, head length, hind leg length and fore leg length from the survey result were 22.83 cm , 17.32 cm , 7.43 cm , 7.54 cm , 6.59 cm and 5.83 cm respectively. The report was similar a study conducted by Egena (2010) who had 25.20 cm , 16.87 cm , 5.36cm , 4.56 cm and 2.53 cm respectively except for the body length that scored high value the rest of the results were lower than the current study. The present results confirms that an average body length, heart girth, height-at-weight, head length, hind leg length and fore leg length of the on-station animals have the following values; 22.00 cm , 17.35 cm , 7.19 cm , 7.14 cm , 6.41 cm and 6.26 cm respectively. Abossede et al. (2019) also obtained 24.94 cm, 14.14 cm and 3.89 cm for head-body length, chest circumference and Left hind foot length (FL) respectively which is lower than present study except for head-body length. The variations may be due to genetic and environmental effects carried out by selective breeding on the animals (Ayagiwe et al., 2015 ; Najat, 2019). In this study, it was found that sex did not have significant effect on body measurements (BW, BL, HG, HW, HL, HLL and FLL) the cavies. The result corroborates with the observation made by Mwangomb et al. (2021) that morphometric

result from the cavies did not experience sexual dimorphism. However, females and males had similar growth patterns. The lack of sex dimorphism depicts that a breeders could use any of the sexes to carry out growth performance without any issue. Effect of location (regions) had significant influence on body measurements such as body length, heart girth, head length, hind leg length and fore leg length of Guinea pigs except for body weight and height-at-withers that did not have influence on the location (regions) in the survey result. From the study it was showed that the location did not have effect on most of the body measurements of Guinea pigs except hind leg length and fore leg length that had significant effect on-station animals. Disparity in body measurements in all the regions may be ascribed to genetic make-up and change in environmental factors such as management, nutrition, climatic condition of the animals (Mwangomb et al., 2021; Ayagiwe et al., 2015 ; Baffour-Awuah et al., 2005). The colours categories did not have influence on body measurements (BW, BL, HG, HW, HL and FLL) of Guinea pigs except HLL and FLL which were significant. Apparently, among thirteen colours combinations of the Guinea pigs, dichromic (two colours category) was superior in body weight (418.27 g) and multichromic (four colours effect) had lowest colour body weight of 340.40 g from survey. However, the thirteen colours combinations from the on-station revealed that Guinea pigs with multichromic (four colours combination) scored heaviest body weight of 290.50 g. Trichromic (three colours variety) recorded the least body weight value 254.77 g. The implication is that variations in body weight may be a result genetic and environment effects (Sanford, 1996 ; Ayagirwe et al., 2015).

5.4 Phenotypic Correlations among Body Measurements of Guinea pigs

Pearson correlation coefficient between phenotypic measurements are profound to know in the present study of the body traits which are good determinant to show the magnitude and direction that change in one trait could influence the other. Generally, in this study the phenotypic correlation figures were superior between weight and linear body measurements ranged from low (0.205) to high (0.907).

The high positive correlation was observed between body length and heart girth (0.907) in on-station study is in line with the result of Egena et al. (2010) and Egena (2010) who indicated that strong and positive correlation among body weight and body length, heart girth and trunk length shows that the breeders could use any of these morphometric traits to predict live body weight of Guinea pigs. The second highest correlation figure (0.874) was found among body weight and body length and also hind leg length and fore leg length from the survey result. Similar results have been reported by Ayagirwe et al. (2018) that strong and significant correlations were between body weight and linear body measurements except between body length (BL) and head length (HL) for the two sexes. Body weight and fore leg length (0.205) had the least correlation value from on-station study. There was no negative correlation among body measurements. However, Hagan et al. (2016) stated in their report that there was positive and significant correlation between live weight and all the linear body measurements of grasscutter for all the sexes. This means breeders could easily use low and high correlation values of the morphological measurements to predict body traits.

5.5 Prediction of Body Weight using Linear Body Measurements of Guinea pigs

Generally, in this study simple linear regression equations were significant on body weight and morphometric traits (body length, heart girth, height-at-weight and head length) of Guinea pigs. The best time to predict cavies' body weight was in week 2 which was detected between body length (BL), heart girth (HG), height-at-withers (HW) and head length (HL) with R^2 of 0.80 which shows that there was 80% of variations in live body weight and linear body measurements of the on-station Guinea pigs. The result was similar with Egena (2010) observation that the $R^2 = 0.84$ (84 %) variations of post weaned Guinea pigs for 10 weeks old were the best fit for body weight between body length, trunk length and heart girth. Moreover, Abossede et al. (2019) reported similar finding that the body weight was significantly influenced by head body length, chest circumference, neck circumference and head circumference which were used to predict live body weight on Guinea pigs. The implication is that increment of 1 kg of live weight of the animal will appreciate 5.51 cm in body length, heart girth (10.11 cm), height-at-weight (15.74 cm) and head length (18.16 cm) respectively in Guinea pigs. Linear body measurements have been used to predict live weight of many livestock species including grasscutters (Annor et al., 2011), rabbits (Husein, 2015), cattle (Maylinda et al., 2017), pigeons (Najat, 2019) and goats (Ofori et al., 2021). According to Birteeb (2012) and Maylinda et al. (2017) who pointed out that despite the use of conventional weighing scales, predictive equation have been very useful determinant of live body weight of livestock. This shows that the use of regression equation in the linear body measurements have become more powerful solution to estimate live body weight on Guinea pigs. Hence, the live body weight of Guinea pigs is profound to predict the growth rate and economic value in livestock that most producers and animal meat processors look up for (Husein, 2015 ; Najat, 2019).

5.6 Production System and Management Practices of Guinea pigs

5.6.1 Housing of Guinea pigs

Provision of housing unit is a good aspect in production system of Guinea pigs that contribute their growth and development. Guinea pigs used for the purpose of this study were housed in pens. However, the on station Guinea pigs were confined in the spacious cages with the dimension of 86 cm x 81 cm x 58 cm and was raised 30 cm above the ground. The result confirms with the following researchers (Egena et al., 2010 ; Stoffels and Hermans, 2014 and Abossede et al., 2019) reports that provision of spacious pen supports growth and survival of cavies. Hence, spacious housing units help Guinea pigs to roam freely and express their natural behaviour.

5.6.2 Feeding and Watering (Nutrition) of Cavies

Guinea pigs feed on almost everything which make their rearing very easy. The on-station animals were fed with forages and normal concentrate of diet and also supplemented with food scraps like fruits, vegetables, roots, tubers, etc. This result agrees with the reports by these researchers (Jessica, 2017 ; Noumbissi et al., 2014 ; Stoffels and Hermans, 2014 ; Numbela and Valencia, 2003 ; Manjeli et al., 1998 ;) who reported that Guinea pigs eat scraps from kitchen such as fruits, vegetables, food leftovers and forages. This implies that Guinea pigs farmers were not finding it difficult to feed the animals. Guinea pig consumed an average of 75 g to 130 g of dry matter feed daily to grow well. However, the average feed intake of Guinea pigs was between 60 g/kg to 70 g/kg per adult animal in a day and the average water intake was 100 ml/kg to 200 ml/kg (Keeble, 2009). According to Jenkins

(2010), Guinea pigs require good quality and balanced diet to meet daily growth and maintenance. This shows that quality feed is a very good factor to enhance the growth and performance of cavies.

5.6.3 Growth and Reproduction of Guinea pigs

Guinea pigs are fast growing animals and they are able to increase their numbers in a very short time. In this study, the mean body weight for newly born Guinea pigs was between 85 - 110 g and weaning weight was between 120 - 200 g in 14 days. Moreover, the average body weight for adult male and female cavy was 405.19 g in 90 days for the study. The result differs from findings obtained by (Ayagirwe et al., 2019 ; Ayagirwe et al., 2015 ; Cicogna et al., 1992) an average weights of Guinea pigs at birth, weaning age of 3 weeks and at 15 weeks of age to be 99, 247 and 738 g respectively in Africa (Bennin, Côte d'Ivoire, Cameroon, Tanzania, etc). This shows that cavies produced in Africa (Bennin, Côte d'Ivoire, Cameroon, Ghana, Tanzania, etc) have similarities in growth rate.

5.6.4 Health Care of Cavies

Routine changing of the portable water, leftover feed and cleaning the feeding and watering troughs are ways to discourage the activities of microorganisms that cause several illness and other health complications among Guinea pigs. The finding is in association with Numbela and Valencia (2003) and Manjeli et al. (1998) results that Guinea pigs are predispose to several diseases such as coccidiosis, pneumonia, salmonellosis, helminthes and arthropods and ecto parasites and myiasis if proper health care is not provided. However, albendazoles and oxytetracycline were administered to cavies to prevent them

from ecto and endo-parasites. The result is in line with Egena et al. (2010) who pointed out that Guinea pigs should be vaccinated against diseases. The cavies used for the study were supplemented with 20 mg/kg to 25 mg/kg of vitamin C daily per animal to boost their immune system. The present results is in consonance with Mancinelli (2016) ; Handlos, (2018) reported that cavies need 15 mg/kg to 20 mg/kg but disagrees with the observations made by these researchers (Terril et al.,1998 ; Richardson, 2000 ; Gad, 2006 and Hollamby, 2009) stated that Guinea pigs need 10 mg/kg to 30 mg/kg of ascorbic acid (vitamin C) for their daily maintenance. This implies that the provision of right dosage of vitamin C would boost the immune function of the cavies. Hence, the productivity of Guinea pigs will do much better through good management practices such as ; good nutrition, health care, housing, etc).

5.7 Production Cost of Guinea pigs

Knowledge about cavies business (i.e. how much goes into the production and how much is obtained from their investment) would be very imperative for animal producers, breeders and policy makers to know. Basically, the production expenses of cavies covered pen construction (standard pen), nutrition, starter stock, transportation cost and many others. The finding is in association with the observation made by Numbela and Valencia (2003) in cavies production. Total production costs for the on-station animals was GH¢ 1,801.16 (US\$ 309.48) for the four (4) months duration. The gross revenue or income received from the sale of the animals within the study period was GH¢ 3,698.12 (US\$ 635.42) and GH¢ 1,896.96 (US\$ 325.94) was received as a profit. According to Komwihangilo et al. (2016) reports in the Kongwa and Mpwapwa districts of Dodoma region, Central Tanzania noted

that one Guinea pig could be sold for Tshs. 2,000 – 3,000 (US\$ 1 = Tsh. 2000) and Tshs 100,000 – 225,000 (US\$ 100 – 150) for those who produced 50 - 75 Guinea pigs in a year to supports household income. However, Herman et al. (2014), Nuwanyakpa et al. (1997) and Manjeli et al. (1998) reported similar findings on the profitability of Guinea pigs production. In a nut shell, to raise one cavy from birth to reach maturity (90) days will cost GH¢ 32.16 (US \$5.53) for each animal. Hence, the overall revenue from the sales of Guinea pigs was GH¢ 66.04 (US\$ 11.35) and GH¢ 33.88 (US\$ 5.82) was obtained as the profit on each animal.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The present study revealed that:

Household cavy production is mainly small scale and the breed was the local type. Guinea pig rearing are not properly in order moreover, it improves the livelihoods of rural poor farmers, (In terms of socioeconomic, nutritional and food security). Local poor farmers and children keep cavy as a prestige and obtain an appreciable income. Hence, cavy production is seen a lucrative venture if proper and needed attention is given to it.

Primarily Guinea pigs are kept by all classes of people; males and females, young and aged and also educated and uneducated.

The production systems and management practices such as labour, feeding, housing and health care were identified by little and small inputs.

The animals relied predominately on forages around and less supplemented with food scraps as feed resources available for survival. Specifically, the average flock size and income from cavy were however very low.

Inadequate feed resources (forages) during the dry season to feed cavy was the major concern to the respondents.

The local cavy are prolific and thereby capable to produce throughout the year.

Basically indigenous Guinea pigs were small in size with Ahafo region being superior in body weight and linear body measurements. The birth weights of young Guinea pigs were between 85 - 110 g and weaned at 14 days with weight between 120 - 200 g. Matured Guinea pigs had an average body weight of 405.19 g when they are about 90 days old and even more.

Cavies have several colour combinations. Pure white, brown-white, greyish-brown-white, black-white and black-brown-white scored higher values in the four regions in the middle belt of Ghana.

Productivity of Guinea pigs could be enhanced through good management practices (good nutrition, health care, housing, etc) can be useful in cavies production.

The sexes did not have influence on Guinea pigs production.

Body length (BL), heart girth (HG), height-at-withers (HW) and head length (HL) were the best predictor of body weight in Guinea pigs. Predictive equation could be useful by farmers, researchers and animal processors to determine the body weight of Guinea pigs. It has accuracy and precision to estimate body weight of cavies through selection for breeding purposes to improve upon body traits in the areas where there is scarcity of weighing scale and tape measures.

The highest correlation value (0.91) was between body length and heart girth , the second highest correlation figure (0.87) was recorded between body weight and body length, also among hind leg length and fore leg length. The least correlation value of 0.21 was found between body weight and fore leg length.

The production cost of raising one cavy from birth to reach maturity (90) days will cost GH¢ 32.16 (US\$ 5.53) for each animal. However, the overall revenue from the sales of Guinea pigs yielded GH¢ 66.04 (US\$ 11.35). Again, GH¢ 33.88 (US\$ 5.82) was recorded as the profit on each animal.

6.2 Recommendation

Body length (BL), heart girth (HG), height-at-withers (HW) and head length (HL) were useful to predict the body weight in Guinea pigs. It is therefore recommended that in some

areas where labour is scarce and labour cost is relatively high, body length, heart girth, height-at-withers and head length can be used to determine body weight using the equation: $BW = -214.69 + 5.51BL + 10.11HG + 15.74HW + 18.16HL - 7.74HLL - 5.34FLL$.

More research works should be conducted on characterization of the local cavies in Ghana such as phenotypic, genetic, molecular, and immunological characterization and genetic parameter estimation. This will facilitate breeding and conservation initiatives in Ghana.

Additionally, systematic selection and breeding programs should be undertaken to improve the production performance on growth, reproductive and costs of production on cavies.

A study should be conducted on experimental diet at different levels of feed using concentrates feed and forages on Guinea pigs. This will help to estimate the nutritive value composition of the guinea pigs at different stages to harness production performance that could influence increase in live body weight and linear body dimensions, litter size and reproductive traits that can affect farmers income positively.

Again, there should be policy formulation on micro livestock production by the policy makers to meet the Ghana government's agenda on "rear for food and jobs." This will boost the morale of young and aged people who are already in the business and also to win more people in the Guinea pigs venture in the Ghana.

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