UNIVERSITY FOR DEVELOPMENT STUDIES

QUAIL PRODUCTION SYSTEMS, PROSPECTS AND CONSTRAINTS IN GHANA

BY

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DECLARATION

Student:

I sincerely proclaim that I am the original author of this thesis and that this work has neither been submitted for a degree nor any aspect of it has been published by different person elsewhere. However, all sources of relevant information from other researchers and scholars in this work have been accordingly cited and referenced.

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DEDICATION

I dedicate this thesis to my adorable wife, Madam Lucy Ata-eramah Awafo and my beloved son, Ivan Yintenremeh Akarikiya.

ABSTRACT

This study was undertaken to assess the production systems, prospects and challenges of quail farming in three (3) ecological zones (Rainforest, Transitional and Guinea Savannah) in Ghana. Sixty (60) quail farmers were purposefully sampled for the study using the snowball sampling technique. Data were gathered through interviews with the aid of structured questionnaire and analysed using SPSS 22.0. The results showed that more males (86.7%) than females (13.3%) were involved in quail farming in Ghana with majority (73.3%) of farmers having less than five years of experience in the business. About 50% of quail farmers had their flock sizes ranging from 501 to 2000 birds. Three (3) major breeds of quails (Japanese, American and Jumbo Giant quails) are reared in Ghana but the most common breed is the Japanese quail due to its prolificacy and ability to tolerate the intensive colony battery cage management system for commercial egg production. Quail production was more prevalent in the ecological zones in Southern Ghana than in the Northern Guinea Savannah zone. Coccidiosis (45%) and Infectious Coryza (43.3%) were identified as the most prevalent quail diseases in Ghana with a mortality rate of <10% detected among quail chicks. Farmers produced quail eggs (main product) and meat for profit. Cannibalism (pecking) was identified as the major production challenge whilst low levels of awareness about the benefits of quail products coupled with perceived non-attractive colours of the eggs were major marketing challenges hampering demand and sales of quail eggs.

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LIST OF ABBREVIATIONS

FAO: Food and Agriculture Organisation

MOFA: Ministry of Food and Agriculture

FAOSTAT: Food and Agriculture Organization Corporate Statistical Database.

FASDEP: Food and Agriculture Sector Development Project.

DFID: Department for International Development.

SMEDA: Small and Medium Enterprises Development Authority

NCFR: Non-conventional Feed Resources

NVRI: National Veterinary Research Institute.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Ghana's economy is based primarily on agriculture, which contributes about 54 % to the Gross Domestic Product (GDP) **and provides over 90 % of the food needs of the country (MOFA, 2001).** According to a survey conducted by the Ministry of Food and Agriculture / Department for International Development (MOFA/DFID, 2002), about 60% of the Ghanaian labour force is engaged in agriculture (crop and livestock/poultry production) and the livestock/poultry subsector offers a 'safety net' to the country; especially the rural folks as it provides a major source of ready cash during periods of emergency needs. Although poultry and livestock populations have been persistently low over the past three decades, contributing only 7% to the agricultural Gross Domestic Products (GDP), their contribution to rural livelihoods and food security is nonetheless significant (FASDEP, 2002; FOA, 2006).

The relatively low productive performance of poultry especially the indigenous chicken could be attributed to high losses due mainly to prevalence of diseases and predators. The exotic pure breeds of chicken on the other hand have not performed satisfactorily in the scavenging systems in the country due to their higher nutritional demand and lower disease tolerance (Blackie, 2014). In order to boost up the poultry industry and alleviate poverty and animal protein deficiency, peri-urban and rural communities need additional species of birds with a short generation interval, easy to rear with minimum capital and offer better income within a very short period.

Quail farming is said to be a short generation industry with a potential of meeting the economic and nutritional needs of developing countries (Ojo *et al.*, 2014). Quails are reared mainly for their meat and eggs. There are many quail breeds under domestication but the most common one is the Japanese quail (*Coturnix japonica*). Japanese quails are small avian species belonging to the same family (Pheasant family) as the chicken (Priti and Satish, 2014). The birds are smaller than the pigeon and much smaller than the chicken (Wilkinson, 1999).

Quail production has been practised in several nations, including Australia (since 1970) and many Asian countries like Japan and India. Quails are commonly reared for meat production in Europe and for egg production in Far East and Asian countries (Karapetyan, 2003). Some African countries that have introduced quail farming in their poultry industry include Kenya and Nigeria (Mohammed and Gharib, 2017). Although, quail is a novel poultry species in Ghana compared to chicken, guinea fowl or duck, its production is growing steadily in the country since its official introduction into the Ghanaian poultry industry (Ofori, 2017).

There are numerous advantages in quail farming which make it worthwhile promoting. Quail farming is less expensive and offers quick returns to farmers and consumers. Quail meat and eggs are also rich in nutritional value and have been reported to have proven efficacy in the treatment of a number of diseases, including diabetes (Narinc *et al*., 2013; Tunsaringkarn *et al.*, 2013).

1.2 Problem Statement and Justification of the Study

Quail production has low awareness in Ghana and is less practised as compared to traditional poultry birds such as chicken and guinea fowl as a result of inadequate information about the bird, its production systems and its commercial and health values. The perceived high economic value of quail farming due to its short generation interval and the low cost of investment in production of quail meat and eggs are some of the possible reasons farmers in Ghana have ventured into quail production. The fact that quail grows and attains early sexual maturity and starts laying eggs in six weeks, compared to the 6 months maturity period of layer chicken, and 2½ months maturity period for broiler chicken makes quail farming comparatively advantageous (Femi, 2011; Bakoji *et al*., 2013). Meanwhile, in a research conducted to determine the growth performance, reproductive, and survival traits of quails in Ghana, it was established that the climatic and environmental conditions of Ghana were very favourable for commercial production of quails (Aikins *et al*., 2019).

Despite its high commercial, nutritional and medicinal values, demand for quail and its products in Ghana was reportedly low (Ayim, 2019) compared to other African countries like Kenya, Zambia and Nigeria (Bakoji *et al.*, 2013). This phenomenon could be attributed to inadequate research information and publicity on quail farming, its potentials and benefits.

Some research works have been conducted elsewhere and reports are available on the present status and production systems of quail (Berthechini, 2012; Redoy *et al.*, 2017),

factors influencing quail production (Muthoni, 2014; Nasaka *et al*., 2018; Nnandi and Odo, 2013) as well as the prospects and challenges facing quail production (Aryan *et al*., 2018; Mohammed and Ejiofor, 2015; Mufutau, 2017; Noman, 2018). It has already been established that the climatic conditions in Ghana are favourable for quail rearing (Aikins *et al*., 2019). Findings from this research was however limited to the Guinea Savannah ecological zone of Ghana. There was a paucity of information on the existing quail production systems and practices, prospects and constraints in Ghana hence the need for a broader investigation about this subject. This is because, in order to commercialise quail production for meat and eggs and to encourage the youth to venture into quail farming as a lucrative enterprise, an in-depth study is required on this new enterprise. It is for this reason that this survey was carried out to assess the production systems, status, prospects and challenges of quail farming in Ghana.

1.3 Research Questions

The questions that needed to be answered by this research included the following:

1. What are the production systems and management practices of quail farming in Ghana?
2. To what extent does access to market influence quail production in Ghana?
3. Do perceived nutritional and medicinal values of quail products influence quail farming in Ghana?
4. What are the constraints to quail farming in the country?

5. What opportunities or prospects are available for making quail farming and its products attractive to Ghanaians?

1.4 Objectives of the Study

The **main objective** of this research was to assess the production systems, status, prospects and challenges of quail farming in Ghana.

The **specific objectives** included:

1. To assess the production systems and management practices of quail farming in Ghana.
2. To establish how access to market influences quail production in Ghana.
3. To assess perceived nutritional and medicinal values of quail products and how that influence quail farming in Ghana.
4. To identify the constraints facing quail farming in the country.
5. To assess available opportunities or prospects for making quail farming and its products attractive to Ghanaians.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Global Production of Poultry

Globally, the livestock division offers a direct contribution to household food security, by contributing significantly to the daily energy and protein requirements essential for nutritional sufficiency (Inyeinyang and Ukpong, 2019). Livestock also provides quality protein with high nutritional value, in the form of dairy products, eggs and meat, besides the provision of power and manure for soil fertility improvement (Molina-Flores *et al*., 2020). Despite the significant contributions of livestock to important household food security variables, aggregate performances in West Africa over the years have not been impressive due to existence of a significant gap of self-sufficiency in meat, milk and eggs (Molina-Flores *et al*., 2020).

In the last four decades, the importance of livestock products and fisheries to per capita calorie consumption was estimated at 5.9% and subsequently dropped to 4.5% in 2000. Within the same period, the role of livestock in daily per capita protein requirements also diminished gradually from 16.4 grams (31% of the total) in 1975 to 14.6 grams (27% of the total) in 2000 (MOFA, 2004). As a result, a total of 925 million individuals representing 16% of the population of developing nations (translating to about one out of every three people) had been estimated to be chronically undernourished and 26-30% of this number is in sub-Saharan Africa (FAO, 2010).

The yawning gap in protein needs is further exacerbated by constant increase in human population in the developing nations, rising income, modernity and urbanisation hence the need to establish additional sources of animal protein. Poultry production (the world's largest meat source) has therefore been identified as a rapid and cheap means of providing high-quality animal protein in the form of eggs and meat address the nutritional deficiencies of the increasing human population (Dei, 2017; Godfray *et al.*, 2010). Besides, poultry products constitute the most abundant and affordable animal protein sources consumed globally by individuals with diverse traditions, cultural values and religious beliefs, hence this makes poultry the most essential in food security and nutrition programmes (Mottet and Tempio, 2017). Due to this fact, the demand for poultry products has been increasing steadily.

Poultry population has been projected to be around 16.2 billion worldwide, with 71.6 % contribution from developing countries, supplying up to 67,718,544 metric tons of chicken and 57,861,747 metric tons of chicken eggs (Badhaso, 2012). As the fastest growing industry in the agriculture sub-sector, especially in developing nations, the world has produced over 23 billion poultry birds occupying almost 3% on the planet (Assa, 2012; FAOSTAT, 2016). One major contribution to this success in Africa and some continents is the short production cycles in poultry production and the fact that the birds are reared in different production systems with the potential of converting variety of agro-based by-products and wastes into mainly eggs and meat for human consumption and manure for crop production (Mottet and Tempio, 2017).

Globally, there are three main categories of poultry rearing systems; namely layers, broilers and backyard poultry farming. The global production of eggs is said to be about 73 million tons while global chicken production is close to 100 million tons (Aslam *et al*., 2020; FAO, 2016). Backyard poultry production alone contributes up to 2% of broiler poultry and 8% of poultry eggs production globally with substantial contribution to meat and egg production in Sub-Saharan Africa, South Asia, Eastern Europe, and to a smaller volume in Latin America, East Asia and the Caribbean. In Africa, village poultry alone produces close to 70% of all poultry products and 20% of all animal protein consumption (Milkias, 2016). Majority (92%) of poultry meat production comes from specialised broiler systems and layers only contribute to 6% of the total.

Globally, the largest poultry meat producer is the United States of America, which produces nearly 20 million tons per annum; next largest producer is China, with 18 million tons; followed by the European Union and Brazil with about 13 million tons (FAO, 2016). Changes in production technology was one of the major determinants of growth in the poultry sub-sector. The shift from free-range to intensive systems of poultry farming radically increased flock size of birds per farmer, facilitated the replacement of capital for labour, and brought about a significant improvement in labour efficiency. Between 1985 and 1996 for instance, the income of poultry farmers with flock sizes of more than 10,000 grew from 42% to 78 % in the Center West region of Brazil (Narrod and Tiongco, 2012). Improvement in breeding techniques that led to

improvement in the size, prolificacy, growth rate and uniformity of animals, have also contributed to an increase in output.

Growth in the world's poultry production is however anticipated to continue progressively as increasing populations coupled with rising incomes and urbanisation continue to drive the demand for poultry products. Among small holders and the poor farmers, poultry production is a main source of income and a solution to poverty reduction, both in rural and urban areas, providing sustainable income and market access. Although the growing market is essentially favouring the commercial poultry operators and access to market is a serious challenge for the small-scale producers, poultry birds serve as household insurance for farmers and can be sold in times of emergency (Deori *et al*., 2019; Mottet and Tempio, 2017).

Poultry production however has a major effect on the environment and depend greatly on natural resources (Mottet and Tempio, 2017). While poultry sector is considered as being efficient in converting natural resources into food, it requires large quantities of land, water and nutrients for the generation of feedstuff and therefore adds significantly to climate change, especially during feed production, and air pollution and water contamination. Poultry production may also be hazardous to human health, as the birds may serve as vectors of infectious (zoonotic) diseases due to their role in antimicrobial resistance (Mottet and Tempio, 2017).

2.2 Present Status of Poultry Production in Ghana

The economy of Ghana is based primarily on agriculture, accounting for up to 41% of Gross National Product (GNP). Nearly 60% of the workforce in Ghana is involved in agriculture, majority of whom either own a crop farm or mixed crop and livestock /poultry farm (FAO, 2006). From 2000 to 2017, poultry business in the country experienced substantial growth with a steady increase in both eggs and chicken meat production from 50,895 tonnes in 2011 to 59,653 tonnes in 2017 (Analysis Poultry Sector Ghana, 2019).

Kusi *et al*. (2015) established that, commercial poultry farming in Ghana can be categorised into large-scale (over 10,000 birds), medium-scale (5,000 to 10,000 birds) and small-scale (≤50 to 5,000) farms with domestic commercial farms being kept by private persons or farm families. The large-scale farmers form almost 20% of the entire poultry sector, with their main focus being on egg production and many of whom establish and run their own feed mills whilst some maintain their hatcheries and parent stocks. The medium-scale and the small-scale farmers constitute 80% of the poultry sector in Ghana and depend on commercial hatcheries and feed mills for their day-old chicks and feed respectively. The medium-scale category of farmers also produces mainly eggs whereas the small-scale group are backyard poultry farmers whose main objective is to produce broiler birds.

The main traditional poultry species under Ghana's commercial production include chicken (*Gallus domesticus*), turkeys, guinea fowls, ducks, Ostriches and pigeons

(FAO, 2006). Although livestock and poultry is said to contribute only about 7% to the agricultural GNP (FASDEP, 2002), they contribute a substantial proportion of animal protein to food security and livelihood and serve as a 'safety net', generating ready cash in times of financial crisis (MOFA/DFID, 2002). According to Ekunwe and Soniregun (2007) and Rajendran and Mohanty (2003), poultry rearing has become foremost among the livestock-based vocations in terms of income supplementation as it guarantees fast income, involves little space and capital, and can be practiced by an average farmer. Poultry also has better feed conversion efficiency to produce meat and eggs compared to other livestock businesses. Commercial layers and broiler production therefore play a significant role in supplying national protein requirements (Kabir and Haque, 2010)

Despite the significant contributions of livestock and especially poultry to national food security and livelihoods, the population of poultry in Ghana (estimated at 33,525,809) has remained one of the least in Sub-Saharan Africa as a result of frequent disease (Newcastle, Gumboro and Avian Influenza) outbreaks and perhaps because no ethnic group relies entirely on poultry for their livelihood (FAO, 2006). Frequent disease outbreaks occur due to low levels of bio-security awareness and practices among some poultry farmers. The level of bio-security measures is greater in the large-scale farms compared to the other categories. The medium-scale and small-holder farmers adopt little bio-security protocols hence permitting strange birds to come into contact with their farm birds, resulting in outbreak of diseases such as the Avian Influenza thereby reducing availability of poultry products (Kusi *et al*., 2015). This is why the national annual per capita poultry product consumption was estimated at 12 eggs and 1.2kg meat,

which is lower than the World' average of 154 eggs and 9.7kg meat, respectively (FAO, 2006).

The main remedy to the problem of inadequate consumption of animal protein source in the developing nations can be attained by increasing the level of production of highly prolific poultry species (Ani and Adiegwu, 2005). The Japanese quail is one of such poultry species that has proven potentials of bridging the gap in the protein needs in Ghana due to its shortest generation intervals and other numerous advantages it has over chicken and other poultry species. According to Aikins *et al*. (2019), Ghana's climatic conditions are very suitable for the growth, reproductive and survival performance of quails in both the dry and wet seasons.

2.3 Quail and its Contribution to the Poultry Industry

Quail production is steadily growing and gaining significance in many developed countries for the purposes of meat (mainly in Spain, France, China and the United States of America) and egg production (mainly in China, Japan, Brazil and France). This growth has seen a corresponding increase in the consumption of quail products in these countries, with a predicted estimated per capita consumption of about 30 quail eggs per year by 2020 (Bertechini, 2012). In Africa, however, commercialisation of quail farming is a latest concern (Moreki and Radikara, 2013 and Moreki and Seabo, 2012) and as such presents limited statistics on the contribution of quail to the region's poultry industry. In Uganda, quail birds attracted interest in urban areas (in early 2010's) for their eggs which were acclaimed to offer superior health benefits and nutritional values

than chicken (Tobiko, 2015). These assertions aroused consumer taste for quail eggs in urban areas of Uganda to the extent that the selling price of quail eggs inflated to almost 70 percent above chicken eggs. Consequently, this hike price encouraged most farmers to venture into quail production.

One major advantage of quail rearing over other poultry species is that many birds can be housed in a very small space. Besides, quails have a short generation interval which gives them a competitive advantage over other poultry species. For instance, the Japanese quails are ready for market as table birds as early as five weeks of age and start laying from the 7th week onwards (Nasaka, 2017; Priti and Satish, 2014).

2.4 Origin and Distribution of Quail

Quail is a small bird belonging to the order *Galliformes* and family Phasianidae, along with domestic chickens, pheasants and partridges (Mizutani, 2003; Priti and Satish, 2014). The bird was originally a wild game species just as any other domesticated animal. The origin of quail as a wild meat could be traced to the Bible in reference to God's provision for the nation Israel in ancient times when they journeyed in the wilderness from Egypt to the promised land (Numbers 11:31-32). Beside this Biblical fact, quails have been domesticated in the olden days, the earliest known history of the quail domestication can be found in the Egyptian symbols (2000 B.C), where quail is denoted by the letter "W" in the Egyptian alphabet (Shanaway, 1994). It is also believed in modern times that quail was first domesticated in China as a pet and singing bird. Later, the bird was introduced into Japan in 1595 where it was consciously bred as farm

animal for the production of eggs and meat (Onyewuchi *et al*., 2013; Premavalli *et al*., 2015). In 1974, improved germplasm of domesticated quail varieties was introduced from Japan to India and its breeding and production as a poultry species has since been promoted (Premavalli *et al.*, 2015). Since the introduction of quail from the Asiatic countries to other parts of the world including USA, Canada, Kenya, Zimbabwe, Zambia, Nigeria, Benin and Ghana, it has not been evenly distributed all over the world. This is because even though a projected 1.4 billion quails are produced annually worldwide for their meat and eggs, over 80% of this number is farmed in China alone (Quail Facts & Worksheets: https://kidskonnect.com). The major quail meat producing countries worldwide include China, Spain, France and the United States of America while the top quail egg producing countries include China, Japan, Brazil and France (Berthechini, 2012).

In Africa, though quail farming is relatively new as it has been introduced in recent times into the poultry sub-sector, it is gaining momentum in many countries in the continent. In Nigeria, the Japanese quail was introduced in 1992 as a farm bird to complement domestic chicken production with the aim of boosting the poultry sub-sector [National Veterinary Research Institute (NVRI), 1994]. Since then, the bird has been an important contributor to the Nigerian poultry industry accounting significantly for animal protein supply in the form of meat and egg (Mohammed and Ejiofor, 2015). In Zimbabwe, the bird was introduced in 2011 by the Zimbabwean local poultry farmers as a domestic game bird and reared for the production of egg and meat (Mushava, 2016).

It is believed that quail farming first started in Ghana somewhere in 2011 in Kasoa in the Central Region when some Ghanaian Expatriates introduced the bird from Israel to the country (Preliminary Field Survey, 2019). Since then, farmers in other parts of the country have adopted quail farming as a business though public awareness, acceptance and patronage of quail and quail products is still on the low side (Ayim, 2019).

2.5 Species and Breeds of Quail

There are over 140 species of quails worldwide (Travis, 2018) but two main breeds are common and most suitable for production purposes. These include the European quail (*Coturnix coturnix coturnix*) and the Japanese quail (*Coturnix coturnix japonica*) (Idahor *et al*., 2015). Table 2.1 shows identification features of other breeds of quails.

Table 2.1: Common breeds of quail for beginners and their characteristics

Breed Name	Identification	Age at maturity	Adult weight	Number of eggs per year
European quail	It is a small, round bird with a streaked brown plumage colour and white eye stripes.	6-7 weeks	70-135g	-
Japanese quail	It is a medium sized bird with dark cinnamon brown (or mottled grey with brown speckles) plumage colour.	6-7 weeks	90-300g	250-300
Northern Bobwhite	Medium, morphologically variable birds with white plumage	8-10 weeks	179 g	150-200
Jumbo Coturnix	The biggest domesticated breed, selectively bred and commonly adopt for its meat purpose.	6-7 weeks	450 g	150-220
The Texas A&M	It has heavy muscles.	6-7 weeks	370 g	150-200
Button Quail	It is a breeder quail bird with smallish body.	5 weeks	130 g	100-120

Sources: Travis, 2018; Zambia AgricBusiness Society http://zabszambia.world.press .com.

2.5.1 The Common Quail

The common quail (*Coturnix coturnix coturnix)* is the ancient form of the wild migratory Galliformes species with an extensive Palearctic and is distributed worldwide (Perennou, 2009). *Coturnix c. coturnix* is the smallest and the most common subspecies in Europe hence it is also known as the European Quail. The European quail is a member of the family *Phasianidae* and the genus *Coturnix, the species coturnix and subspecies coturnix.* Hence its scientific designation is *Coturnix coturnix coturnix,* which differentiates it from the Japanese quail, *Coturnix coturnix japonica (*SMEDA, 2011*)*. Phenotypically, European quail is a small, round bird and measures 16-18 cm long with a body mass of between 70-135g. It has a streaked brown plumage colour with white eye stripes. The male can be distinguished from the female by its white chin (Plates 2.1).

According to Del Hoyo *et al.* (1994) and Johnsgard (1988), there are other identifiable subspecies of the common quail apart from the *C. c. coturnix*. These include:

i. *C. c. confisa,* located in the Canary Islands and the Madeira archipelago;
ii. *C. c. conturbans,* which is common in the Azores;
iii. *C. c. inopinata,* found in Cape Verde Islands
iv. *C. c. africana,* common in Eastern and Southern Africa;
v. *C. c. erlangeri,* native to East Africa ;
vi. *C. c. orientalis,* the Grey Quail widely distributed in India and Pakistan;
vii. *C.c. japonica,* which originated from Eastern Asia.

Historically, domestication of the common quail can be traced to China in the 1595. It is a migratory bird with long wings as befits its migratory nature and due to its migratory ability, the bird later moved to America and Europe. As a protected species, the common quail has an outstanding history as a game bird in Southern European countries (Sanchez-Donoso *et al*., 2015) but migrates between Europe and Africa (Mondry, 2016). Though the bird is popular and breeds successfully in North Africa and Europe with Spain being Western Europe's major breeding source (Perennou, 2009; Rodríguez-Teijeiro *et al.*, 2006), it is now being widely distributed in other continents including the African continent. The common quail is a dual-purpose bird raised for both eggs and meat production.

Plate 2.1: The male (left) and female (right) Common Quail (Coturnix coturnix)

2.5.2 The Japanese Quail

The Japanese quail (*Coturnix coturnix japonica*) is a member of the order *Galiformes and* family *Phasianidae*, the same as the common quail (Mizutani, 2003). It is also known as the Pharoah or Coturnix Quail. Although it is believed quails were first domesticated in China, the first account of wild Japanese quail dates back to the 8th

century in Japan where it was originally reared as a pet song bird (Crawford, 1990; Kayang *et al*., 2004) and later (around 1595) received much importance as a source of food when it was bred mainly for its egg production (Kayang *et al*., 1984). Since then, it has been the most frequently farmed species for egg and/or meat (Mondry, 2016). Currently, the Japanese quail is native to Europe, Africa and Asia (Vargas-Sánchez *et al*., 2019). It can be identified by its dark cinnamon brown (or mottled grey with brown speckles) plumage colour with the mature female having light chest plumage with dark-coloured spots. The mature male on the other hand has even dark faint-red plumage colouration on the chest and cheek (Mizutani, 2003, Plate 2.2). Other variations of the Japanese species have different colours including albino, white, isabelline, silvery, brown, mixed, and black tuxedo. A new breed, *Corturnix japonica jumbo* (Jumbo giant), shows much improvement in performance.

The Japanese quail is a sexually dimorphic bird. The female has a bigger body mass than the male and distinction between male and female can be made when the bird is 3 weeks old (Chang *et al*., 2005; Sezer et *al*., 2006). Due to their larger body sizes, the female quail needs extra time than the male to attain sexual maturity (Reddish *et al*., 2003). The difference in growth rate between the male and female quails are therefore distinguished phenomenon (Balcıoglu *et al*., 2005; Sezer & Tarhan, 2005). In the Japanese quail, sexual dimorphism is more pronounced than the common or European quail (Rodríguez-Teijeiro *et al*., 2006). The bird attains sexual maturity at about 6-7 weeks with an average body size of about 90g although some can weigh up to 300g

(Travis, 2018; Mondry, 2016) and begins to lay eggs, and continue to produce eggs up to 250-300 eggs per annum for at least a year (Bakoji *et al.*, 2013; Travis, 2018).

Research has revealed that the domesticated Japanese quail can successfully crossbreed with the wild European quail, and this leads to an introgression of domestic Japanese quail alleles into the European quail gene pool (Sanchez-Donoso *et al.*, 2014). This crossbreeding is believed to be a major threat to the conservation of common quail as it could lead to introduction of maladaptive alleles (Perennou, 2009).

Plate 2.2: Male (left) and female (right) Japanese quails

2.5.3 Other Breeds of Quail

The Jumbo Brown Coturnix Quail and the Northern Bobwhite Quail (*Colinus virginianus*) (Plate 2.4) are other breeds of quails under domestication. The Jumbo Brown Coturnix (Jumbo giant) is an alternative breed of the coturnix quail (*Coturnix japonica*). Being the largest in terms of body size, the Jumbo Brown quail (Plate 2.3) is the most preferred breed than all quail breeds when the main purpose is meat

production. At maturity, the standard Japanese quail generally weighs around 90g to 300g whilst the Jumbo Brown weighs averagely 450 to 460 grams at its adulthood. The Northern Bobwhite Quail (Plate 2.4) is another species which is also raised as a broiler quail with an adult body mass of about 170 grams (Travis, 2018).

Plate 2.3: Jumbo brown coturnix quail

Plate 2.4: Northern Bobwhite quail

2.5.3 General Characteristics of Quail

- An adult quail has a relatively smaller body size and weight (of 200 grams) compared with the domestic fowl of similar age.
- Due to its smaller body size, quail eats little quantities of feeds and will seldom over-eat.
- Quails occupy smaller housing space and require minimal care and management compared to chickens of similar age.
- The birds grow to sexual maturity within a short period and start to lay eggs at approximately 6 – 8 weeks old.
- Quails lay small-sized eggs with dark spots. Although the taste of quail eggs is similar to that of chicken, the yolk to white ratio of quail eggs is slightly higher than that of chicken.
- Quails are prolific layers, laying at least an egg a day. In the first year, they are capable of laying an average of 250 to 300 eggs. They lay well for the first one and half years but will slow down significantly in the subsequent years (Food and Agriculture Organisation, 2011).
- The birds are poor brooders hence for large scale/commercial quail production, an incubator is necessary to hatch their eggs, and for those reared on small scale, broody hen can be used to hatch their eggs.
- Fertile quail eggs take about 15 - 18 days to hatch into chicks using an incubator which is less than an average of 21 days required by the chicken to hatch successfully.

- Quail eggs and meat are low in fat content hence serve as better alternatives for most health conscious consumers.
- Quails have lifespan of 3 to 4 years under good husbandry or management practices.
- The birds are less susceptible to most diseases that affect the poultry industry hence they do not require vaccinations against most of the poultry diseases.

2.6 Overview of Quail Farming

Commercial quail production became intensive between 1910 and 1941 in Japan which led to a rapid increase in the population of Japanese quail specifically in cities of Mishima, Tokyo, Grifu, Nagoya, and Toysehashi. This was the period characterised by an imperial expansion in the history of Japan resulting in the domestication and intensive farming of the Japanese quail in other Asiatic countries such as China, Hong Kong, Korea and Taiwan which subsequently extended to South East Asia. On the other hand, the government of the United Kingdom legalised Japanese quail farming in 1957. Due to the multipurpose benefits of quail and its products, there has been a rapid expansion in the quail industry as early as 1960 in the USA, Hong Kong, France, and Italy. In Italy for instance, commercial farming of Japanese quail began in the late 1950s and reached a population of 80 million birds per year by 1980 (Musa *et al* 2008). In Brazil, quail production was introduced in the early 1960s mainly for the purpose of egg production (Freitas *et al*., 2013), but the industry did not receive national recognition until the early 2000s when new production technologies were developed through series of scientific research, and discussions at various symposia in the country led to

continued growth of the quail segment (Berthechini, 2012). The Japanese quail was first introduced into India in 1973 and was later bred and reared in Tamil Nadu a decade later at the Poultry Research Station, Nandanam (Arumugam, 2008). Quail rearing is also a promising agricultural enterprise in the Philippines. Farmers in the Philippines country have taken the advantage to venture into quail production because the birds are easy to house and raise, fast growers, prolific, have high feed conversion efficiency and are resistant to various diseases common to poultry, especially chickens (Bolla and Randall, 2012; Lambio, 2010). According to Cabaral *et al*. (2017), quail is rated third next to broiler chicken and ducks as the primary and secondary sources respectively in the production of poultry products. Moreover, quail farming is easier and less demanding since the birds can be raised with the minimum initial capital compared to the domestic fowls and ducks. The steady growth in the population of quails in the western and developed countries has resulted in an increase in the consumption of quail products in these countries. Further increase is anticipated in these countries as Berthechini (2012) predicted a per capital consumption of averagely 30 quail eggs per year by 2020.

In Africa, commercial quail production is a novelty (Moreki and Radikara, 2013). As such, inadequate information is available on the role of quails to the region's poultry sector (Nasaka *et al*., 2017). Quail farming is nonetheless a promising industry in many African nations including Ghana. The Japanese quail was the earliest quail breed introduced into Nigeria in 1992 as a farm bird to complement domestic chicken production with an aim to boost up the poultry industry. Since its introduction, quail has

been contributing immensely to the Nigerian poultry business as it has contributed enormously to the supply of quality protein through meat and egg production (Mohammed and Ejiofor, 2015; Muhammad-Lawal *et al*., 2017).

In Kenya, commercial quail production started in 2010 and was well accepted nationwide until around 2014 when a cross-section of consumers began to feel that the perceived nutritive and therapeutic benefits of quail and its products as touted by middlemen were being over-hyped. This resulted in poor patronage by consumers culminating in a ditch in the quail business by most quail farmers (Tobiko, 2015). Recently, however, quail business in Kenya has received renewed interest and promotion leading to an increase in quail population. Consequently, quail population is widely distributed in Kenya either as a farmed bird (common among which is the Japanese quail) or a wild migrated species in various locations in the country (Wamuyu *et al*., 2017). Other breeds of quail mostly found in Kenya are the common quail (*Coturnix coturnix*), African harlequin quail (*Cortunix delegorguei*), African blue quail (*Coturnix adansonii)* and the rain quail (*Cortunix coromandelica*) (Lewis & Pomeroy, 1989).

In the early 2010s, quail farming in Uganda witnessed an improved interest in many urban areas especially for egg production due to the claims that quail eggs have better nutritional and health values compared to other poultry eggs (Tobiko, 2015). These assertions motivated many farmers to increase production as it stimulated consumer

demand for quail eggs to a point where market prices of quail eggs increased up to about 70% higher than the prices of eggs from the domestic fowl (Nasaka, 2017).

Quail farming is a recent initiative in Zimbabwe. The bird was introduced in 2011 by the Zimbabwean local poultry farmers as a domesticated bird for the purpose of meat and egg production (Mushava, 2016). Currently, most of the quail farmers in Zimbabwe are urban dwellers who engage in backyard quail rearing as an alternative livelihood in order to cope with the increasing cost of living in the cities.

In Ghana, commercial quail farming is believed to have started around 2011 somewhere in Accra when some Ghanaian expatriates introduced the bird into the country (Preliminary Field Survey, 2019). While the demand for quail and quail products have witnessed a steady increase in other African countries like Nigeria, Kenya, Uganda, Zimbabwe and Zambia, there seems to be low awareness and patronage among the Ghanaian populace (Ayim, 2019). This is due to low national recognition coupled with low regards to the nutritive and medicinal potentials of quail meat and eggs.

2.7 Quail Farming Systems and Management Technology

The quail farming system is a more recent industry but has similar management characteristics as in the broiler and layer chicken industries (Berthechini, 2012). The success of quail farming as a poultry industry is dependent to a large extent on good management technologies (Baliyan and Masuku, 2017) which have been discussed below.

2.7.1 Quail Farming / Housing Systems

Technically, quail farming system is a novel type of poultry production that specialises on the intensive rearing and breeding of small birds called quails as a farming enterprise for the purpose of egg and meat production or for other uses (Ahmed, 2008; Aliyu, 2016). *'Quail farming'* can also be referred to as the intensive raising of quails commercially for the purpose of gainful eggs and meat production. Quail is probably the smallest poultry bird reared for the purpose of producing eggs and meat. Due to its prolificacy in egg production and high meat productivity, quail farming is an economically profitable business (Zambia AgriBusiness Society, 2019).

Housing system is said to be a major factor that affects performance in the overall poultry industry (Roshdy *et al*., 2010). Although quail can adapt to almost all types of weather conditions, their housing system must be very conducive and suitable for quail farming. The smaller body size of quail coupled with less space requirements by the bird results in generally low cost of housing for quails compared with other conventional livestock enterprises (Faitarone *et al.,* 2005).

Generally, there are two main housing systems under the intensive system of quail production, namely the deep litter systems (concrete floor pens) and the battery cage systems. The deep litter and battery cage systems can both be used in raising quails without any adverse effects on their welfare, productive and reproductive performance, as long as all requirements for biosecurity measures and growth are properly satisfied (Ojedapo, 2013; Olawumi, 2015).

i. Deep litter housing systems (Concrete Floor pens)

The deep litter system of poultry housing (Plate 2.5) involves the spreading of locally available bedding material of approximately 10 cm thick on a concrete floor. Common bedding materials used in the litter system include rice husks and wood shavings (Noman, 2018). Although fertility is higher in quails reared on deep litter concrete floors and lowers in cages (Farooq *et al*., 2001) the traditional concrete floor pens may not be recommended for especially quails reared for breeding purposes. When quails are kept directly on the concrete floors, they usually bury their eggs inside the litter (bedding material) and egg collection becomes more difficult and time consuming than the battery cage and losses may occur due to egg damage, birds consuming eggs, or egg contamination. These factors may reduce the quantity of eggs harvested, hatchability and may result in poor quality of chicks. Furthermore, with flocks that lay on deep litter floors, it is difficult for producers to detect and cull low or nonproductive birds. Additionally, birds produced on the deep litter are largely exposed to parasitic pathogens compared to those in the battery cage system. In order to eliminate the challenges associated with the traditional concrete floor pen housing, the floor is sometimes modified. In such conditions, the birds are kept on slatted floors large pens similar to the traditional floor pen setup but with the floor covered with removable slatted or wire-type floors. Hence this eliminates the challenges related to birds being kept directly on the litter floors (Dozier *et al*., 2010).

Plate 2.5: The deep litter system of rearing quails

ii. Battery cage systems

Quails can successfully be reared in individual or colony battery cage housing systems designed with wire floors with maximum protection from direct sunlight, wind and adequate ventilation (Plate 2.6). After two weeks old, about six (6) birds can be kept in a square feet of floor space (Monika *et al*., 2018). Several cages sizes can be used, which include 2'x2'x12" and 2'x4'x12" that can accommodate 25 and 50 birds respectively; the height should be 12" or less to discourage jumping (with possibility of injuries) (Cambel, 1994). Priti and Satish (2014) reported that 100 young quails in the first two weeks of age can be raised in a cage of size 3 x 2.5 x 1.5 ft. whilst 50 birds in their third to sixth weeks can be housed in cage sizes of dimensions 4 x 2 .5 x 1.5 ft. (Table 2.2).

Plate 6: Battery cage system of rearing quails

Table 2.1: Cage size for rearing quail

Age	Cage Size	No. of birds
First 2 weeks	3 x 2.5 x 1.5 ft.	100
3- 6 weeks	4 x 2 .5 x 1.5 ft.	50

Source: Priti and Satish (2014)

In order to save space, quails can be raised in multitier systems with up to the sixth tier and about four to five cages per row. The length of each tier should be about 120cm with height 25cm and width 60 cm and about 20 to 40 birds kept in each tier cage. The base of each cage is often fixed with wooden plates which are easily removed for regular collection and cleaning of droppings of the birds. Commercial layer quails are often kept in colony cages of about 10-12 birds in each cage. For the purpose of breeding, male quails are raised along with the females in cages in the ratio of about 1:3 respectively (Monika *et al.*, 2018).

Long and narrow feeding troughs are usually positioned in front of the cage whereas drinkers are usually positioned at the rear end of the cage. To avoid feed losses or wastage, the feeding troughs should be filled up to three-quarters and fresh clean drinking water should be provided throughout the day. Quail housing systems should be designed with facilities that provide 14 - 18 hours of light and for optimum feed intake and egg production in the rainfall periods, additional light should be available in the quail housing unit. If the purpose of raising quails is for commercial production of broilers, 24 hours of light should be available for fast growth and early maturity to market age (Chakrabarti *et al*., 2014). Below is a comparison of space requirement for quail in both battery cage and deep litter housing systems (Table 2.2).

Table 2.2: Housing space requirement for rearing quails

Age (weeks)	**Space (cm^2/bird)**		**Feeding (cm^2/bird)**	**Watering (cm^2/bird)**
	Deep litter	**Battery cage**		
0-4	75	75	2	1
5-6	200	150	2.5	1.5
>6	250	175	2.5 – 3	1.5

Source: Monika *et al*., 2018

Due to some challenges posed by the deep litter system, the cage housing is preferred in quail farming. Tauson (1998) reported that the cage system of managing quails has the advantage of reducing ammonia gas and dust levels that create a conducive work environment. Rajendran and Mohanty (2003) opined that the battery cage housing unit

is more effective for egg production compared to the deep litter system and that it helps in reducing cost of feeding and increasing feed efficiency.

Although some reports indicate that the housing systems of Japanese quails have no significant influence on their fertility level (Arumugam *et al*., 2014), cage reared quails were reported to have attained early sexual maturity with greater egg production capacity than those reared under the deep litter system (Alam *et al*., 2008). Also, the average daily feed consumption per bird is reportedly higher for cage rearing than in deep littered floor. However, the cage system of housing quails has some demerits that must not be overlooked (Dozier *et al*., 2010). These disadvantages include the following:

- Injuries may be caused to the quails' feet if the floor of the cage is rough and have sharp pointed ends. Injuries caused on the feet of quail may decrease mating frequency and thereby lead to reduction in fertility. Presence of injuries may also increase the risk of infections, diseases and mortality.
- Housing quails in a cage with 1–2 males per cage may lead to reduction in mean fertility rate for a whole flock.
- Cannibalism is a major problem among quails in the battery cage system especially where the birds are kept in smaller colony cages. This is so because birds that are victims of pecking cannot escape and flee from the more aggressive ones.

2.7.2 Quail Management Technology

According to Arinze (2013), management is a tool of production where various combinations of labour, capital and land are employed in the least cost and most efficient manner to produce marketable commodity. In the poultry business, management technologies and practices adopted determine the difference between success and failure. Quail management technology is therefore the art of taking care of quails in a given production or housing system (Muthoni, 2014). The process of raising quail however does not only require just feeding and use of equipment but it also requires a commitment by the farmer to maintain recommended management practices in order to prevent diseases and promote productivity. Aliyu (2016) indicated that disease is the biggest enemy in quail management and that about 80% of all quail mortality could be prevented with proper quail management.

The Japanese or Coturnix quails are the easy to manage, fastest growing and prolific birds. They are less susceptible to diseases and are the best species of quail to raise by beginners for especially egg production. The Japanese quail begin to lay eggs at six weeks old, and can be consumed at four to five weeks of age.

2.7.2.1 Breed Selection

Selection of a particular breed of quail for rearing is dependent on the purpose of production, which in turn is controlled by the local demands or the desired benefits of the farmer (Travis, 2018). This is because some quail breeds are more appropriate for commercial production of meat whilst others are more suitable for the purposes of

producing eggs. Depending on the aim of production, quail rearing can be divided into three categories, namely; layers, broilers and breeders (Zambia AgriBusiness Society, 2019).

i. Layer Quail Farming/Production

Layer Quail Farming is the process of raising quails purposely for egg production. Quail egg production and demand has increased considerably in the last decade as data indicate that global consumption of quail eggs has doubled from 13 quail eggs per person/annum in 2010 (Berthechini, 2012) to 27 quail eggs per person/annum in 2015 (Fernandez *et al*., 2018).

Some high-value egg producing quail breeds include the Coturnix (Japanese quail), Pharaoh, British Range, Tuxedo, Manchurian Golden and English White (Arya, 2018). The Bobwhite quail serves dual purpose, producing both eggs and meat. Typically, the Coturnix quail at 6-7 weeks old and the bobwhite quail at 8-10 weeks old begin to produce eggs (Bakoji *et al*., 2013). The Japanese quail begin egg production at age 6-7 weeks, laying between 250-300 eggs per annum, while the bobwhite quail can lay 150-200 eggs per annum under good management practices and based on the quality of birds at the beginning. However the Japanese quails are generally in full egg production by 50 days and can lay eggs throughout the year (Monika *et al*., 2018; Muhammad-Lawal *et al*., 2017). Quail egg shell have white to brown colour with dark spots and are usually protected with a light blue substance. The egg is approximately one-fifth

of the body mass of a chicken egg (that is, 10-13.8 g, representing about 8% of the layer's body weight) but their nutrient and health value is far higher than chicken eggs (60 grams). Quail egg also have little cholesterol with the yolk to albumen proportion being 39:61, which is higher than the eggs of chicken (Table.3) (Arya *et al*., 2018; Priti and Satish, 2014).

The Japanese quail has some physiological and behavioural variations compared to the domestic fowl. For instance, it takes about 18-20 hours for quail eggs to be synthesised (Pinto *et al*., 2003), but about 24 hours for chicken eggs to be synthesised (Fiuza *et al*., 2006). Eggshell synthesis also happens at different periods of the day; in Japanese quails eggshell synthesis mostly happens in the day time, whereas it occurs at night in the domestic fowls (Hassan *et al*., 2003). As a result, the peak periods for egg laying is often recorded in the morning in the domestic fowl but occurs in the afternoon to evening hours (15-19h) in quails (Pizzolante *et al*., 2007). Qails require 24 hours of photoperiod for the first two weeks of age which could be decreased to 12 hours towards the end of the third week and this duration of light should be maintained until when the birds are 5 weeks old. Afterwards, approximately 16-18 hours of light is essential for optimum egg production (Arya *et al*., 2018).

Generally, female quail has a life expectancy of 2 to 2 ½ years (Daikwo *et al*., 2014; Mohammed and Ejiofor, 2015). Quails lay about 80% of their daily eggs in the late afternoon to evening between 15-19 hours (GMT) whilst 20% of the

eggs are laid during the night (Cabaral *et al*., 2017). The eggs are usually laid every 16-24 hours for 8-12 months during the first year of egg laying; in the second year, egg laying reduces to around 48% of the first year's production and eventually falls significantly in ensuing production years (Arya *et al*., 2018; Chakrabarti *et al.*, 2014). To avoid daily egg losses and organise the number of clean and viable hatching eggs produced, the eggs should be collected two to five times each day (Chakrabarti *et al*., 2014; Dozier *et al.*, 2010).

In order to produce fertilised eggs, it is recommended to keep both male and female quails together in the same pen when the birds are 8-10 weeks old, at a male to female ratio of 1:2. However, a maximum male, female ratio of 1:5 is also desirable (Priti and Satish, 2014). This is because when several males and females are together, one male will dominate the others and will peck, injure, or even kill the other males (Martin *et al*., 1998).

ii. Broiler Quail Farming / Production

Broiler quail farm (Plate 2.7) is a quail farm with its main objective being meat production. Broiler quail production is regarded as an alternative source of meat beside the broiler chicken and some findings revealed that quail offers a more tasty, delicious and nutritious meat than that of chicken (Ayyub *et al*., 2014). The Jumbo Giant Quail, Northern Bobwhite Quail (American) and White Breasted Quail (Indian) are the major broiler quails and are famous for their commercial production of meat. The Japanese quail is also suitable as a dual-

purpose bird under the intensive system of management for commercial production of eggs and meat (Rahman *et al*., 2016).

The average Northern Bobwhite Quail weighs at about 179 grams whilst the Jumbo giant quail attains a body mass of 450 to 460 grams at maturity. Although their main purpose is to produce meat, broiler quail can also produce on the average 150-250 eggs per annum.

Plate 2.7: Broiler Quail Farm

iii. Breeder Quail Farming / Production

The general purpose of keeping a breeding stock is to produce fertile eggs for hatching and sale of quail chicks (Plate 2.8). Naturally, sexual maturity is attained at 6-7 weeks of age in the Japanese quail and 8-10 weeks in the bobwhite quail. Breeding stock can lay eggs and hatch quail chicks for up to 30

weeks of its age. However, egg fertility, embryo survivability/viability and hatchability are important indices that influence chick production from a breeding flock (Daikwo *et al*., 2011). Generally, fertility and hatchability in poultry species and in quail breeding in particular are directly influenced by various factors including parental age, rate of laying, climatic factors, pre-incubation storage, mating ratio and egg weight (Daikwo *et al*., 2011; Narahari *et al*., 1988). Although embryo mortality as high as 28.84% has been observed in quails (Farooq *et al*., 2001), high percentage fertility and hatchability of 68-79% has been confirmed in quail breeding (Daikwo *et al*., 2011).

Plate 2.8: Breeding Quails (deep litter)

Sex determination is a very crucial management practices in breeding poultry species including the Japanese quail. Sex determination in young quails before the age of three weeks is very difficult except by DNA analysis in a molecular genetic technique known as polymerase chain reaction (Vali and Doosti, 2011). This is because there are no

apparent variations in the plumage colour between the male and female Coturnix before they are three weeks old as newly hatched Japanese quail chicks have brown colouration with yellow stripes, so the only way to distinguish them morphologically is to rely on their size difference since females are bigger at that stage (Amoah and Martin, 2010; Jensen *et al*., 2003).

Sex determination between male and female quails become easier when the bird is about 3 weeks from hatching. The adult male quails are lighter in colour than the females and have cinnamon plumage colour at the upper portion of their breast (chest) and light brown in shade at the lower portion (Vali, 2008). In adult male quail, there is a hypertrophied gland in the cloaca for semen production (white foaming fluid discharge from the cloaca). On the other hand, females have brown colour with speckled (black) stripes on the neck, cheeks and upper part of the chest or breast (Shit *et al*., 2010; Singh *et al*., 2011).

There are two main methods of quail breeding. The first method is the mixed population where both male and female quails are put together in colony cages for large-scale quail chick production. This method however has some disadvantages, which include uncontrolled breeding, irregular egg laying rates and aggressive pecking by males in the breeding group (Wechsler *et al*., 1998). Also, productive and reproductive factors may be affected by stocking density of birds per cage as a higher population of especially male quails in the same cage may increase competition between males for females, social interactions and constant struggle for feed and space (Faitarone *et al*., 2005;

Santos *et al.*, 2011). Stocking or mating ratio of male to female of up to 1:4 for quails kept in colony battery cages is desirable for breed improvement (Narinc *et al.*, 2013). The other method involves selecting and keeping individual males and females in separate cages from the 3rd week onwards and feeding them with separate diets (Monika *et al.*, 2018). It is the best recommended practice for quail breeding as the farmer periodically crosses the female quails with the males to obtain fertile eggs for hatching into quail chicks. This method therefore helps to address inbreeding and other consequences of uncontrolled breeding. It is also a good method for practising on small-scale breeding in order to achieve high fertility rate and breeding quality.

2.7.2.2 Nutrient Requirement and Feeding of Quail

In backyard quail farming, the birds could be fed with any available agro-byproducts, household leftover food grains and commercial chicken feed at the proportion of 1 kilogram to 50 quail layers per day for maximum gain (Cambel, 1994; Chakrabarti *et al.*, 2014). According to Cambel, (1994), better egg production can be obtained when laying quails are fed with rations prepared by mixing 50kg chicken layer mash with 1kg fish meal and 3kg soybean oil meal.

However, for large scale or commercial production, Chakrabarti *et al.*, (2014) suggested that layer quails are given a balanced ration with 2700 to 2800 ME Kcal/kg of feed, 22 to 27% protein and adequate calcium (3%) and phosphorus (0.8%) for optimum laying performance. Leeson and Summers (2005) also confirmed recommended CP values of 28%, 18%, and 20% for quail chicks (ME 2,900 Kcal/kg), grower quails (ME 2,900

Kcal/kg) and layer quails (ME 2,950 cal/kg) respectively. Prabakaran (2003) has shown that quails can be profitably raised in the tropics on starter (0-2 weeks), grower (3-5 weeks), and production (6 weeks and beyond) diets containing CP levels of 24% (ME 2,750 Kcal/kg), 20% (ME 2,700 Kcal/kg), and 19% (ME 2,650 Kcal/kg), respectively. High protein requirement is necessary especially during the early growth stages (starter and grower periods) of the bird because there is higher requirement for protein and essential amino acids for optimal performance (Chakrabarti *et al*., 2014). During the 1st week of growth, Chakrabarti *et al*. (2014) further recommends that quail be fed about 5 grams of feed per day whilst 10 grams, 15 grams, 19 grams and 22 grams of feed should be provided per day for the 2nd, 3rd, 4th and 5th weeks of growth respectively and that daily feed consumption of an adult quail at 6 weeks and above is between 20 to 25 grams of feed. According to Priti and Satish (2014), quails at age 5 weeks can ingest up to 500 grams of feed. At 6 months old, quails consume a daily feed of about 30-35 grams and need almost 400 grams feed in order to produce a dozen of eggs.

Feed alone accounts for approximately 60-75% of the overall *cost* of commercial poultry production (Smith, 2001; Swain *et al*., 2014), hence the nutrients in quail rations should be balanced, cheap and especially formulated with indigenous feed resources. According to Fernandez *et al.*, (2018), feeding material of quail should be made of small particles for easy ingestion and digestion. According to Chakrabarti *et al*. (2014), a standard quail diet may be formulated with ingredients tabulated below (Table 2.4).

Table 2.3: An ideal quail ration

Ingredients	Starter Ration (%)	Grower Ration (%)	Layer Ration (%)
Rice polish	14	9	10
Maize	43	35	40
Groundnut cake	16	30	25
Sunflower Cake	14	12	10
Fish meal	10	12	10
Bone Meal	1.4	0.7	0.2
Lime Stone	1.0	0.5	0.5
Salt	0.3	0.5	0.5
Vitamins and Minerals	0.3	0.3	0.3

Source: Chakrabarti *et al*. (2014)

Although home-feed formulation and mixing has been reportedly confirmed as an important cost-saving mechanism among urban and semi-urban poultry farmers (Kasule *et al*., 2014), majority of quail farmers in Uganda for instance are using commercially-mixed feeds as opposed to home-compounded feeds.

Non-conventional protein feed resources are increasingly being used in poultry diets in the developing world (Abang *et al*., 2016; Makkar *et al*., 2014). This is because the major conventional protein ingredients (i.e. soyabean and fish) and energy sources (i.e. maize, Guinea corn, and Millet) are also essential staple foods for human consumption thereby making expensive to purchase (Bamgbose *et al*., 2004; Nasaka *et al*., 2017). The most frequently used non-conventional protein feed resources in quail nutrition are

plant protein sources (Kasule *et al.*, 2014). Termite meal has also now been confirmed and recommended as a high quality and economic protein source for use in Japanese quails farming (Deori *et al*., 2019). The use of organic non-conventional ingredients in quail ration such as medicinal herbs, vegetables, seeds, worms, bee products, and edible fungi in the diet has the ability to improve carcass and meat quality as they reduce oxidation (Vargas-Sánchez, 2019). The use of **s**weet orange (*Citrus senensis*) peel meal, as a substitute for maize for up to 25% said to have significantly reduced the cost of quail production (Guluwa *et al*., 2014) whilst cocoa husk meal (CHM) at 14% (Olubamiwa *et al*., 1999) and dried citrus pulp at 6% (Florou-Paneri *et al.*, 2001) successfully replaced maize in layer quail diets with no significant deleterious effect on laying performance. Fernandez *et al.* (2018) reported an enhancement in laying performance including average egg weight of quails fed *ad libitum* at 16 hours (GMT) at the age of 26 to 34 weeks. Thus, it is recommended that adequate feed be provided for quails from 16h to 19h (GMT) which times also coincide with the peak of egg laying.

Adult quails need about 1.25cm to 2.5 cm of space per bird for feeding. Enough feed should be provided, but care should be taken in order to prevent excessive waste of feed. Fresh and clean water should be available throughout the day with a minimum drinker space of 0.6 cm per quail. The most appropriate drinking troughs for mature quails are nipple drinkers and cups where one nipple or cup is provided per 5 birds (Noman, 2018).

2.7.2.3 Sanitation and Biosecurity

Biosecurity refers to safety protocols or measures that have been put in place to prevent infection and spread of pathogenic organisms such as bacteria, fungi, viruses, parasites, insects and rodents in a flock as these organisms affect the health of birds (Dozier *et al.*, 2010). According to Muhammad (2006), sanitation and biosecurity in quail production involves obtaining birds (chicks) from sources free from diseases, ensuring good sanitary conditions in the housing unit and its surroundings, restricting visitors from coming into contact with the farm, keeping birds of the same age group together and proper disposal of dead birds and contaminated litter. Control of rodents is an essential component of biosecurity. According to Dozier *et al.*, (2010), the effects of rodents include destruction and contamination of feed, attacking and causing distress and panic to quail birds and/or destruction caused to electric wiring and introduction of parasitic diseases such as *Salmonella, Leptospira and Coccidian*. Muhammad (2006) suggested that in order to inhibit diseases entry into the farm, only new stocks such as chicks or eggs should be introduced and if it becomes necessary to purchase adult birds, then new stock must be isolated from the old flock for not less than one month.

2.7.2.4 Diseases and parasites control

Unlike other poultry species, quails are fairly hardy and can resist most of the diseases that affect poultry such as Fowl pox and Ranikhet disease, and therefore do not require special treatment or vaccination except control of environmental factors (Cambel, 1994; Chakrabarti *et al.*, 2014). Quail chicks are very fragile during the first to second weeks from hatching, and may therefore require special protection against environmental or

seasonal changes such as rain water, intense and cold winds, and hot temperatures. However, some common infections in quail farming include Quail Pox, Quail Bronchitis and Ulcerative Enteritis (Table 2.5). Coccidiosis, Botulism, Myoplasma and Capillaria worms are other infectious diseases and parasites that have been posing problems in quail production and management (Arya et al., 2018; Dozier et al., 2010). Proper housing, good nutrition and good sanitation are the best recommended management practices and assurance against quail diseases (Musa *et al.*, 2008) since there are no approved medications and vaccines available in the market for quails (Dozier *et al.*, 2010). Most diseases of quails are being treated on experimental basis with terramycin in water and in such cases human consumption of eggs laid are avoided for at least two weeks following treatment (Martin *et al*., 1998). Deworming, regular cleaning and disinfection of housing facilities such as feeders, drinkers, cages and general hygiene practices are therefore very important in quail farming (Chakrabarti *et al*., 2014; Musa *et al*., 2008). Arya *et al*. (2018) and Zambia AgriBusiness Society (2019) however suggested various specific ways of controlling some quail diseases and parasites (Table 2.5). In addition, debeaking with a simple nail cutter is recommended in commercial quail farming to prevent cannibalism. Over cutting of beak should however be avoided as it may reduce fertility in quails as a result of difficulty of males to cross the females (Chakrabarti *et al*., 2014). Birds that are appearing sick should be isolated and quarantined from healthy birds with veterinary diagnosis of the disease made before treatment is commenced (Musa *et al*., 2008).

Table 2.4: Some diseases and parasites of quails and their preventive measures

Types of infection	Diseases/pests	Symptoms	Control/prevention
Viral	Infectious Bursal Disease. Newcastle disease. Pox. Bronchitis.	Respiratory distress, sneezing and loose, watery droppings coughing	Lasota vaccination through drinking water.
Bacterial	Salmonellosis Colibacillosis Ulcerative enteritis	Partially closed eyes, ruffled feathers diarrhoea, restlessness, retracted neck, drooping wings, anaemia and watery white faeces	Antimicrobial drugs
Mixed	Mycoplasmosis, Aspergillosis, and Haemoprotus infection	Anaemia, lameness, poor growth and general weakness.	Antimicrobial drugs
Parasitic	Coccidiosis	Birds go off feed, weak-legged, pale and die if not treated.	Coccidiostat
Internal parasitic	Roundworms Tapeworms	Drop in egg production, an increase in hunger and diarrhoea.	Antihelmintic

Source: Arya *et al.*, 2018; Zambia AgriBusiness Society (2019).

2.7.2.5 Breeding of quails

The ideal age for selection of breeding stock in quail production is from 10 to 30 weeks old as fertility during this age remains high in quail but begins to decline gradually thereafter. If the diet of the parent quails are deficient in vitamins and minerals, it affects their young ones which may appear lean and have weak feet. To prevent this phenomenon, there should be mineral and vitamins supplementation in feed provided for the female breeders (Priti and Satish, 2014).

In order to ensure optimum fertility in a breeding stock, the male : female ratio should be controlled. For research and development purposes, the ideal method of attaining optimum fertility in breeding is to enclose one male and one female in a small cage (Monika *et al*., 2018). However, for commercial quail production, a ratio of up to one male to three female quails is recommended in order to produce fertile eggs with high hatchability (Chakrabarti *et al*., 2014; Monika *et al*., 2018). Adherence to an ideal male female ratio in commercial breeding is desirable. When the female quails begin to have bare backs as a result of worn out feathers, it is an indication that the population of males in the flock is more than the required number. Under such circumstances, one male may dominate the rest and may peck, injure, or even kill the other males. On the other hand, an insufficient population of male quails leads to pecking amongst the female quails (Cambel, 1994; Khalil *et al*., 2015).

According to Dozier *et al*. (2010), the main aim of quail breeder producers is to raise birds with the intention of producing and selling day-old quail chicks to out-grower

producers. The out-grower producers' main specialisation is to brood the day-old chicks and continue to raise them until they are at least 6 weeks old from hatching and can be sold as a point of lay birds to farmers. In Georgia, farmers into quail breeding normally price day-old quail chicks at US$0.30 to US$0.35 (GH¢1.78 to GH¢2.02) per bird, whereas out-grower producers sell point of lay (flight-ready) birds at approximately US$3.10 to US$3.50 (GH¢17.92 to GH¢20.23) per bird (Dozier *et al*., 2010).

2.7.2.6 Incubation and hatching of quail eggs

Domesticated quails have lost their nesting and broody instinct and therefore do not have the tendency for brooding and hence the only way of hatching quail chicks (Plate 2.9) is either by using an artificial incubator or by using a broody hen for hatching (Mohammed and Ejiofor, 2015; Arya *et al*., 2018). Depending on the breed as well as the incubation conditions and control, the incubation period for quail eggs ranges from 16-23 days (See Table 2.5. below).

Table 2.5: Comparison of incubation period of quail eggs and other poultry species

Egg Type	Days to Hatching
Chicken	21
Duck	26
Coturnix Quail	17
Button Quail	16
Bobwhite quail	23/24

Source: Dozier *et al*. (2010).

The ideal incubation temperature for successful hatches ranges from 37.6ºC to 38.3ºC whilst optimum humidity of less than 70% is recommended (Martin *et al*., 1998;

Noman, 2018; Romao *et al.*, 2009). From a research conducted by Martin *et al.* (1998), the following temperatures and humidity schedules are recommended for a forced air incubator (Table 2.6)

Table 2.6: Temperature and humidity schedules for egg incubation

Days	Temperature		Humidity (Wet Bulb Temperature)	
	(°F)	(°C)	(°F)	(°C)
0 – 12	99.5	37.5	87	30.6
13 – 15	99.0	37.2	85	29.5
16 (10 Hours only)	98.5	37.0	82	27.8
16 – 17	99.5	37.6	90	32.3

Source: Martin *et al.* (1998)

Dozier *et al.* (2010) indicated that the best eggs for incubation should be healthy-looking with no shell defects, free from dirt, fairly big and have the best shell quality and that standard egg selected for incubation should have an average size of 10 to 11 g. In order to optimise the proportion of the best qualities for incubation, it is recommended that the eggs should be collected 3 to 5 times each day (Dozier *et al.*, 2010). Recent studies revealed that whilst eggs with spherical and round shape are not suitable for incubation, oval shaped eggs are perhaps the best and should be selected for incubation in order to attain high hatchability in the production of quail chicks (Idahor *et al.*, 2015). However, pre-incubation handling conditions affect hatchability to a large extent. It is therefore recommended that before the onset of incubation, quail eggs should be kept in cool and dry places (preferably in plastic bags to reduce dehydration) at a temperature of between

12-17^{0}C with 70-75% relative humidity after fumigation with formaldehyde gas (containing 60% potassium permanganate and 40% formalin) for 15 to 20 minutes. This is because at temperatures above 18 degree Celsius, development of the little embryos begins (Arya *et al*., 2018). Chakrabarti *et al*. (2014) also disclosed that quail eggs can be kept in storage for a maximum of 7 days post-laying, as hatchability becomes poor when eggs are stored longer than a week.

Plate 2.9: Hatching of Japanese quail eggs

2.7.2.7 Brooding and rearing of quail chicks

The colour of day old quail chicks is brown with yellow streaks and often weigh approximately between 7-8 g (see Plate 2.10). Although egg characteristics such as its colour, shape and weight could be used to determine the sex of quail chicks before hatching, post hatching vent inspection is the most common sexing technique in quails. These techniques may however require expertise and equipment which may not be afforded by many farmers.

Care for newly hatched chicks up to the first 2 weeks is very crucial as chicks may die if they are not properly cared for and managed (Chakrabarti *et al*., 2014). Although quails are immune to most poultry diseases and vaccination is not required for protection against infections, quail chicks are more susceptible to diseases and temperature changes than that of chicken (Redoy *et al*., 2017). Hence artificial heat, proper ventilation and adequate exposure to lighting are required for the first 2 to 3 weeks in order to prevent clustering of young chicks which could lead to high mortality rates (Arya *et al*., 2018; Noman, 2018; Zambia AgriBusiness Society, 2019). Table 2.8 indicates the required temperature and lighting during the first two weeks of brooding till the birds are three weeks old. At the chick stage, proper care and management such as disinfection of housing facilities and equipment, provision of clean drinking water and balanced rations are necessary in order to prevent disease outbreaks in quail farms (Priti and Satish, 2014).

Plate 2.10: Japanese quail chicks (day old)

Table 2.7: Temperature and light requirements during brooding of quail chicks

Quail Age	Temperature(degree C)	Light(hours)
1st Week	37.7	24
2nd Week	35	24
3rd Week	32.2	12

Source: Arya *et al*., 2018; Zambia AgriBusiness Society (2019).

2.7.3. Nutritive and medicinal benefits of quail eggs

There are increasing concerns by many organised bodies including the Food and Agriculture Organisation (FAO) over alternative food security, particularly dietary sources that are more suitable in solving malnutrition challenges in the world as a result of an increasing world population which is estimated to reach nine billion people by 2050 (FAO, 2017). These concerns have become more imperative as consumers are now being conscious of the nutritional components of foods they consume (Laryea *et al.*, 2016). Fortunately, the availability of a diversity of poultry species that produce variety of products offer alternative sources of nutrients for consumers' choices (Chepkemoi *et al*., 2016; Jeke *et al*., 2018). The introduction of poultry birds including guinea fowl (*Numida meleagris*), geese (*Alopochen aegyptiaca*), pheasant (*Phasianus colchicus*) and most recently, quail (*Coturnix coturnix*) in nutrition and food security intervention programmes has been recommended, mostly for developing nations (Geldenhuys *et al*., 2013).

Regardless of the fact that quail egg weighs about 11-13g, which is much smaller than that of a chicken (Okonko *et al*., 2019), quail egg is packed with more quality nutrients

(about 3–4 times) compared to the nutritional composition of chicken eggs (Abduljaleel *et al.,* 2011; Tunsaringkarn *et al*., 2013). Reports indicate that the egg contains higher calories and protein value, higher fat content and less bad cholesterol and has higher proportion of yolk to albumen (39:61) than chicken's eggs (Campos *et al*., 2013; Sathiya *et al*., 2017; Redoy *et al*. 2017; Tolik *et al*., 2014; Tunsaringkarn *et al*., 2013). Further studies revealed that quail eggs are richer in antioxidants, vitamins and minerals salts than those offered by other poultry eggs (Muhammad-Lawal *et al*., 2017). Monika *et al*., (2018) further indicated that in comparison with chicken, quail egg has specifically more calcium, iron, potassium, vitamin B2, phosphorus and HDL cholesterol.

The European and Asian countries are popularly noted for high consumption of the Japanese quail eggs with the leading consumers being Japan, Italy, France and the United Kingdom (Genchev, 2012; Tunsaringkarn *et al*., 2013). Even though Japanese quail egg is a novelty in Africa and its benefits surrounded by myths and controversies in some African countries, its consumption is increasingly becoming popular in countries such as Zimbabwe, Zambia, Benin, Ghana and Nigeria (Campos *et al*., 2013; Mohammed and Ejiofor, 2015; Mushava, 2016; Tolik *et al*., 2014; Tobiko, 2015; Tunsaringkarn *et al*., 2013). This worldwide acceptance of quail is as a result of the belief in its nutritive benefits (Campos *et al*., 2013; Chekpemoi *et al*., 2015; Jeke *et al*., 2018; Tolik *et al*., 2014) and these are illustrated in Table 2.8 and Table 2.9 below.

Table 2.8: Nutrient content per unit weight of eggs from different poultry species

Poultry species	Egg weight (g)	Crude protein (%/g)	Crude fat (%/g)	Cholesterol (mg/g yolk)	Ash (%/g)
Japanese quail	12.06	1.00	1.00	14.3	0.09
Guinea fowl	46.65	0.27	0.23	14.6	0.02
Pheasant	25.79	0.50	0.42	14.1	0.04
Chicken	60.31	0.30	0.05	14.0	0.02
Wild quail	11.75	2.00	0.23	14.2	0.09

Source: Jeke *et al*., 2018

Table 2.9: Comparative nutritive value of chicken and quail eggs

Component	Chicken egg	Quail egg
Calories	147	158
Total fat	9.9g	11.1g
Saturated fat	3.1g	3.6g
Cholesterol	423mg	844mg
Carbohydrate	0.8g	0.4g
Protein	12.6g	13.1g
Vitamin A	487 IU	543 IU
Calcium	53 mg	64 mg
Iron	1.8mg	3.6mg
Sodium	140mg	141mg

Source: Redoy *et al*. (2017).

Furthermore, Japanese quail eggs are said to contain various healing properties as a result of the presence of certain functional protein substances such as ovomucoid, lysozymes, ovotransferrin and cystatin (Douglas, 2013; Kovacs-Nolan *et al*., 2005). Besides, biochemical nutrient profiling of quail eggs revealed that there are adequate amounts of polyunsaturated fatty acids that are useful in preventing coronary heart diseases (Sinanoglou *et al*., 2011).

Additionally, the availability of sufficient essential nutrients as well as nutrients of biological significance in the eggs reduces the necessity for nutrient supplementation in human diets and therefore prevents the incidence of kwashiorkor and other diseases caused by nutrient deficiency in children (Jeke *et al*., 2018). Hence, the interest to consume quail eggs is most likely becoming a practical alternative to conventionally consumed chicken eggs. It is however worth noting that the biochemical constituents and quality of domesticated quail eggs could be altered by various factors including stocking density, composition of diet, age of birds at laying, length of storage and environmental factors (Douglas, 2013).

Due to its affirmed health values, quail eggs are used in orthodox medicine in various countries for treatment of various diseases. For instance, regular consumption of quail eggs is said help to combat various gastrointestinal diseases including ulcers of the stomach. It also boosts up immunity, enhances intelligence, improves brain functions and stabilises the nervous system. Quail eggs are also useful in treatment of anaemia by

boosting haemoglobin level in the blood while detoxifying the body (Tunsaringkarn *et al*., 2013; Umera *et al*., 2018).

In China, quail eggs are used for treating tuberculosis, asthma and diabetes. They also use quail eggs in the prevention of kidney, liver and gallbladder stones or even the removal of these types of stones (Lalwani, 2011; Meluzzi *et al*, 2000; Tanasorn *et al*., 2013; Umera *et al*., 2018). In Japan, regular consumption of Japanese quail eggs had numerous acclaimed benefits which include improvement in metabolism, stress prevention; and helps in controlling asthma and obesity (Truffier, 1978). Anca *et al*., (2008) disclosed that, Brazilians also consume quail eggs due to claimed potency of relieving several disorders including tuberculosis, hypertension, stomach ulcers, anaemia diabetes, arteriosclerosis and asthma.

Regular consumption of quail eggs increases sexual appetite in humans and strengthens the body of a pregnant woman and especially after delivery by caesarian section. It is also beneficial in enhancing physical and mental balance in developing foetus and in the physical rehabilitation and rejuvenation of cells for the mother after delivery including improving the quality of breast milk (Bakoji *et al.*, 2013). Quail eggs are also said to promote and rejuvenate body growth, improves brain functions, memory and intelligence quotient in children. It is therefore good for children in its raw or cooked form (Bakoji *et al.*, 2013).

Other benefits of quail eggs include the following:

- Inclusion of quail eggs in the diet of children make them more resistant to infectious diseases.
- Apart from quail egg being a good sources of proteins, fats, vitamin E, minerals (nitrogen, phosphorus, iron and zinc) and reproductive hormone (progesterone) which influence sexual potency and enhance the development, maturation, activation of dead cells in humans (Tunsaringkarn *et al*., 2013).
- The eggs also have some evidence in improving the skin colour and strengthens hair in women. Hence they are recommended for use in cosmetic and hair care products.
- The eggs help to prevent and treat anaemia by increasing blood haemoglobin level whilst detoxifying the body (Zambia AgriBusiness Society, 2019).

2.7.4. Nutritive and medicinal benefits of quail meat

Quail meat is rich in health and nutritive qualities as it is packed with essential nutrients. It is delicate and white with very low subcutaneous fat and cholesterol, low caloric value and well-known for high value protein of high biological importance, making it the most preferred meat by people suffering from high blood pressure (Tuleun *et al*., 2011). The protein quality shows the presence of sufficient amounts of essential amino acids such as lysine, valine and leucine and some non-essential amino acids such as alanine and aspartic acid (Genchev, 2012; Layman and Walker, 2006). Quail meat is also said to be leaner and has more nutritive value than chicken (Table 2.10). These qualities, especially the low-fat content, make quail meat preference for consumption by people with cardiovascular conditions including hypertensive people and those with high level

of cholesterol. Quail meat is also said to stimulate body and brain development among children (Monika *et al.*, 2018).

Table 2.10: Comparative nutritive value of quail meat and chicken

Parameter	Chicken meat (100g)	Quail meat (100 g)
Calories	263	134
Total fat	16 g	5g
Saturated fat	3g	1g
Protein	15%	22%
Iron	6%	25%
Calcium	2%	1%
Vitamin C & A	0%	1%

Source: Monika *et al.*, 2018

2.8 Prospects and Opportunities for the Quail Industry

The world's human population, especially in developing nations has continued to grow over the years. It has become necessary therefore to find alternative sources of animal protein to augment the existing ones (El-Katcha *et al.*, 2015). Kusi *et al.* (2012) indicated that, there is low consumption of animal protein among the Ghanaian populace as an average Ghanaian consumes about 59.8 g of protein per day of which 16.7 g (27.9%) is from animal origin compared with the daily animal protein consumption in the developed nations which is 60% in the United Kingdom, 67% in Denmark, 68% in New Zealand and 71% in USA (Oduns *et al.*, 2007). The recommended daily protein requirement reported by the Food and Agriculture Organisation (FAO 1990), is between 70-80 g of which at least 50% should come from animal protein sources. The low meat

consumption in the situation of Ghana is attributable to low meat production in the country (Kusi *et al*., 2012).

In order to boost up meat production, some developing countries such as Zambia, Zimbabwe, Kenya and Nigeria have introduced the production of animals with short generation intervals (Mohammed and Ejiofor, 2015). Poultry is said to be the most rapid source of generating meat with the highest rate of productivity involving the least precarious and strenuous production processes compared to other livestock enterprises (Smith, 2001). This is why Ani and Adiegwu (2005) suggested that a remedy to the challenge of insufficient consumption of protein of animal sources in the developing countries is to promote the production of highly fertile animals that have short production cycles like rabbits, pigs and poultry. The Japanese quail is one such poultry species that has the potentials of bridging the obvious yawning gap in the protein needs in developing nations (including Ghana) due to its shortest generation intervals and other numerous advantages over chicken and other species of poultry.

Raising quail is easy and less strenuous. This is because unlike in chicken production, quails do not require complex housing structure (Lambio, 2010). The miniature size of quail, its fast growth, early sexual maturity and early attainment of market age enable quail businesses to be established easily with little investment whilst providing a quicker returns and higher cost-benefit than chicken and other layer production (El-Katcha *et al*., 2015; Monika *et al*., 2018; Owen & Dike, 2013). According to Martin *et al*. (1998) quail husbandry is about five times more profitable than turkey and chicken farming,

and thus a farmer who has 400 layer quails is economically better off than a farmer who has 2000 laying chickens. Their laying prolificacy is very high, capable of producing more than 300 eggs per bird per year whilst chicken needs averagely six months duration to attain sexual maturity and start producing eggs (Monika *et al*., 2018).

The fast growth and ability of quail to start producing eggs at very early age also make the bird the most suitable for use in biological experiments that are aimed at producing vaccines, especially in the production of Newcastle disease vaccines to which quails are resistant. Moreover, quails require less feed (20-25g per quail/day) but grow and multiply fast and convert feed to egg and meat very efficiently (Bolla and Randall, 2012). When egg production in female quails begin as early as six weeks of age, it continues for at least a year with the female producing eggs equivalent to 8% of its own body mass than the 3% that occurs in the domestic fowl (Martin *et al*., 1998). Table 2.11 below is a summary of advantages or the merits of quail production over chicken production which means quail farming is a more lucrative poultry business hence a motivation for a gradual increase in commercial quail production in most African countries (Monika *et al*. 2018).

Table 2.11: Comparative advantages of quail farming over chicken farming

Quail farming	Chicken farming
i. Low capital requirement	i. High capital requirement
ii. Quails require a floor space of 0.2 sq ft/bird	ii. Requires floor space of 1-2.5 sq ft/ bird
iii. It possesses remarkable disease resistance, hence hardly requires any vaccination.	iii. It is highly susceptible to common poultry diseases and vaccination is a must
iv. Feed requirement is 25-30 g/bird/day	iv. Feed requirement 110- 120 g /bird/day.
v. 8.4-10 kg feed is required to produce 300 eggs with average egg weight of 10-14 g.	v. 42-48 kg of feed is required to produce 250 -260 eggs with average egg weight of 54-58 g.
vi. In a year quail produces 25-30 times more eggs than its body weight	vi. A hen produces 8-9 times more eggs than its body weight
vii. Quail starts laying egg at 6weeks and attain peak production at 10 weeks of age which continues up to 54 weeks	vii. Hen starts laying egg at 20^{th} weeks and reach peak at 27-29^{th} weeks and continue to lay up to 72 weeks
viii. Broiler quails are sold at 35 days	viii. Chicken broilers are sold at 35-40 days
ix. Quail meat is good for asthma and arthritis	ix. Having no such medicinal properties
x. Housing is cheaper, can be reared in multi-tier battery cages	x. Housing is substantially costlier than that in quails
xi. Culled birds fetch more money in terms of body weight	xi. Culled birds fetch lesser price in terms of body weight.

Source: Monika *et al.* (2018)

From the above literature, it is obvious that quail farming is a viable and sustainable livelihood venture with a lot of prospect of improving the living conditions of both urban and rural farmers (Majoni *et al.*, 2018).

2.9 Influence of market access to quail production

According to a research by Arthur (2013) in Vancouver British Columbia, the market system of quail and duck eggs can be described as relatively '*loose'* as the system is not well organised. One major weakness of the industry identified by the research was that little is known about market access for quail and quail eggs as there is paucity of information. As a result, individual farmers and other stakeholders have to find their own markets access which is limited to the following value chain: producers, farm gate middlemen, processors, distributors, restaurants and final consumers. Fortunately, there is currently a rising market for the eggs and meat of quails in the bars, restaurants, stores, hotels and streets and in some countries quail eggs and products are in great demand (Cabaral *et al.*, 2017). The greatest demand for quail eggs is located in Japan while the major quail meat consuming nation is France (Perennou, 2009).

The primary market for quail and duck eggs and their products is however currently dependent on the stability and frequency of customers who buy for regular meal preparations. These limited market opportunities therefore suggest that farmers and processors have no control over markets and essentially have to accept prices offered by customers and this phenomenon may influence production and distribution of quail products (Arthur, 2013).

2.10 Constraints of Quail Farming

Although quail farming is such an easy to manage business than any other micro livestock or poultry business, there are quite a number of constraints confronting the quail industry the world over and Africa in particular. These constraints include production management constraints as well as transportation and marketing constraints. According to previous studies, lack of information or knowledge on the part of producers and consumers about quail farming requirements and value, market instability, high cost of transportation, lack of government and institutional support, necessity of incubators for hatching quail eggs and inadequate funds are the major constraints militating against the quail industry (Adeoti and Baruwa, 2019; Majoni *et al*., 2018).

The major production challenges faced by quail farmers include high cost of feeding, lack of knowledge on nutritional requirements of the bird, climatic factors and high chick mortality rates as a result of poor quality of day old chicks and sensitivity to cold temperatures (Adeoti and Baruwa, 2019; Naibi *et al.*, 2009). According to El-Demerdash *et al*. (2013), high mortality may be recorded in day old quail chicks due to respiratory disorders in their first week but this challenge may be overcome after the first week with proper management practices. Other production management constraints include disturbing crowing noise by the male, high ammonia content in their droppings producing offensive odour and pecking among males leading to severe injuries, cannibalism and death. Cannibalism in quails may arise due to inadequate feeding or drinking space, under-nutrition, malnutrition, inadequate nesting space, overstocking,

high levels of maize in diet, frequent feeding of compressed or pellets feeds, high artificial light intensity, high environmental temperatures and irritation by ecto-parasites (Redoy *et al.*, 2017). Besides these challenges, during the short days of winter, quails need supplementary lighting in order to keep them laying (Martin *et al*., 1998; Redoy *et al.*, 2017).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The study was conducted in three (3) agro-ecological zones of Ghana. Ghana is a West African country located in the tropics, and lies above the equator in the northern hemisphere. The country lies between latitudes 4° and 12°N, and longitudes 4°W and 2°E with a total land area of about 238,535 km².

According to Acheampong (1988), Ghana as a tropical country, experiences two major seasons; the rainy and the dry seasons. These seasons are determined by rainfall and temperature. The country is divided into six agro-ecological zones which are characterised by different natural vegetation and determined by climatic factors and soil characteristics. From North to South, these agro-ecological zones are: Sudan Savannah, Guinea Savannah, Transition, Semi-deciduous Rainforest, High Rainforest and the Coastal Savannah Zones (Oppong-Anane, 2006). Three agro-ecological zones were considered for the purpose of this study, namely: include the Guinea Savannah, the High Rainforest and the Transitional Zones. Eight (8) regions comprising at least two from each agro-ecological zone and a total of 26 districts/municipalities/metropolises were purposefully selected for this study.

3.1.1 Northern/Guinea Savannah Zone

The Northern or Guinea Savannah zone forms part of the Savannah Ecological Zone. It covers most parts of Northern Ghana (Upper East, Upper West, Northern, North-East

and Savannah Regions) and extends from the southern boundaries of the Sudan Savannah to the northern boundaries of the transitional zone. The Guinea Savannah Ecological Zone is characterised predominantly by relatively short trees with shrub and grass undergrowth (predominantly *Andropogon spp*.). The zone is associated with a uni-modal rainfall pattern, allowing for only one main growing season. The rainy season has a duration of 140-190 days with a total annual rainfall of about 1000-1300 mm. It is interesting to note that, about 60% of the rainfall is experienced within three months (July, August and September), with torrential rainfall occurring at its peak resulting in erosion and other serious drainage problems. The single growing season in the North ends with the harmattan period, which starts in December and ends in March (Wood, 2013).

3.1.2 Middle/Transition Zone

This is the zone that divides the Semi-deciduous Rainforest to the south and the Guinea Savannah to the north. The Middle /Transition Zone covers Ahafo, Bono, Bono East, parts of Ashanti and parts of Eastern Regions. It is known as a transition zone due to the fact that it shares its climatic characteristics with the Savannah hence it is also known as Forest-Savannah Transition. This transition zone occupies 28% of the total land area of Ghana and has a bimodal equatorial rainfall pattern, permitting two annual cropping seasons (major and minor copping seasons). It receives an annual rainfall of 1200mm, lasting for up to 180-200 days of rainfall. This agro-ecological zone largely supports annual food crops such as maize, roots and plantain (Barry *et al.* 2005).

3.1.3 Southern/High Rainforests Zone

The high rainforests zone in Ghana is located in the South western regions (including most parts of Western and some parts of Central Regions). For the purpose of this study, the southern zone includes the Greater Accra Region of Ghana. The high rain-forest experiences a bi-modal rainy seasons with high rainfall of up to 2200 mm per annum. The first rainy season commences in April to June and the second rainy season starts from September and ends in November. The high rain-forest consists of trees that serve as habitats for many wild animals. The trees are mostly hardwood and the land that lies within the rain-forest is very fertile. The soils and the rains support the cultivation of crops such as root tubers and plantain (Barry *et al.* 2005).

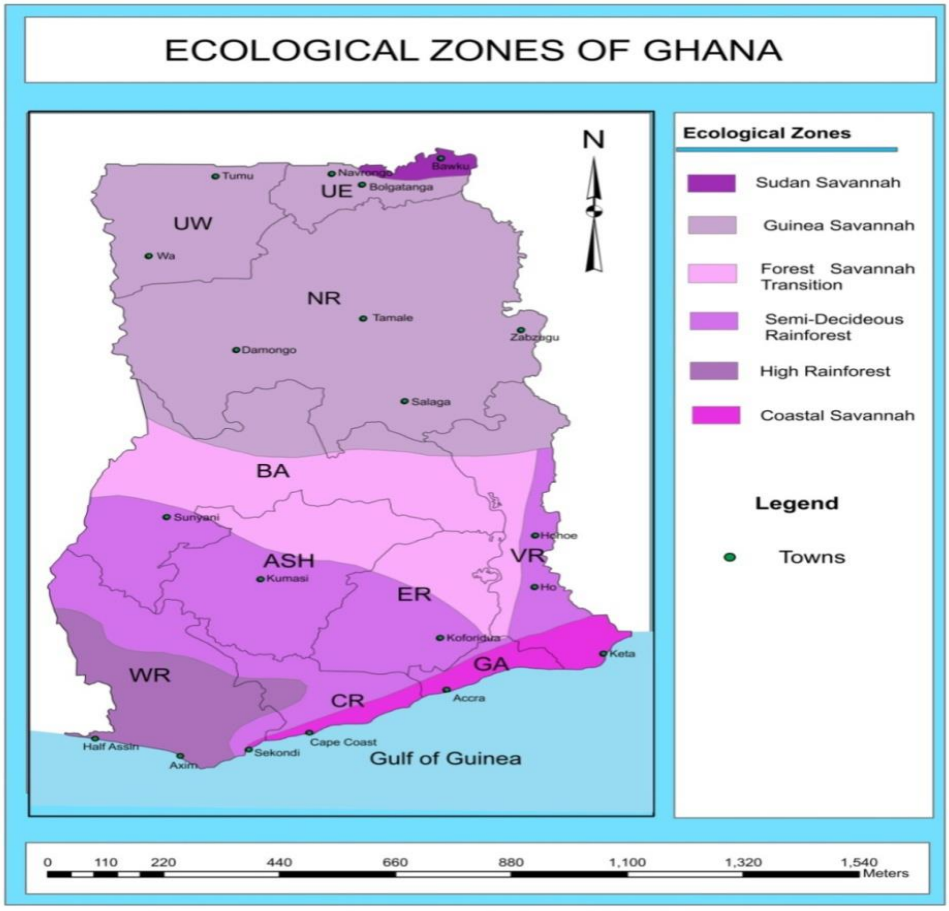

Figure 3.1: Ecological Zones of Ghana (Issaka et al., 2012)

3.2 Sampling and Data Collection

Three (3) ecological zones, 8 administrative regions and 26 districts/municipalities/ metropolises were purposefully sampled for the study. The Snowball Sampling Technique was employed in order to successfully locate respondents from each district/municipality/metropolis. The respondents for the study were small, medium or large-scale quail farmers / breeders. In all, sixty (60) respondents (farmers) were used for the study. Table 3.1 presents the distribution of respondents by regions and districts/municipalities/metropolis.

Table 3.1: Regions and districts involved in the study

Ecological zones	Regions	Districts	Number of respondents per district	Regional Frequency	Regional Percentage
Southern/ High Rainforest	Greater Accra (G/R)	Ablekuma Central Municipality Adentan Municpality Ashaima Municipality Ga East Municipality Ga West Municipality Katamaso District Korley Klottey Municipality Tema Metropolis	1 3 4 7 3 1 2 2	23	38.3
	Central (C/R)	Awutu Senya East Eguafo-Abirem Municipality Effutu Municipality Gomoah East District	2 1 1 1	5	8.4
Middle/ Transition	Ashanti (A/S)	Abuakwa District Asokore Mampong Municipality Atwima District Ejisu Municipality Bantama Municipality Afigya-Sekyere District	1 1 3 2 1 4	12	20
	Bono (B/R)	Sunyani West District	2	2	3.3
	Bono East (BE)	Techiman Municipal	2	2	3.3
Northern / Guinea Savannah	Northern (N/R)	Kumbungu District Sagnarigu District	2 7	9	15.0
	North East (NER)	East Mamprusi District West Mamprusi District	3 2	5	8.4
	Upper East (UER)	Bolgatanga Municipaliy Kasena-Nankana District	1 1	2	3.3
	Total		**60**	**60**	**100**

The data were collected from January to July 2020. Descriptive survey was used to gather data from the 60 quail farmers with the aid of structured questionnaires (open

and closed ended questions). The questionnaire were designed to capture the socio-economic characteristics of quail farmers, quail production systems and management practices, perceived nutritive and medicinal values of quail meat and eggs, marketing of quail and quail products, constraints facing quail farmers and prospects of the quail industry in Ghana. Observation was also employed as a method to ascertain firsthand information on the housing units, equipment used, quails and quail products on each farm. Pictures were taken as evidence where necessary.

3.3 Statistical Analysis

The data gathered from the questionnaires were organised, coded and entered in Microsoft Excel (2013) worksheet and processed. They were further summarised using descriptive statistics and then analysed with chi-squared in Statistical Package for the Social Sciences (SPSS 22.0, IBM). The results were then presented in percentages using charts and tables.

The descriptive statistics was used to describe socio economic characteristics, production systems, management practices and also production and marketing constraints. Qualitative traits such as the types of breed, categories of quails reared, kinds of feed, feeding and watering frequencies as well as farmers' purpose of quail production were subjected to goodness of fit, Nonparametic Tests of Chi-square. Cross-tabulation was used in Chi-square test of association to test for association between level of education of farmers and their record keeping practices on the farm. Likert scale (as described by McLeod, 2019) was used to rank the factors that affect production and

management, as well as production and marketing constraints in their order of importance. The Likert scale is a five (or seven) point scale which was used to allow the individual to express how much they agreed or disagreed with a particular statement. The score of 5 or 7 was assigned to the most affected factor or constraint and 1 to the least affected factor or constraint and the farmers were asked to rank them.

CHAPTER FOUR

4.0 RESULTS

4.1 Socio-Demographic Characteristics of Respondents

4.1.1. Sex and age distribution of respondents.

Results from the survey revealed that out of 60 quail farmers interviewed, majority of them were males whilst a few were females. It also indicated that most of them were relatively young and were in the youthful age group of ≤ 40 years, others were in the middle age brackets and the rest of them were ≥ 51 years (Table 4.1).

Table 4.1: Sex and age of respondents

Characteristics	Frequency	Percentage (%)
Sex of respondents		
Male	8	13.3
Female	52	86.7
Total	**60**	**100**
Age in years		
21-30	6	10.0
31-40	34	56.7
41-50	11	18.3
≥ 51	9	15.0
Total	**60**	**100**

4.1.2. Educational level, marital status and year of establishment of quail farms.

The study also showed that all the respondents had some kind of formal education and that most of them had acquired tertiary education. Majority of the respondents were married, while those who were single were either widowed, divorced or never married at all (Table 4.2). The result further revealed that commercial quail farming in Ghana started in 2012 and more than half of the farmers had less than five years old in the quail business (Table 4.3).

Table 4.2: Educational level, marital status, and year of establishment of quail farm.

Characteristics	Frequency	Percentage (%)
Educational status		
Basic	3	5.0
Senior High	6	10.0
Tertiary	51	85.0
Total	**60**	**100**
Marital status		
Married	42	68.3
Never married	13	21.7
Divorced	3	5.0
Widowed	3	5.0
Total	**60**	**100**

Table 4. 3: Year of establishment of quail farm

When farm was establish	Frequency	Percentage (%)
2012	5	8.3
2013	2	3.3
2014	4	6.7
2015	5	8.3
2016	8	13.3
2017	17	28.3
2018	10	16.7
2019	8	13.3
2020	1	1.8
Total	**60**	**100**

4.1.3. Size of flock and income

The study revealed that majority of the farmers in Ghana started quail business with an initial flock size of less than 100 birds and about 50% of them have their current flock sizes ranging from 501 to 2000 birds per farm. It also came to light from the study that, less than half (43.3%) of quail farmers in Ghana earn a gross income ranging between GH¢1001.00 and GH¢9000.00 per month (Table 4.4).

Table 4.4: Flock size and gross income

Initial flock size per farmer	Frequency	Percentage (%)
≤100 birds	40	66.7
101-200 birds	15	25
201-300 birds	1	1.6
301-500 birds	4	6.7
Total	**60**	**100**
Current flock size per farmer		
≤ 200 birds	15	25.0
201-500 birds	15	25.0
501-1000 birds	10	16.7
1001-2000 birds	5	8.3
Above 2000 birds	15	25.0
Total	**60**	**100**
Gross income from quails farm per month (GH¢)		
≤ 1000	34	56.7
1001-3000	19	31.7
3001-5000	3	5.0
5001-7000	3	5.0
7001-9000	1	1.6
Total	**60**	**100**

4.1.4. Training and other support for Quail Farmers

The survey revealed that an overwhelming majority of quail farmers never had any external support for their quail production businesses. Only a few of them had some level of knowledge and skill training on quail farming and a little number ever had some financial assistance in their quail business (Table 4.5).

Table 4.5: External support for quail farmers

Characteristics	Frequency	Percentage (%)
Financial support	1	1.7
Knowledge/skill training	5	8.3
No support	54	90
Total	**60**	**100**

Most of the quail farmers therefore strongly indicated the need for external support by way of skill training in the areas of marketing, management, modern technology, human relations and leadership. Among the skills required by farmers, marketing skill was ranked first followed by management skill. Technological skills, human relations skill, and leadership skill were ranked third, fourth and fifth respectively (Table 4.6).

Table 4.6: Ranking of skills training required by quail farmers

Skill training required	Score	Percentage (%)	Rank
Marketing skill	22	36.7	1st
Management/entrepreneurial skill	18	30.0	2nd
Technological skill	11	18.3	3rd
Social contact/human relation skill	6	10.0	4th
Leadership skill	3	5.0	5th
Total	**60**	**100**	

4.2. Production Systems and Management Practices of Quail Farming

4.2.1 Quail Housing Systems

The survey discovered that majority of the quail farmers raised their quails in the battery cage intensive housing system where quails were kept in colony cages whilst a few of them used the deep litter system of rearing (Table 4.7).

Table 4.7: Type of quail housing and facilities

Type of housing system	Frequency	Percentage (%)
Battery cage only	53	88.3
Deep litter only	4	6.7
Battery cage and Deep litter	3	5.0
Total	**60**	**100**

4.2.2. Feeding and Watering of Quails

The result indicated that most quail farmers ($P<0.001$) used commercial chicken feed ration (Table 4.8; Table 4.9) for feeding their quails from chick to adult stages. A few of them however used standard commercial quail feed ration (Table 4.11) and the rest used homemade (home formulated) broiler/layer mash for the commercial production of quails. Apart from the use of these feed resources, some of the quail farmers confirmed the use non-conventional feed resources (NCFR) for feeding their quails. These NCFR were said to either serve some medicinal purposes or fed as nutrient supplements or replacements (Table 4.11). These ingredients include bitter leaf, orange peels, mango bark, cabbage, watermelon fruits, dandelion leaves, Moringa leaves and

cocoyam leaves. Various feeding regimes were adopted by farmers. While some of the quail farmers fed their birds *ad libitum* others either fed them two times or three times a day. Averagely, each adult quail consumed an estimated daily feed ration of between 20 and 25 grams (Table 4.8).

Table 4.8: Kinds of feed, feeding and watering frequency for quails in Ghana

Characteristics	Frequency	Percentage (%)	Chi-Square	P-Value
Kinds of feed			37.3	<0.001
Commercial chicken feed*	41	68.3		
Commercial quail feed**	16	26.7		
Homemade feed	3	5.0		
Total	**60**	**100**		
Feeding frequency			2.1	<0.001
Ad libitum/ continuous	21	35.0		
Twice daily	14	23.3		
Thrice daily	25	41.7		
Total	**60**	**100**		
Watering frequency			**79.76**	<0.001
Once daily	53	88.3		
Twice daily	3	5.0		
Thrice daily	4	6.7		
Total	**60**	**100**		
Daily feed intake per adult quail				
Above 25 grams	15	25		
25 grams	23	38.3		
20 grams	17	28.3		
Below 20 grams	5	8.3		
Total	**60**	**100**		

**Composition shown in Table 4.9; **Composition shown in Table 4.10*

Table 4.9: Nutrient composition of commercial chicken feed used by quail farmers

Nutrient	Starter diet (%)	Layer diet (%)
Protein	23.05	17.43%
Phosphorus	0.43	0.5%
Calcium	1.75	3.50%
Lysine	0.25	0.83%
Methionine	0.30	0.3%
Sodium	0.25	0.25
M.E. (Kcal/kg)	2802	2700

Source: Field Survey, formulated by Agricare Limited, Tamale

Table 4.10: Quail starter and layer mash used by farmers

Nutrient	Starter mash (25kg)	Layer mash (25kg)
Protein	24.0	20.0
Phosphorus	0.45	0.46
Calcium	1.17	2.79
Lysine	1.12	1.16
Methionine	0.46	0.45
Sodium	0.25	0.25
M. E. (kcal) kg	2880	2700

Source: Field Survey, formulated by Akropong Feeds and Stationary Limited, Kumasi

Table 4.11: Reasons for feeding NCFR to quail birds

Characteristics	Frequency	Percentage (%)
Use of non-conventional feed resources (NCFR)		
Yes	29	48.3
No	31	51.7
Total	**60**	**100**
Reasons for giving NCFR		
Medicinal value	39	65.0
Nutrient replacement	4	6.7
Nutrient supplement	12	20.0
Supplement and Medicinal	5	8,3
Total	**60**	**100**

Various types of feeding and watering troughs were used in the quail production (Plates 4.1 and 4.2). These included plastic and metallic feeding and watering troughs and wooden feeding troughs (Table 4.12).

Table 4.12: Types of feeding and watering troughs used

Characteristics	Frequency	Percentage (%)
Feeding troughs		
Metallic	15	25
Plastic	31	51.7
Wooden	2	3.3
Metallic + plastic	4	6.7
Plastic + wooden	6	10
Metallic + plastic + wooden	2	3.3
Total	**60**	**100**
Watering troughs		
Metallic	7	11.7
Plastic	53	88.3
Total	**60**	**100**

Plate 4.1: Metallic (extreme left) and plastic feeding troughs

Plate 4.2: Quail watering systems (troughs) of different designs

4.2.3 Species and breeds

Three major breeds of quails were identified, but the most prevalent breed was the Japanese quail (X^2 = 76.90). The other breeds included the American quail and the Jumbo giant quail (Fig. 4.1). Three categories of quails were reared by the farmers, namely layers, broilers and breeders. The research revealed that most of the farmers reared layer quails only for production eggs, whilst a few others either reared broiler quails only or breeder quails only (Table 4.13).

The result further indicated that among the surveyed regions, Greater Accra region had the highest quail population (Fig. 4.2) and up to 15% of farmers in that region had a flock size above 2000 birds per farm (Fig. 4.3).

Table 4.13: Categories of quails kept by farmers

Category of quail	Frequency	Percentage (%)	Chi-Squared	P-Value
Layers only	37	61.7	41.17	<0.001
Broilers only	4	6.6		
Breeders only	9	15.0		
All the above	10	16.7		
Total	**60**	**100**		

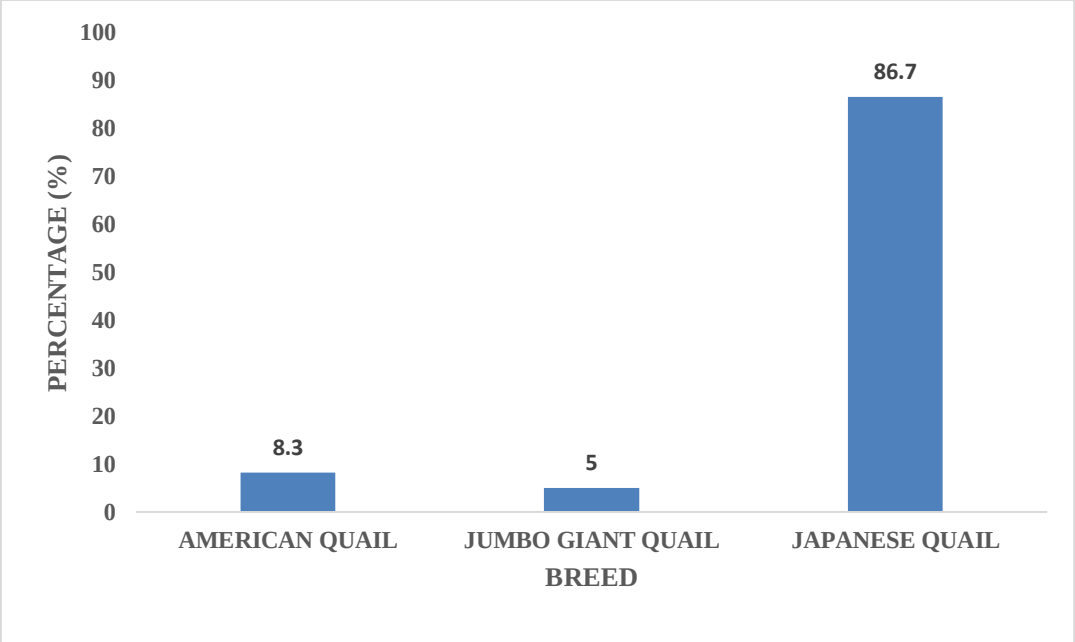

Figure 4.1 Quail breeds kept in Ghana

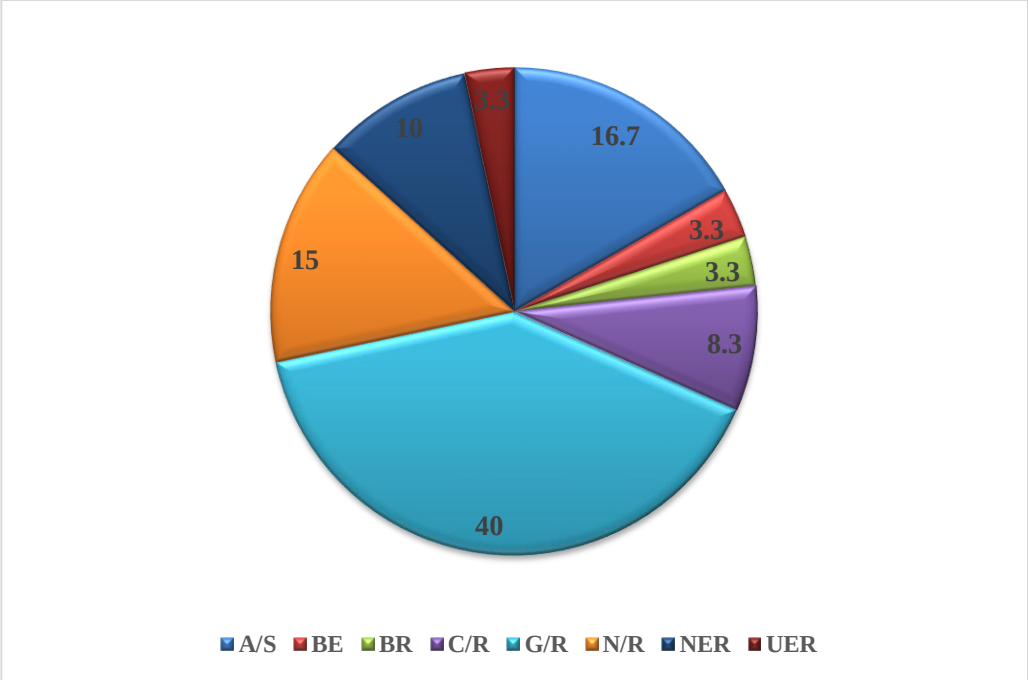

Figure 4.2: Regional distributions (%) of quails

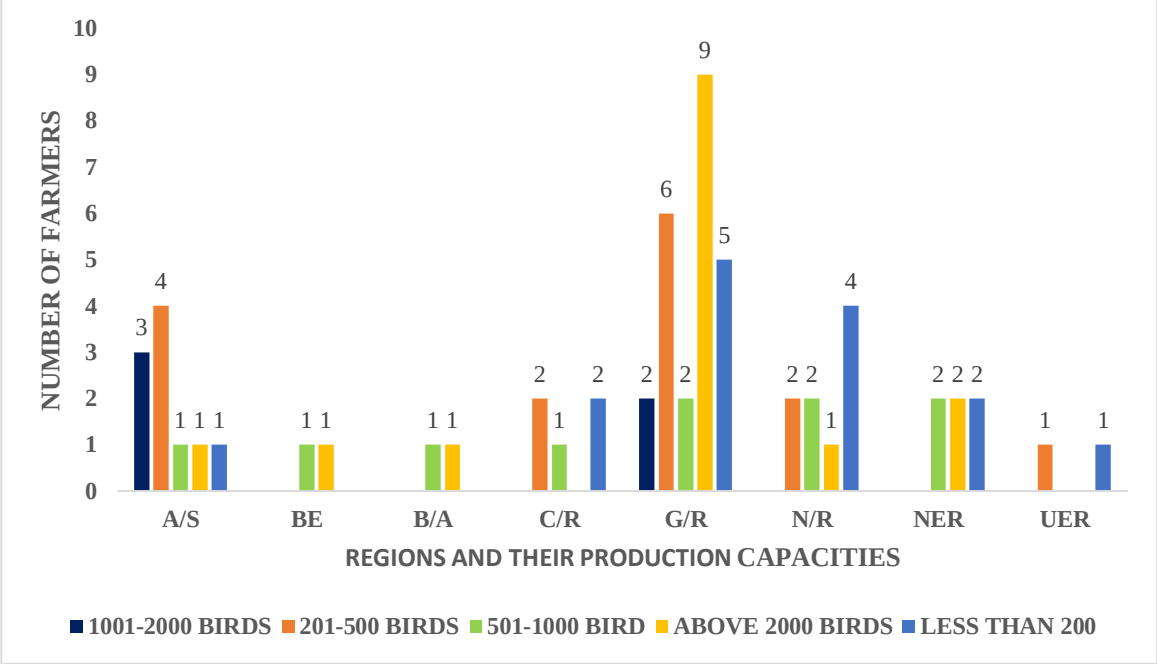

Figure 4.3: Regional distribution of flock size

4.2.4 Quail Egg Production

The survey revealed that most of the farmers kept male and female quails together in the same pen. Table 4.14 below indicates that majority of the quail farmers produced fertilised eggs only whilst a few of them produced both fertilised and unfertilised (table) eggs and none produced unfertilised eggs only. The findings also revealed that most of the layer quail farms recorded a hen-day production of ≤ 80% per day with majority of the farmers producing at most 10 trays (30 eggs each) of quail eggs per day (Table 4.4). Strategies adopted by farmers in order to increase percentage hen-day included the following: culling of unproductive quail hens, proper feeding, feeding with green leaves (supplements) and providing sand baths for quails to release stress.

Egg collection was mostly done in the evening or night hours because majority of egg laying was recorded from 15:00 hours till night (Table 4.15) (Plate 4.3).

Table 4.14: Egg type, percentage hen-day production and daily egg quantities in trays per farm

Characteristic	Frequency	Percentage (%)
Type of eggs		
Fertilised eggs only	42	70
Both fertilised and unfertilised eggs	18	30
Total	**60**	**100**
Quantity of eggs produced per farm per day		
0-10 trays	37	61.7
11-20 trays	8	13.3
21-30 trays	4	6.7
31-40 trays	2	3.3
> 40 trays	9	15.0
Total	**60**	**100**
Percentage hen-day production		
> 90%	6	10.0
86-90%	3	5.0
81-85%	8	13.3
71-80%	15	25.0
61-70%	22	36.7
≤ 60%	6	10.0
Total	**60**	**100**

Table 4.15: Daily egg laying periods of quails

Period	Frequency	Percentage (%)
15Hrs - 19Hrs	48	80.0
09Hrs-12Hrs	12	20.0
Total	**60**	**100**

Plate 4.3: Eggs laid in the cage and ready for collection in the night.

Observations from the survey revealed that quail farmers had various ways of collecting and storing eggs. Farmers collected and stored eggs in egg trays and other containers (Plate 4.4) before they were either set in an incubator for hatching or processed into other finished products or packaged in cartons/crates and sold to consumers.

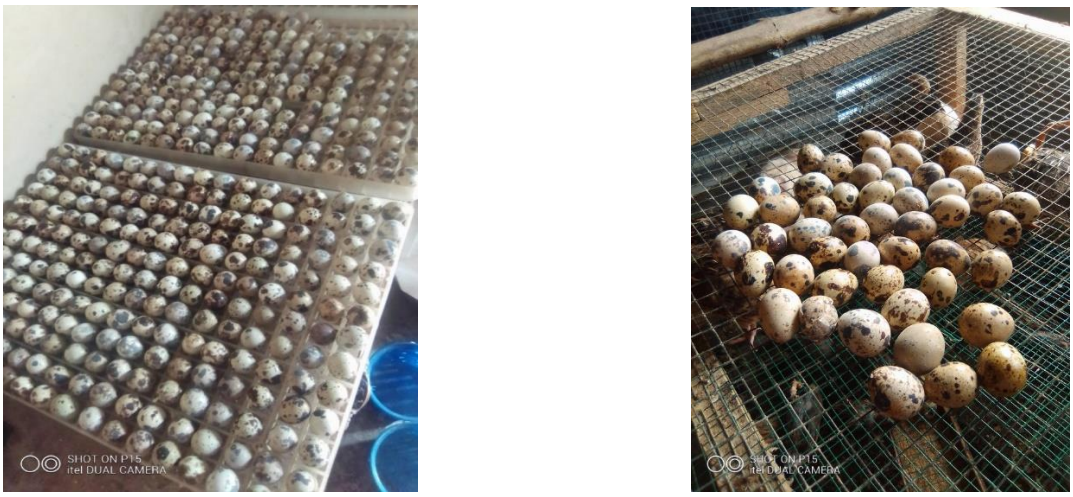

Plate 4.4: Quail eggs stored in trays (left) and wire mesh (right) awaiting sales or incubation

4.2.5. Breeding and Sex Identification of quails

i. Source of Breeding Stock

The survey indicated that majority of the farmers acquired their breeding stock by hatching their own eggs into chicks using an incubator. A few others however purchased either day old chicks or 2 weeks old chicks at average cost of 2-3 Ghana Cedis and 3-5 Ghana Cedis per chick respectively (Table 4.16, Figure 4.4).

Table 4.16: Sources of breeding stock

Characteristics	Frequency	Percentage (%)
Source of breeding stock		
Purchase of 2 weeks old chicks	5	8.3
Purchase of day-old chicks	10	16.7
Using incubator	45	75.0
Total	**60**	**100**
Cost of day-old chicks (GH₵)		
< 2.00	5	8.3
2.00-3.00	43	71.7
4.00-5.00	11	18.3
> 5.00	1	1.7
Total	**60**	**100**
Cost of 1-2 weeks old chicks (GH₵)		
< 3.00	14	23.3
3.00-4.00	41	68.3
> 5.00	5	8.4
Total	**60**	**100**

ii. Sex identification of quails

The study showed that most of the quail farmers determined the sex of their quails by themselves and did so when the birds were 3 weeks old. It was further revealed that quail farmers used various identification features to distinguish

between the male and female quails (Table 4.17, Plate 4.7). Generally, males were noticed to have bulging cloacae, which discharged white foaming semen when pressed with the fingers (see Plates 4.5 and 4.6).

Table 4.17: Sex identification features between male and female quails.

S/N	Male quail	Female quail
1	Absence of brown spots on chest and neck plumage.	Presence of brown spots on the chest and neck plumage.
2	Enlarged or bulging cloaca indicating presence of male sex organ.	Cloaca is not enlarged or bulging.
3	Discharge of white-foamy semen from cloaca when squeezed.	Absence of semen when cloaca is squeezed.
4	Males quail makes crowing sound.	Female quails do not crow.
5	Presence of crown on the head.	Absence of crown on the head.
6	Absence of bare backs.	Presence of bare backs among layers.

Source: Field survey, 2020

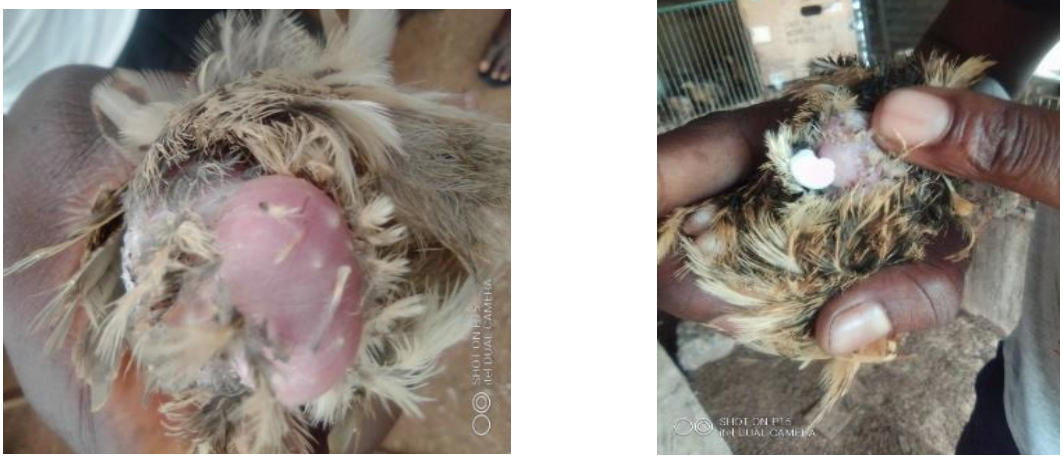

Plate 4. 5: Vent sexing, bulging vent of male quail with white

Plate 4.6: Vent of female quail, less bulging

Plate 4.7: Sexing of Japanese quail by plumage colour of chest (Left –male; Right –female)

Electricity, charcoal and kerosene lanterns were the major sources of heat and light in brooding and in raising broiler and layer quails in both the battery cage and deep litter housing systems. Table 4.18 shows that most of the respondents used electrical bulbs only during the brooding and rearing periods of chicks and those that depended on charcoal and kerosene were few (See Plates 4.8 and 4.9).

Table 4.18: Sources of heat/light during brooding of quail chicks

Source of light/heat in quail housing unit	Frequency	Percentage (%)
Electricity only	41	68.3
Charcoal only	1	1.7
Kerosene lanterns only	1	1.7
Electricity + charcoal	10	16.7
Electricity + charcoal + kerosene lanterns	7	11.7
Total	**60**	**100**

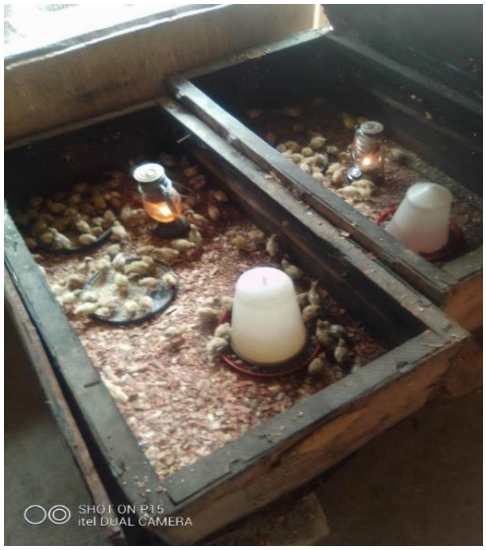

Plate 4. 8: Kerosene lamp in brooding of quails

Plate 4.9: Electric bulbs in brooding of quails

4.2.6. Farm labour and records keeping

Result from the survey suggests that an overwhelming majority of farms had less than 5 hired workers to care for and manage their flocks and that most farmers relied on family members as their main source of labour. Results of the research further suggests that more than half of the farmers kept records (Table 4.19) of various farm activities and majority of those that kept farm records fall within age group 31-40 years compared to the rest. The results also indicated a significant association between farmers' level of education and their record keeping practices ($P<0.001$). Most of the farmers that kept farm records had attained tertiary educational status, only a few of those who attained up to secondary education kept farm records and none of the respondents with only basic education kept any form of farm records. Records kept by the quail farmers include: mortality records; purchasing records; sales records; egg production records; hatchery records; medication records and feeding records.

Table 4.19: Source of farm labour and records keeping.

Characteristics	Frequency	Percentage
Source of labour		
Casual labour	5	8.3
Family members	43	71.7
Permanent hired labour	3	5.0
Family members + permanent hired labour	9	15
Total	**60**	**100**
Number of workers		
Less than 5 workers	55	91.7
5-10 workers	4	6.7
11-20 workers	0	0
Above 20 workers	1	1.6
Total	**60**	**100**
Record keeping		
Yes	40	66.7
No	20	33.3
Total	**60**	**100**

4.2.7. Diseases and parasites

The result revealed that most of the farmers did not experience any form of diseases and parasites on their farms. For those farms that recorded disease incidence, Coccidiosis and Infectious Coryza, an eye disease (Plate 4.10) were the major diseases that affected

quails while ectoparasites and endoparasites were also reported on few farms (Table 4.20). Majority of the respondents were aware of veterinary services for quails. However most of them got their veterinary information from the internet hence many of them practised self-medication in the control of diseases and parasites (Table 4.20). Apart from the use of drugs by majority of respondents ($P<0.001$), regular observance of biosecurity protocols / good sanitation and proper feeding regiments were the major control measures for diseases and parasites (Table 4.21). Majority of the farms confirmed mortality rates of less than 10%, occurring mostly during the brooding of chicks (Table 4.20).

Plate 4. 10: Infectious Coryza disease of Japanese quail

Table 4.20: Quail diseases and parasites

Characteristics	Frequency	Percentage (%)
Diseases incidence on quail farms		
Coccidiosis	27	45.0
Infectious Coryza	26	43.3
None	7	11,7
Total	**60**	**100**
Parasite infestation on farms		
Ecto-parasites (lice and mites)	10	16.7
Endoparasites (worms)	6	10.0
None	44	73.3
Total	**60**	**100**
Who treats the diseases and parasites?		
Self	46	76.7
Veterinary officers	14	23.3
Mortality records		
Yes	53	88.3
No	7	11.7
Total	**60**	**100**
Mortality rate		
< 10%	46	76.6
10-20%	7	11.7
None	7	11.7

Total	**60**	**100**
Growth phase at which mortality is common		
Chicks	32	53.3
Growers	2	3.3
Layers / broilers	19	31.7
All the phases	7	11.7
Total	**60**	**100**

Table 4.21: Disease control methods

Method	Frequency	Percentage (%)	Chi-squared	P-value
Treatment with drugs	25	41.7	34.2	<0.001
Biosecurity / good sanitation	13	21.6		
Proper feeding regimes	7	11.7		
Others	15	25.0		
Total	**60**	**100**		

4.3. Nutritive and medicinal benefits of quail eggs and meat

Table 4.22 below shows the main purpose of going into quail farming by farmers. The figures show that majority of the farmers started quail production because of its medicinal value, whilst others started raising the bird either because of its nutritive value, income generation, as a hobby (entertainment) or for multipurpose.

Table 4.22: Purpose of rearing quails and consumption of quail products

Characteristics	Frequency	Percentage (%)	Chi-Squared	P-Value
Purpose of rearing quails			**37.07**	<0.001
Medicinal value	20	33.3		
Income generation	11	18.3		
Entertainment / hobby	7	11.7		
Nutritive value	4	6.7		
Others / multipurpose	18	30.0		
Total	**60**	**100**		
Do you eat quail products?				
Yes	59	98.3		
No	1	1.7		
Total	**60**	**100**		
Which product is consumed most?				
Eggs	54	90.0		
Meat	6	10.0		
Total	**60**	**100**		

All the respondents of the study indicated that quail eggs and meat contain some nutritive and health benefits and less than half of them indicated that their initial purpose for venturing into quail rearing was to derive the purported nutritive and medicinal

benefits of the eggs and meat. Majority of the respondents affirmed that quail eggs in particular are very effective for the treatment of various diseases (Table 4.23).

Apart from the production of quails for their eggs and meat, a few farmers affirmed that they processed quail eggs into various industrial products including quail egg powder and capsules, quail egg oil, quail egg ointment and quail egg soap (Plate 4.11 & Plate 4.12). They also indicated that the meat is being processed into khebab, grilled, smoked and frozen meat (Table 4.24).

Table 4.23: Nutritive and health benefits of eating quail eggs

Characteristics	Frequency	Percentage (%)
Do you think quail eggs are very effective in treatment of some diseases?		
Yes	47	78.3
No	2	3.3
Not sure	11	18.4
Total	**60**	**100**
Quail products consumed		
Eggs	51	85.0
Meat	4	6.7
Egg + meat	5	8.3
Total	**60**	**100**

Table 4.24: Processing of quail products into other products

Do you process quail eggs and meat?	Frequency	Percentage (%)
Yes	18	30
No	42	70
Total	**60**	**100**

Plate 4.11: Quail capsules produced and packaged by some farmers

Plate 4.12: Quail soap (left) & oil (right).

4.4. Marketing of quails and quail products

Most of the respondents claimed that the demand for quail meat and eggs is gradually increasing in Ghana. Majority of the respondents also attributed the hiking demand for the eggs to their claimed health benefits (Table 4.25). Most of the farmers revealed that various customers come to buy the eggs which were sold in less than 7 days (Table 4.26).

Table 4.25: Why people patronise quail eggs

Reasons you think people buy quail eggs	Frequency	Percentage (%)
Health benefits only	50	83.4
Nutritional benefits only	6	10.0
Income generation purpose only	2	3.3
Health + nutritional benefits	2	3.3
Total	**60**	**100**

Table 4.26: Storage duration before sale of eggs

Storage duration	Frequency	Percentage (%)
< 7 days	35	58.3
7–14 days	21	35.0
< 7 days + 7-14 days	4	6.7
Total	**60**	**100**

The research revealed that majority of quail farmers in Ghana sell their eggs at a price range of GH¢10.00 – 20.00 per tray of 30 pieces of eggs (Plate 4.13), whilst an adult quail was sold at GH¢10.00 – GH¢ 20.00 (Table 4.27).

The survey further discovered that the current status of market promotion of the quail eggs was driven mainly by the famers themselves. Some of respondents used their own means of transport to distribute and deliver quails and quail eggs to consumers whilst others relied on public means of transport (hired vehicles).

On few instances however, some Poultry Feed Shops and Farmers Associations on social media platforms assisted farmers in market promotions through advertisement (distribution of leaflets, charts, and sampled products) and sale of quails and quail products. Various ways of improving marketing and market access were proposed by the quail farmers, which include processing of eggs into more durable products; the use of delivery trucks/bikes; increased public education; and the use of social media and sales points/stands.

Plate 4. 13: Different designs of quail egg trays used by farmers

Table 4.27: Prices of quail products

Characteristics	Frequency	Percentage (%)
Selling price of eggs per tray (30 pieces per crate)		
< GH¢ 10.00	5	8.3
GH¢10.00 – 20.00	38	63.3
GH¢21.00 – 30.00	10	16.7
> GH¢30.00	7	11.7
Total	**60**	**100**
Selling price of an adult quail		
< GH¢ 10.00	23	38.3
GH¢10.00 – 20.00	36	60.0
GH¢21.00 – 30.00	0	0
> GH¢30.00	1	1.7
Total	**60**	**100**

4.5. Constraints of Quail Farming

The survey showed that quail farmers in Ghana faced a number of constraints in the areas of production, transportation and marketing.

4.5.1. Production and management constraints

Production constraints identified by the farmers include adverse climatic conditions, necessity of incubators, lack and high cost of electricity and pecking among the birds. The major management challenge that confronted most quail farmers was pecking and cannibalism (Table 4.28; see Plate 4.14). Many of the farmers strongly agreed that quail

farming was alien to the poultry industry in Ghana hence most poultry farmers do not have the requisite knowledge and expertise in quail production and management.

Table 4.28: Major management challenges

Management challenge	Frequency	Percentage (%)
Adverse weather conditions (temperature variations)	6	10.0
Cannibalism and pecking/injuries	32	53.3
High noise	18	30.0
Cannibalism and pecking/injuries + high noise	4	6.7
Total	**60**	**100**

Plate 4. 14: Injuries caused by pecking among quails

Temperature variations and length of day were the major climatic factors that militated against quail production according to the survey, but the most serious one that confronted most farmers was variations in temperature (Table 4.29).

Table 4.29: Climatic factors that affect quail production

Climatic factors	Frequency	Percentage (%)
Temperature variations	42	70.0
Length of light	10	16.7
Temperature variation + light	8	13.3
Total	**60**	**100**

Incubators were major a production equipment used by farmers to hatch quails eggs. Majority of them strongly affirmed that incubators were very necessary in the hatching of quails chicks for all categories of quails; breeders, layers and broilers

4.5.2. Transportation and Marketing Constraints

The study showed that transportation was not a very serious challenge, but some of the farmers indicated that high transportation cost had adverse effects on their quail business as it affected price determination. Though most of the farmers were satisfied with the existing marketing systems in Ghana, majority of the farmers strongly indicated how low levels of education about the benefits of quail products and lack of government and institutional support were challenges that hampered successful quail farming in Ghana. Apart from these challenges, majority of the respondents affirmed that non-attractive

colours and short shelf life of quail eggs were serious challenges confronting the demand and sales of the eggs.

4.6. Prospects and Opportunities for Quail Production in Ghana

A whopping majority of respondents affirmed that quail business in Ghana is a sustainable venture (Table 4.30). According to the farmers, the relatively low cost of production; numerous health and nutritive benefits of the quail eggs; little space requirement of the birds; and the high resistance of the birds to a lot of diseases common among most poultry species were some of the prospects of the quail industry. Majority of farmers strongly alluded that quails require no special diet, hence most of them further strongly indicated that availability of feed for quails is not a problem. Majority of the farmers specified that they acquired inputs especially feed and equipment for quail production from the urban areas whilst the rest got their inputs from peri-urban and rural areas (Table 4.31).

Most of the respondents confirmed that they made profit from quail farming and further rated their profit as being very good, good and average. Generally, majority of the farmers indicated that quails have a short generation hence they started making profit from their flocks in less than one year of commencement of the business (Table 4.30).

Table 4.30: Prospects of the quail industry in Ghana

Characteristics	Frequency	Percentage (%)
Is the quail industry sustainable?		
Yes	58	96.7
No	2	3.3
Total	**60**	**100**
Do you make profit?		
Yes	50	83.3
No	10	16.7
How long does it take to begin making profit?		
1-2 years	4	6.7
< 1 year	56	93.3
Total	**60**	**100**
Profit rating		
Very good	18	30.0
Good	16	26.7
Average	16	26.7
Poor	1	1.7
N/A	9	15.0
Total	**60**	**100**

Table 4.31: Sources of farm inputs

Sources of farm inputs	Frequency	Percentages (%)
Urban areas	46	76.7
Peri-urban areas	9	15.0
Rural areas	4	6.7
Urban + peri-urban areas	1	1.6
Total	**60**	**100**

CHAPTER FIVE

5.0 DISCUSSION

5.1 Socio- Demographic Characteristics of Respondents

5.1.1. Sex and Age distribution of Respondents.

Unlike in Uganda (Nasaka *et al.*, 2017) and in Zimbabwe (Majoni *et al.*, 2018) where women were found to have more stakes in the quail rearing, commercial quail farming in Ghana is a male-dominant vocation as only a few women were engaged in quail rearing in the study area. This findings is however similar to findings obtained in selected areas of Bangladesh (Rahman *et al*, 2016) and Benin (Ekpo *et al*, 2020) where majority of quail farmers were males. The prevailing poor female participation in quail farming in Ghana could be attributed to the fact that males may have more propensity to want to venture into supplementary sources of income for livelihood and economic sustenance of their families. The demand and stress related to quail production could also be some contributory factors that deter women who may like to venture into quail farming.

Although various age groups of individuals were involved in quail production in Ghana, it is obvious from the findings that majority of the farmers were either young or middle-aged adults in their economically vibrant age. This could be because young and middle-age adults are more eager likely to adventure into a novel and quicker means of income generation venture such as quail farming. Also, this group of individuals are energetic and are more likely to cope with the physical stress related to quail production. Similar findings were reported in Kenya (Muthoni, 2014) and in Benin (Ekpo *et al*., 2020).

5.1.2. Level of education, marital status and year of establishment of quail farm.

All the respondents had some level of formal education, majority of whom had acquired tertiary education. This findings was similar to data obtained by Aliyu (2016) and Muhammad-Lawal *et al*. (2017), but varied from results obtained in the Kaduna State of Nigeria (Okusaga, 2016) which indicated that 59% of small holder quail farmers had no formal education. The situation in Ghana is a positive indication as one's level of education is necessary in the adoption of new innovations, adventures and effective management of some challenges that may arise from quail production and marketing.

The result further elucidates that commercial quail farming in Ghana started in 2012, which is almost at the period quail farming was introduced in other African countries such as Uganda and Kenya in 2010 (Tobiko, 2015), and Zimbabwe in 2011 (Mushava, 2016). Analysis of study further revealed that quail farming is still a novel poultry enterprise in Ghana compared with Nigeria (in 1992) and other African countries (NVRI, 1994) most of the quail farmers had less than five years of experience. This confirms earlier findings that quail farming is a novelty in the African continent (Moreki and Seabo, 2012; Moreki and Radikara, 2013). However there was an increasing trend in the number of farmers engaged in quail production, attaining the highest in 2017 but subsequently begun to decline (Table 4.3). Decline in the adoption rate of quail farming in Ghana could be ascribed to little awareness by most Ghanaians about quail and quail products as suggested by previous reearchers (Ayim, 2019).

5.1.3. Size of flock and income

Most of the quail farmers (66.7%) had a stock size of less than or equal to 1000 birds, whilst the rest kept more than 1000 birds on their farms. On the basis of scale of production, poultry farmers with flock size less than 2000 birds are said to be small-scale producers (Kusi *et al*., 2015; Okantah *et al*., 2003). This finding was in consonance with results obtained by Olorunfemi *et al*. (2016) who reported that majority of quail farmers were small-scale and medium-scale producers. The fact that most of the respondents did not have any form of external support in terms of capacity build (Table 4.5 and Table 4.6) could be the reason most of them could not expand their quail business into the medium and small scale production.

5.1.4 Regional Distribution of Respondents

Result from the survey suggests that Greater Accra Region had the greatest number of farmers involved in quail production representing 38.3% followed by the Ashanti Region with 20% of the sampled size used in this study. The cosmopolitan nature of most communities in Greater Accra and Ashanti Regions makes cost of living high hence might be the reason for the highest numbers of quail farmers recorded in those regions either to generate supplementary income or to serve as alternative source of livelihoods for people (Table 4.4). The findings from this research revealed that Upper East, Bono East and Bono regions had the least proportions (3.3% each) of farmers involved in quail farming and this could be attributed to low awareness about quails and its benefits coupled with lack of knowledge in quail production and management. This is because previous study (by Adam *et al*., 2010) affirms that livestock farmers'

adoption of new systems, practices or ideas is influenced by their level of awareness and knowledge of those systems and practices through extension contacts.

5.1.5. Training and other Support for Quail Farmers

A large number of respondents never had any form of capacity building before and after adoption of quail farming. It was therefore not surprising that the capacity needs assessment of the respondents revealed that many of them were lacking skills related to the quail production systems and management practices (Table 4.5 and Table 4.6). This revelation further elucidates why there is low participation of farmers in some regions of Ghana in the production of quail. Since quail production like any other poultry business is capital intensive and only a few (1.7%) of quail farmers had some financial assistance, this might contribute negatively to the number of farmers that can start and remain in the quail production business.

It was for this reason that majority (81.7%) of the quail farmers strongly indicated the need for external support especially skill capacity building in the areas of marketing, production management, modern technology, human relations and leadership; marketing and production management skills being the most important training needs (Table 4.6).

5.2. Production Systems and Management Practices of Quail Farming

5.2.1 Quail Housing Systems

The survey confirmed that majority (88.3%) of the quail farmers used the battery cage intensive system of quail housing where quails were kept in colony cages compared to

the deep litter housing system (6.7%). The quail farmers preferred to use the battery cage housing over the deep litter system because under the cage system, management of quails is easier, it reduces dust and ammonia gas accumulation, collection of eggs is easier, it reduces feed wastage and increased feed utilization efficiency (Tauson, 1998; Rajendran and Mohanty, 2003).

5.2.2. Feeding and Watering of Quails

Although homemade feed formulation and mixing has been reported in other parts of the world as an important cost-saving mechanism among poultry farmers (Kasule et al., 2014), a large proportion of quail farmers (68.3%) in Ghana used commercial chicken feed ration for feeding their quails, from the chick stage to the adult stage. It is also clear that only a few farmers (26.7%) used the appropriate commercial quail feed (supplied by Akropong Feeds and Stationary Limited in Kumasi) for feeding their birds and that homemade formulated ration constituted only 5% of feeds used by the farmers for commercial production of quails. It was revealed that most of the farmers used commercial chicken feed for feeding their quails due to the unavailability of appropriate commercial quail feeds. Some quail farmers however believed that quails require no special diet, hence the unavailability of commercial feed was not a problem. The use of chicken rations in feeding quails may however hamper optimum productivity in quails since quails require slightly higher crude protein (CP) levels (20%) for optimum egg production compared to that (17.43%) required by chicken (Leeson and Summers, 2005; Cambel, 1994).

The research further showed that quail farmers fed calculated quantities of feed to their birds at various frequencies. Majority of the farmers provided feed thrice a day (35%), some fed twice a day (23.3%) and the rest supplied feed to their quails *ad libitum* (35%). Feed intake per adult quail birds per day were recorded as follows: above 25 grams (25%), 25 grams (38.3%), 20 grams (28.3) and below 20 grams (8.3%). Feed rate records in Kenya were however slightly higher compared to findings obtained in Ghana from this study (48.8% of farmers recorded 30 grams, 27.4% recorded above 30 grams and 23.8% recorded below 30 grams of feed per day) (Muthoni, 2014).

The use of cheap and locally available non-conventional feed resources mainly of plant origin as potential cost reduction strategies and sources of energy, protein and essential vitamins in poultry including quails production has been well established in previous studies (Kasule et al., 2014; Chakrabarti *et al*., 2014; Swain *et al*., 2014). It is for these reasons that most (48.3%) of the quail farmers (compared with 37.2% obtained in Kenya; Muthoni, 2014) affirmed the use of non-conventional feed resources (NCFR) of plant origin such as bitter leaf, orange peels, mango bark, cabbage, watermelon fruits, dandelion leaves, Moringa leaves and cocoyam leaves for feeding their quails. These resources according to the farmers were either used as feed supplements or for prevention and treatment of various quail diseases and parasites.

The study also confirmed the use of various types of feeding and watering troughs in quail production. The types of feeding troughs used by the quail farmers include metallic (25%), plastic (51.7%), wooden (3.3%) and others (20%) while a distribution of farmers according to the type of watering troughs used include, metallic (11.7%) and plastic

(88.3%). The farmers' choices of the type and design of feeding and watering troughs were based on their availability, easiness to clean or wash and growth stage of the birds.

5.2.3 Species and breeds

A large proportion of respondents kept the Japanese quail breed ($P < 0.001$; $X^2 = 76.90$) although some few others reared the American quail and the Jumbo giant quail (Fig. 4.1). Most farmers preferred the Japanese quail to the other breeds because it is the most appropriate and tolerable quail breed for commercial meat and egg production under the intensive system of management (Rahman *et al*., 2016). Besides, the Japanese quail is a highly prolific breed that starts laying eggs at a very early age of 6-7 weeks and can lay up to 250-300 eggs per annum while the other quails start egg laying when they are 8-10 weeks old, producing only 150-200 eggs per annum (Bakoji *et al*., 2013). It was not surprising that many of the quail farmers were raising the Japanese quail since most farmers significantly ($P < 0.001$; $X^2 = 41.17$) kept layer quails for the main objective of egg production (Table 4.13).

Even though Aikins *et al*. (2019) established that the climatic and environmental factors in the Northern Region (guinea savanna ecological zone) of Ghana are very conducive for quail farming, this research however revealed that commercial quail production was predominant in the ecological zones in Southern Ghana (High Rainforest and Transitional zones) than those in Northern Ghana. The result specifically showed that the Greater Accra region (in Southern Ghana) had the highest population of quails, representing 40% of all the quails produced in the surveyed regions with up to 15% (9/60) of respondents in the region keeping a flock size of above 2000 birds per farm.

Further analysis revealed that Greater Accra and Ashanti regions (both in Southern ecological zones) had quail farmers with the largest flock sizes and cutting across all the categories (ranging from less than 200 birds to above 2000 birds). This suggests that the southern ecological zones of Ghana are very conducive for commercial quail production. It could also be attributed to the fact that Greater Accra and Ashanti regions are cosmopolitan in nature and therefore citizens are increasingly venturing into quail production every year as a survival or coping mechanism to the high cost of living in those cities.

5.2.4 Quail Egg Production

The survey revealed that for the purpose of producing fertilised eggs, a high proportion of the farmers kept male and female quails together in the same pen at an average male to female quail ratio of 1:3 while 30% of them produced both fertilised and unfertilised eggs and none produced unfertilised eggs only. Findings reported in Kenya suggested expounded a percentage distribution of quail farmers for production as 91.5% fertilised eggs, 5.5% unfertilised eggs and 3.0% both fertilised and unfertilised eggs (Muthoni, 2014). This current study however revealed a contrary findings as none of the farms visited produced table (unfertilised) eggs only. The practice of housing both male and female quails together in the same colony cages by quail farmers in Ghana seems to conform to recommended best practices worldwide as stocking ratios of male to female of 1:2 and up to 1:5 quails kept in colony cages are desirable for improving upon their genetic makeup (Narinc *et al.*, 2013; Priti and Satish, 2014).

The findings further showed that most of the layer quail farms recorded lower hen-day production compared to findings in other parts of the world which suggest that the Japanese quail when given the right energy and protein levels can record hen-day production of up to 90% (Ratriyanto *et al*., 2018). Perhaps the lower hen-day production recorded in this study may be due to the fact that farmers used the commercial chicken feed which had lower CP and energy levels and provided less than the daily recommended rations to their laying quails as only a few of them fed their birds ad libitum (Fernandez *et al.*, 2018). The survey also indicated that a large proportion of egg laying was recorded in the evening or night hours from 15:00 hours till night (19:00 hours) during which egg collection was done and this agrees with findings by Fernandez *et al.* (2018). Observations from the survey revealed that quail farmers collected and stored eggs in egg trays and other containers before they were either set in incubators for hatching or packaged in cartons and sold to consumers or better still, processed into other finished industrial products.

5.2.5. Breeding and Sex Identification of quails

i. Source of Breeding Stock

In conformity with earlier research findings which suggested that the domestic quail has lost its brooding instinct (Mohammed and Ejiofor, 2015; Arya *et al*., 2018) and the desire to breed quails in commercial quantities, majority of the farmers acquired their breeding stock by hatching the chicks by themselves using incubators. A few others however purchased either day-old chicks or 2 weeks old chicks. This is in sharp contrast with results obtained in a similar study

by Muthoni (2014) that suggested that 73.8% of farmers in Kenya acquired their breeding stocks by purchasing 2 weeks old chicks and 24.4% of them obtained their stock by using incubators. Quail farmers in Ghana from this study may have adopted the use of incubator to hatch their own eggs due to the high cost of day-old quail chicks and 2 weeks old chicks. This confirms why the farmers indicated the necessity of incubators in quail production as a challenge especially for beginner farmers due to high purchasing and running costs of such machines.

ii. Sex identification of quails

The study further expounded that most quail farmers in Ghana could distinguish between male and female quails by themselves especially when the birds were 3 weeks old. The farmers used various identification features to distinguish between the male and female quails. One prominent identification feature was that male Japanese quails at sexual maturity were observed to possess bulgier cloacae than the females, and their cloacae also discharged white foaming semen when pressed between fingers. Other features farmers used to distinguish male quails from their female counterparts have been tabulated in the preceding chapter (Table 4.18). These sex determination procedures agree with features established by earlier research findings (Vali, 2008; Singh *et al*., 2011; Shit *et al*., 2010) and was applied by individual determine the male to female stocking ratio housed in the same cage for fertilised egg production.

iii. Brooding of quail chicks

Electricity (electrical bulb) emerged as the major sole source of heat and light for majority of respondents for brooding and rearing of quail chicks. A few of the farmers who did not have access to electricity or wanted to reduce cost of brooding however used charcoal and kerosene lanterns in brooding of chicks. This finding is in consonance with earlier publications that suggested that electricity was the major source of heat and light for quail brooding (Muthoni, 2014).

5.2.6. Farm labour and records keeping

The findings showed that quail farmers relied on family members as their major sources of labour on their farms. The use of family labour in quail management in Ghana confirms the suggestions that quail farming is considered a backyard/family poultry business in many countries (Sonaiya and Swan, 2004). Besides, since quail is a small bird and can easily be housed in a small space under multitier colony cages (Monika *et al*., 2018), and the fact that more than half of the respondents were small-holder quail farmers (<1000 birds) suggest that most of the farmers wanted to reduce labour cost by engaging paid family members instead of hired labour who were not relatives.

The research further pointed out that farmers kept records of various farm activities such as mortality, purchasing, sales, egg production, incubation and hatchery, incidence of diseases and medications, and feeding. There was a significant association between some specific socio-economic characteristics (age and education) and the record

keeping (X^2 = 68.67). These findings corroborated reports by Muhammad-Lawal *et al*. (2017) who posited that age and level of education were essential socio-economic characteritcs who found a significant relationship between some selected socio-economic characteristics as they define the availability, effectiveness and efficiency of human resource for daily farm activities such as record keeping. The inability of respondents over 40 years to keep farm records could be attributed to their extra family and social responsibilities which may affect their time available for full routine farm activities. There was also significant relationship from the results between record keeping and educational level of respondents (P < 0.001).

5.2.7. Diseases and parasites

This study confirmed assertions made by Cambel (1994) and Chakrabarti *et al*. (2014) that quails are resistant and therefore less susceptible to most poultry diseases and parasites. The most prevalent disease identified by farmers was Coccidiosis and Infectious Coryza with a mortality rate of less than 10% mainly at the chick stage. This result was similar to findings reported by Muthoni (2014) but varied from findings by Rahman *et al*. (2016) that identified Diarrhoea as the most prevalent diseases followed by Pneumonia, Infectious Coryza and Newcastle disease among others. According to El-Demerdash *et al*. (2013), high mortality among day-old quail chicks may be attributed to respiratory disorders in their first week from hatching, but this challenge may be overcome after the first week with proper management practices.

The findings further revealed that majority of farmers used drugs for treatment of quail diseases and others observed biosecurity protocols whilst a few others adopted proper feeding regimes as control measures for diseases and parasites. However, since there were no approved medications and vaccines in the market for quails (Dozier *et al.*, 2010), treatment of specific quail diseases in Ghana by farmers had been on experimental basis as they had no other options than to rely on drugs meant for chicken and other poultry species. Good management practices such as regular cleaning and disinfection as well as proper feeding, which some farmers had adopted, were therefore essential in the control and prevention of quail diseases and parasites. This practice seemed to be very useful since a large number of the farmers had recorded very low mortality rates.

5.3. Nutritive and medicinal benefits of quail eggs and meat.

Although, there is no available scientific and industrial research findings in Ghana on the medicinal and nutritive value of quail products (eggs and meat), findings from this research established that the fundamental purpose for which many farmers went into quail production was due to the medicinal and nutritive values of the bird. Majority of the respondents further testified that quail eggs in particular were very effective for the treatment of various diseases including stomach ulcers, asthma, kidney stones, diabetes, high and low blood pressures, anaemia among children and pregnant women, prostate cancer, sexual impotency and infertility in men and various skin conditions such as rashes, boils, eczema and pimples. These claims may be correct as earlier researchers (Tuleun *et al.*, 2011; Campos *et al.*, 2013; Tunsaringkarn *et al.*, 2013; Douglas, 2013;

Tolik *et al*., 2014; Sathiya *et al*., 2017; Umera *et al*., 2018) confirmed that quail meat and eggs have high quality protein of high biological importance, little fat content and less bad cholesterol and these qualities make quail eggs the most preferred choice products for hypertensive patients, body and brain development among children, for treatment of asthma, tuberculosis and diabetes, and for prevention and removal of kidney, liver and gallbladder stones. It was for those reasons that a lot of the respondents admitted they have been consuming some of the quail meat and eggs from their farms with their family members and friends in order to supplement their dietary needs. This perhaps explains why most of the respondents earned low monthly gross income (≤ 1,000.00 Ghana Cedis) from their farms as they might have given the eggs to relations at little or no cost at all. A few others however went into quail production as a form of business mainly for income generation purpose and this category of farmers may include those who earned monthly gross income of between GH¢1,001.00 and GH¢9,000.00 (Table 4.3).

5.4. Influence of market access to quail production

Similar to reports from previous study, market structure of quail eggs in Ghana is unstructured and a relatively '*loose'* system (Arthur, 2013). The research revealed that prices of quail eggs in Ghana ranged from GH¢10.00 to 20.00 per tray of 30 pieces of eggs, whilst an adult quail was sold at GH¢10.00 to GH¢ 20.00 (Table 4.27). A large number of the respondents however affirmed previous report by Ayim (2019) that the demand for quail products was low despite their acclaimed health and nutritional

benefits. This was not surprising since most of the respondents could not grow their farms from small to medium and large scale holdings.

In order to improve market access and remain in business, most of the quail producers, had to create their own markets through various market promotions strategies from the farm gate to the consumers. Some few quail farmers therefore relied on poultry feed shops and unregistered Farmers Associations to assist them in the advertisement (by distributing leaflets, charts, and sampled products, etcetera) and also served as sales outlets for quail eggs and other products. This study confirms earlier reports by Arthur (2013) and Muthoni (2014) which stated that in quail marketing systems, individual farmers have to look for various strategies of selling their products. These strategies seem to be working well as more than half of the farmers confirmed that their eggs were often sold out in less than 7 days from laying (Table 4.26). In order to increase the shelf life of the eggs that kept longer than a week, some farmers have adopted some value addition strategies such as processing them into quail egg powder and capsules, quail egg oil, quail egg ointment and quail egg soap (Plate 4.11 and Plate 4.12) whilst the meat is processed into khebab, grilled, smoked and frozen meat. Similar findings were reported in other countries by Muthoni (2014) Arthur (2013) that suggested that customers that patronised quail eggs include individuals (for personal consumption) or retailers who buy at the farm gates, supermarkets, hotels and brooders. However, although there was no organised market for quail products like that of chicken meat and eggs (Ahmed, 2008), it appears performance of the current market systems of quail eggs in Ghana seemed satisfactory compared to Kenya (an African country) where majority

(51.8%) of producers could keep their eggs up to a period of two weeks before sales due to poor markets (Muthoni, 2014).

5.5. Constraints of Quail Farming

Findings from this study suggest that quail farmers in Ghana were faced with a number of constraints in the areas of production, transportation and marketing.

5.5.1. Production constraints

Production constraints identified by the respondents included adverse climatic conditions, necessity of incubators, lack and high cost of electricity and cannibalism among the flocks. Cannibalism (pecking) was considered the major production challenge that confronted most quail farmers. According to Redoy *et al*. (2017) and, Bolla and Randall (2012), various kinds of cannibalism exist in quails kept together in cages (colony cages) but the most common one was nose pecking. This study however observed that the most common form of cannibalism which was a challenge to most respondents was feather pecking, head pecking and neck pecking (Plate 4.14). The effect of cannibalism in quails was that, the more aggressive birds pecked at the feathers of their victims, the flesh is exposed and the victims may bleed excessively and die or become permanently deformed and rendered unproductive and therefore had to be culled. The study revealed that underfeeding, nutritional and mineral deficiencies, overcrowding, insufficient feeder or drinker space and high ambient temperatures were conditions that may have resulted in cannibalism among the birds (Redoy *et al*., 2017).

The major climatic factors identified by farmers were temperature variations and length of light but the most serious one was variations in temperature (Table 4.29). According to the farmers, high ambient temperature reduces feed intake, laying performance and increase pecking among birds. This assertion agrees with Redoy *et al*. (2017) whose findings explained that quails are much affected by temperature changes and may therefore require artificial heat and temperature management especially from day-old up to 14 to 21 days old.

Since previous studies have established that the domesticated quail has lost its nesting and brooding instinct and has no tendency for brooding (Mohammed and Ejiofor, 2015; Arya *et al*., 2018; Noman, 2018), the only way to hatch quail chicks in commercial quail farming was by the use of artificial incubators. Therefore, a large proportion of the farmers strongly affirmed that incubators were very necessary in all the categories of quails; breeders, layers and broilers. The use of incubators however was dependent on electricity which was erratic in supply and unavailable in some deprived farming communities. Where electricity was available, was not cost effective the quail farmers since majority of them were backyard/small-scale holders.

5.5.2. Marketing and Transportation Constraints

Unlike in other countries such as Japan and France which have the largest market for quail eggs and meat respectively (Perennou, 2009), the market opportunities of quail in general and Ghana in particularly was very limited and unstructured compared to chicken and other poultry (Arthur, 2013). Although some of the farmers were quite

satisfied with the existing marketing system they have created by themselves, various marketing constraints were identified from this study. For instance, majority of the farmers lamented how low levels of awareness about the benefits of quail products coupled with perceived non-attractive colours of the eggs were hampering demand and sales of quail eggs and meat as quail eggs appeared alien to most Ghanaians. In consonance with findings by Norman (2018), this study revealed that some Ghanaians upon their first sight of quail eggs described the eggs as the "*eggs of snake"* due to their miniature size and mottled color (multi pigmented nature) and this made them lost interest in buying the eggs. Similar to research findings obtained elsewhere in Kenya, Zimbabwe and Bangladesh (Majoni *et al*., 2018; Muthoni, 2014; Noman, 2018), majority of the respondents believed that lack of government and institutional support contributed negatively to the low patronage of quail products in Ghana.

Furthermore, most of the respondents bemoaned that the fertilised eggs which majority of them produced easily got bad especially when demand due to poor demand as most of the respondents did not have incubators to hatch their eggs into chicks. This study confirms previous reports that suggested that quail eggs have a maximum shelf life of 14 days in storage at room temperature (Imai *et al*., 1984) unless they are kept under refrigeration at 4^{o}C (Sanchez *et al*., 2009). Another marketing challenge that confronted most respondents was the high cost of transportation of farm inputs to the farm and products to the marketplaces and that affected the quail business in the country as many of the farmers acquired their production inputs especially feed and equipment from the urban areas while the rest got their inputs from peri-urban areas.

The farmers identified the need to intensify awareness creation especially at all public gatherings on the health and nutritional benefits of using quail eggs and other products in order to mitigate these challenges and improve market access. This was possible because according to El-Katcha *et al*. (2015), marketing challenges can be overcome by increasing the level of awareness on the health and nutritional value of quail eggs. This would become more effective if government through the Ministry of Food and Agriculture (MOFA) could give official recognition and promotion to quail farming and marketing in Ghana just like any other traditional poultry species.

5.6. Prospects and Opportunities for Quail Production in Ghana

Results from the research has demonstrated that there is a brighter future for the quail industry in Ghana. A large proportion of respondents believed that quail business is a sustainable venture especially if the challenges that confront quail production and marketing are addressed. The advantages of the quail bird over chicken and other poultry species support the assertion from this study that the quail industry has a brighter future in Ghana. These include its low cost of production (Redoy *et al*., 2017); the numerous health and nutritive benefits of quail eggs; the little space required to start raising quails; and the ability of the bird to tolerate a lot of diseases that affect most poultry species (Monika *et al*., 2018). The short generation intervals of quails and the fact that most farmers could begin to make profit from quail farming in less than a year give implies that quail production has the potential of addressing the nutritional and economic deficiencies in the country if taken seriously (Ani and Adiegwu, 2005; Mohammed and Ejiofor, 2015; Rajendran and Mohanty, 2003).

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Based on the findings of this study, the ensuing conclusions can be drawn:

- Commercial quail farming in Ghana started in 2012 with majority (73.3%) of farmers having less than five years of experience in the business. More males (86.7%) were involved in quail rearing than females (13.3%).
- Three major breeds of quails (Japanese quail, American quail and Jumbo giant quail) are identified in Ghana but the most common breed for under production was the Japanese quail due to its prolificacy and ability to tolerate the intensive management system for commercial egg production.
- Quail production is concentrated in the ecological zones in Southern Ghana, precisely in the Greater Accra and Ashanti Regions with a cumulative percentage of 58.3% farmers. Upper East, Bono East and Bono regions had the least proportions of farmers involved in quail farming (3.3% each).
- Averagely 50% of quail farmers in Ghana had their flock sizes ranging between 501 and 2000 birds, and Greater Accra region was the leading producer of quails with a flock size of above 2000 birds per farmer.
- All quail farmers in Ghana practiced the intensive system of production. Majority (88.3%) of the farmers used the colony battery cage system of housing, most (70%) of whom kept both male and female quails together in the same pen.

- Most of the layer quail farms recorded a percentage hen-day production of between 61-70% with majority (80%) of egg laying recorded in the evening or night hours from 15:00 hours till night (19:00 hours).
- Quail farmers used various identification features to distinguish between the male and female quails but the most prominent feature was that male Japanese quails were observed to possess bulgier cloacae than their female counterparts, and their cloacae also discharged white foaming semen when pressed between fingers.
- The most prevalent quail diseases in Ghana were Coccidiosis (45%) and Infectious Coryza (11.7%) whilst ectoparasitism and endoparasitism constituted 16.7% and 10.0% respectively of farms visited. Mortality rate of less than 10% was detected in most farms (76.6%), which was common among quail chicks.
- Despite 85% of quail farmers in Ghana were aware of veterinary services for quails, majority (66.7%) of them did not have access to veterinary services and therefore had to rely on information from the internet for self-medication in controlling quail diseases and parasites.
- The research also established a claim that quail eggs and meat contain some nutritive and health values that are effective in treating various health conditions including stomach ulcers, asthma, kidney stones, diabetes, high and low blood pressures, anaemia among children and pregnant women, prostate cancer, sexual impotency and infertility in men and various skin conditions such as rashes, boils, eczema and pimples.

- Cannibalism (pecking) was identified as the major production challenge confronting most (53.3%) quail farmers. The most common form of cannibalism was feather pecking, head pecking and neck pecking.
- Low levels of awareness about the benefits of quail products and perceived non-attractive colours of the eggs were major marketing challenges hampering demand and sales of quail eggs.
- There is a brighter future for the quail industry in Ghana if the challenges confronting quail production and marketing are addressed since quails need relatively low capital investment in terms of feeding and housing. Also, quail production has a short generation period, thus profitable in less than one year after start of business.

6.2 Recommendations

In order to address the constraints in the quail industry, improve upon quail production and make it more sustainable in Ghana, the following recommendations were proposed:

- The universities, the Centre for Scientific and Industrial Research (CSRI) and other relevant research institutions should clear doubts in the minds of consumers and the general public by conducting an in-depth study to ascertain the health and nutritive benefits of quail eggs and recommend same for inclusion in nutrition and health promotion programmes.
- Quail farmers need to form vibrant Farmers Associations to enable them work together to access skill development programmes and support each other to advertise, create awareness and market their products.

- Individuals, pharmaceutical and other companies should invest into value addition of quail meat and eggs by processing them into medicines, nutrient supplements and other less perishable and more valuable products compared to the raw eggs which have relatively short shelf life.
- The Animal Production Directorate and the Veterinary Services Division of the Ministry of Food and Agriculture should give official recognition and promotion to quail farming just like any other traditional poultry species through the necessary research, training and other support services.
- Quail is a highly prolific bird with numerous economic, health and nutritive benefits, and if these benefits are confirmed by the relevant research institutions, the Government of Ghana should include quail production in its Rearing for Food and Jobs flagship policy. More women should be encouraged and supported to engage in quail farming.
- For optimum performance in quail productivity, further study should be conducted to establish nutrient requirements for quails in the country.

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APPENDICES

APPENDIX I:

QUESTIONNAIRE FOR QUAIL FARMERS IN GHANA

Introduction

I am Samuel Azebadumah Akarikiya, an MPhil (Animal Science) student at the University for Development Studies, Nyankpala Campus. As part of my MPhil research thesis, I am conducting a survey that investigates ***quail production systems, prospects and constraints in Ghana***. This questionnaire is therefore designed to solicit information from you about your knowledge and experiences in quail farming. Please tick in the appropriate boxes and also fill in the blank spaces provided for those questions where elaborate answers are required. You are required to complete this questionnaire as honestly and objectively as possible. Thank you.

Section A: Personal Data

Please indicate by ticking [√] where appropriate.

1. Gender: (i) Male [ ] (ii) Female [ ]
2. Age (in years): (i) 20 and below [ ] (ii) 21 -30 [ ]
   (iii) 31 -40 [ ] (iv) 41 -50 [ ] (v) 51 and above [ ]
3. Marital status: (i) Never married [ ] (ii) Married [ ] (iii) Widowed [ ] (iv) Divorced [ ]
4. Address:

   Postal……

   Mobile phone……

5. What is your educational level? (i) Never being to school [ ] (ii) Basic [ ] (iii) Senior High/Tech [ ] (iv) Tertiary [ ] (v) Non Formal [ ]
6. How much do you earn from quails per month? GHS ……(approximate)

Section B: Production Systems and Management Practices

7. When did you establish your quail farm? …….
8. What was your initial flock size? (i) Less done 100 birds [ ] (ii)100–200 birds [ ] (iii) 201- 300 birds [ ] (iv) 301-500 birds [ ] (v) Above 500 birds [ ]
9. What is your present flock size?
   (i) None [ ] (ii) Less than 200 birds [ ] (iii) 201 – 500 birds [ ] (iv) 501 -1000 birds [ ]
   (v) 1001-2000 birds [ ] (vi) 2001-3000 birds [ ] (vii) Above 3000 birds [ ]
10. What is the source of labour you engage? (i) Family members [ ]
    (ii) Permanent hired labour [ ] (iii) Casual labour [ ] (iv) Contract labour [ ] (v) Others, specify…….
11. How many workers do you currently engage on your farm?
    (i) Less than 5 [ ] (ii) 5-10 [ ] (iii) 11-20 [ ] (iv) above 20[ ] (v) None [ ]
12. What type of quail housing do you have? (i) Deep litter [ ] (ii) Individual cages [ ] (iii) Colony battery cages [ ] (iv) Backyard fencing [ ] (v) Others (specify)……
13. What type of lighting and heating systems do you use for brooding of quail chicks?
    (i) Electricity [ ] (ii) Charcoal [ ] (iii) Lanterns (iv) Others, specify……
14. What type of feed do you give to your quails? (i) Chicken feed [ ] (ii) Standard quail feed [ ] (iii) Others (Specify)…….

15. Where do you get your feed from? (i) Commercial feed shops [ ] (ii) Homemade []

    (iii) Others (Specify)……..……

16. What type of feeding troughs do you use for your quail farm?

    (i) Metallic [ ] (ii) Plastic [ ] (iii) Wooden [ ] (iv) Concrete [ ] (v) Others (specify)..

17. How often do you feed your quails per day?

    (i) Once [ ] (ii) Twice [ ] (iii) Trice [ ] (iv) Ad libitum [ ]

18. What quantity of feed do you give to each quail per day?

    (i) Below 20g [ ] (ii) 20g [ ] (iii) 25g [ ] (iv)Above 25g [ ]

19. Do you give non-conventional feed resources (NCFR) to your quails?

    (i) Yes [ ] (ii) No [ ]

20. If yes to Q19 above, specify which type …….....

21. What is the reason for giving the NCFR named in question 20 above to your quails?

    (i) As supplement [ ] (ii) As replacement [ ] (iii) As medicine [ ] (iv) Others…...

22. What type of drinkers do you use for your quail farm?

    (i) Metallic [ ] (ii) Plastic [ ] (iii) Wooden [ ] (iv) Concrete [ ] (v) Others (specify)..

23. How often do you provide/change drinking water in a day?

    (i) Once [ ] (ii) Twice [ ] (iii) Thrice [ ] (iv) Never [ ]

24. What breed of quail do you keep?

    (i) American quail [ ] (ii) Japanese quail [ ] (iii) Others (specify) ……

25. How do you get your breeding stock? (i) Using brooding hen [ ] (ii) Using incubator

    [ ] (iii) Purchasing day old chicks [ ] (iv) Purchasing 2 weeks old chicks [ ]

26. What categories of quail do you keep?

(i) Layers [ ] (ii) Broilers [ ] (iii) Breeders [ ] (iv) All the above [ ]

27. If broilers to Q26 above, at what age do you sell your broiler quails?

(i) 4weeks [ ] (ii) 5weeks [ ] (iii) 6 weeks [] (iv) 7 weeks [ ] (v) Above 7 weeks [ ]

(vi) I have not sold any yet [ ]

28. If layers to Q26 above, what type of eggs do you produce from your quails?

(i) Fertilised [ ] (ii) Unfertilised [ ] (iii) Both [ ]

29. Do you process your eggs or meat into any product(s)?

(i) Yes [ ] (ii) No [ ]

30. If yes to Q29, name the product(s)

Meat products: …….

Eggs products: …….

31. Do you rear male and female quails in different housing? (i)Yes [ ] (ii) No [ ]

32. Who does the sexing of your quails?

(i) Trained chicken sexers [ ] (ii) Hatcheries [ ] (iii) Self [ ]

33. At what age from hatching are you able to distinguish between male and female quails?

(i) Day old [ ] (ii) 2weeks old [ ] (iii) 3-5weeks old [ ] (iv) At least 6weeks old [ ]

34. What criteria do you use to distinguish between male and female quails?

……
……
……

35. What is the average age from hatching at which your quails begin to lay eggs?

(i) 4 weeks [ ] (ii) 5 weeks [ ] (iii) 6 weeks [ ] (iv) 7weeks [ ] (v) Above 7 weeks [ ]

36. Which period of the day does egg laying mostly occur?

(i) Before 09hrs [ ] (ii) 09hrs -12hrs [ ] (iii) 12hrs -15hrs [ ] (iv)15hrs till night [ ]

37. What quantity of quail eggs do you collect in a day?

    (i) 0- 10 crates [ ] (ii) 11-20 crates [ ] (iii) 21-30 crates [ ] (iv) 31-40 crates [ ]

    (v) Above 40 crates [ ]

38. What is the average percentage hen-day in your farm? (i) At most 60% (ii) 61-70%

    [ ] (iii) 71- 80% [ ] (iv) 81-85% [ ] (v) 86- 90% [ ] (vi) Above 90% [ ]

39. In your opinion, what are the factors to be considered in order to get the optimum

    egg yield percentage in your farm?

……
……
……

40. Have you ever received any external support on your quail farming? (i) Yes [ ] (ii)

    No [ ]

41. If yes, what kind of support have you received? (i) Monetary [ ] (ii) Training [ ]

    (iii) Inputs [ ] (iv) Others (specify)……..……..

42. If training, what kind of skills have you acquired?

    (i) Production management skills [ ] (ii) Processing skills [ ] (iii) Marketing skills

    [ ] (iv) Technological skills [ ] (v) Leadership skills [ ]

43. Which organisation or agency has given you the support? (i)Government agency []

    (ii) Marketing Associations [ ] (iii) NGOs [ ] (iv) Others (specify)…...……

44. Are you aware of any veterinary services for quail health maintenance?

    (i) Yes [ ] (ii) No [ ]

45. If yes, mention the source(s) of veterinary information.

(i) Radio [ ] (ii) Newspapers [ ] (iii) Internet [ ] (iv) Vet officers [ ] (v) Others (specify)…

46. Which of the following diseases affect your quails?

(i) None [ ] (ii) Quail bronchitis [ ] (iii) Haemoprotus infection [ ] (iv) Ulcerative enteritis [ ]

(v) Coccidiosis [ ] (vi) Others (specify)……

47. Which of the following parasites affect your quails? (i) None [ ] (ii) Worms [ ]

(iii) Lice [ ] (iv) Mite [ ] (v) fleas [ ] (vi) Others (specify)……..…

48. Who treats your quails diseases and / or parasites?

(i)Veterinary officers [] (ii) Community Livestock Health Workers [] (iii) Self [ ]

(iv) Others (specify)……

49. Do you record any mortality of quail on your farm? (i) Yes [ ] (ii) No [ ]

50. If yes to question Q49, at which stage do you observe the mortality or death of quails?

(i) Chicks (DOC-2 weeks) [ ] (ii)Growers (3-5) [ ] (iii) Layers/broilers (6 weeks and above) [ ]

51. How many quails died in the past 8 weeks? (i) less than 5% [ ] (ii) 5 - 10% [ ]

(iii) 11-20% [ ] (iv) 21-30% [ ] (iv) 31-40% [ ] (v) Above 40% [ ] (vi) None [ ]

52. Which disease control strategy do you use most?

(i) Vaccination [ ] (ii) Treatment with drugs/herbs [ ]

(iii) Good sanitation/ regular disinfection [ ] (iv) Good feeding regime [ ]

53. Which of these is a major management challenge to you?

(i)Cannibalism [ ] (ii) Pecking/injuries [ ] (iii) Temperature variations [ ] (iv) High noise [ ]

54. How do you get general information on quail farming?

(i) Extension services [ ] (ii) Radio [ ] (iii) Newspaper [ ]

(iv) Local meetings /social media [ ] (v) Neighbours [ ] (vi) Internet [ ] (vii) Phone calls [ ]

55. What is the price per day old chick (GH¢)?

(i) Less than 2.00 [ ] (ii) 2.00-3.00 [ ] (iii) 4.00 -5.00 [ ] (v) More than 5.00 [ ]

56. What is the price per one/two weeks old chick (GH¢)?

(i) Less than 3.00 [ ] (ii) 3.00-5.00 [ ] (iii) More than 5.00 [ ]

57. What is the cost of feed per bird per month (GH¢)?

(i) Less than 5.00 [ ] (ii) 5.00-10.00 [ ] (iii) 10.10-15.00 [ ] (iv) Above 15.00 [ ]

58. What is the cost of labour per bird per month (GHS)?

(i) Less than 1.00 [ ] (ii) 1.01-1.75 [ ] (iii) 1.76-2.00 (iv) Above 2.00

59. What is the cost of medication per bird per month (GH¢)?

(i) Less than 1.00 [ ] (ii) 1.01-1.75 [ ] (iii) 1.76-2.00 (iv) Above 2.00 [ ]

60. What is the cost of production per egg (GH¢)? (i) Less than 0.10 [] (ii) 0.10-0.25 [] (iii) 0.26-0.75 [ ] (iv) 0.76-1.00 [ ] (v)Above 1.00 [ ]

61. Do you keep any records on your farm? (i) Yes [ ] (ii) No [ ]

62. If yes to Q61, name the types of farm records kept

……
……
……

63. If no to Q61, explain why?

……..

64. What in your opinion are the advantages of quail rearing over chicken or other poultry farming?

……
……
……

65. Do you agree the following environmental factors affect egg production on your farm?

REASONS	SA	A	N	D	SD
i. Temperature regulation in hot days					
ii. Seasonal diseases					
iii. Farm ventilation					
iv. Any other (specify)……					

66. Rank the environmental factors which affect the poultry egg production in *your farm.*

S/N	ENVIRONMENTAL FACTORS	RANK			
		1	2	3	4
i.	Temperature regulation in hot days				
ii.	Seasonal diseases				
iii.	Farm ventilation				
iv.	Any other (specify)……				

67. Do you agree the following farm management factors affect egg production on your farm?

MANAGEMENT FACTORS	SA	A	N	D	SD
(i) Feed quality					
(ii) Quality of chicks					
(iii) Medical care					
(iv) Bio security / sanitary practices					
(v) Farm input management					
(vi) Timing of feeding					
(vii) Any other (specify)……					

68. Please rank the farm management factors which affect quail production in your farm.

S/N	MANAGEMENT FACTORS	RANK						
		1	2	3	4	5	6	7
i.	(i) Feed quality							
ii.	(ii) Quality of chicks							
iii.	(iii) Medical care							
iv.	(iv) Bio security / sanitary practices							
v.	(v) Farm input management							
vi.	(vi) Timing of feeding							
vii.	(vii) Any other (specify)……							

Section C: Perceived Nutritive and Medicinal Values

69. What was your main initial purpose for going into quail farming?

(i) Income generation [ ] (ii) Nutritive value [ ] (iii) Medicinal value [ ]

(iv) Entertainment / hobby [ ] (v) Others (specify) ……

70. Do you eat any of the quail products? (i) Yes [ ] (ii) No [ ]

71. If yes which of the products do you consume more? (i) Eggs [ ] (ii) Meat [ ] (iii) Others……

72. In your opinion, do quails eggs have special health or nutritional values? (i) Yes [ ]

(ii) No [ ]

73. Which of the following diseases have you heard that quail eggs can treat?

DISEASE	TICK APPROPRIATELY
(i) Ulcers	
(ii) Asthma	
(iii) Kidney stones	
(iv) Skin condition	
(v) Anaemia	
(vi) Sexual impotency	
(vii) Cancer	
(viii) Heart condition	
(ix) Diabetes	
(x) Others, specify	

74. Do you think quail eggs are effective in treating the diseases you confirmed in Q73 above? (i) Yes [ ] (ii) No [ ] (iii) Not sure[ ]

Section D: Market Access

75. Do you face any constraints in marketing your quail and quail products?

(i) Yes [ ] (ii) No [ ]

76. If yes, how would you rate the constraints you experience when marketing your quails? Please indicate with a **tick** in the Table below of those challenges as very serious, serious and not serious.

CONSTRAINT	VERY SERIOUS	SERIOUS	NOT SERIOUS
Low Prices			
Lack of market information			
Reliability of the market			
Long distance to the market			
Presence of retailers			
Low volumes purchases			
Others (specify) ……			

77. What are the current selling prices (in GH¢) per bird / crate of eggs?

    Eggs (crate): (i) less than 15 [ ] (ii) 15-20 [ ] (iii) 21-25 [ ] (iv) 25-30[ ] (vi) above 30 [ ]

    Adult quail: (i) Less than 10 [ ] (ii) 10-20 [ ] (iii) 21-30 [ ] (iv) More than 30 [ ]

78. Which category of buyers do you sell your eggs to? (multiple answers are allowed)

    (i) Individuals consumers [ ] (ii) Hotels [ ] (ii) Supermarkets [ ] (iii) Retailers [ ] (iv) Brooders [ ]

79. How long do you keep quails eggs before selling?

    (i) Less than 7 days [ ] (ii) 7-14 days [ ] (iii) more than 14 days [ ]

80. What types of organisations have been assisting you to market your quails and quail products? (i) None [ ] (ii) Government agencies [ ] (iii) Marketing Associations [ ]

    (iv) NGOs [ ] (iv) Others specify…..……

81. What kinds of assistance do the organisations named in Q80 above offer?

    (i) None [ ] (ii) Extension services [ ] (iii) Marketing Services [ ] (iv) Others specify…….

82. In your opinion, which two ways can market access be improved?
    ……..……
    ……

Section E: Constraints in Quail Farming

Production Constraints:

83. Which of the following climatic conditions affect your quail business most (e.g. egg yield percentage, growth rate of chicks, seasonal diseases, etc.)? (i) Light [ ]

(ii) Temperature variations [ ] (iii) Relative humidity [(iv) Wind speed and direction [ ]

84. In your opinion, do you consider the following factors as constraints to quail production in Ghana? **SA** – Strongly Agree; **A** – Agree; **N** – Neither Agree nor Disagree; **D** – Disagree; **SD** – Strongly Disagree.

CONSTRAINTS		**SA**	**A**	**N**	**D**	**SD**
(i)	High cost of feeds and concentrates					
(ii)	Lack of knowledge in quail farming					
(iii)	Poor quality day old chicks resulting in high mortality rate.					
(iv)	Poor hatchability of quail eggs					
(v)	Necessity of incubators to hatch quail eggs					
(vi)	Lack of electricity					
(vii)	Any other (specify)….....					

85. Please rank the factors you considered as quail production constraints in Q84 above.

S/N	**CONSTRAINTS**	**RANK**						
		1	2	3	4	5	6	7
(i)	High cost of feeds and concentrates							
(ii)	Lack of knowledge of quail farming							
(iii)	Poor quality day old chicks resulting in high mortality rate.							
(iv)	Poor hatchability of quail eggs							
(v)	Necessity of incubators to hatch quail eggs							
(vi)	Lack of electricity							
(vii)	Any other (specify).....							

Transportation and Marketing Constraints:

86. How do you transport eggs from your farm to market place? (i) Own vehicle [ ]

(ii) Dealers' vehicle [ ] (iii) Hired vehicle [ ] (iv) Others

(specify)……..……

87. What is your level of satisfaction with the existing methods/systems of quail and quail eggs marketing? (i) Highly satisfied [ ] (ii) Satisfied [ ] (iii) Neutral [ ] (iv) Dissatisfied [ ]

(v) Highly dissatisfied [ ]

88. In your opinion do you consider the following as transport and marketing constraints to the quail industry in Ghana? **SA** – Strongly Agree; **A** – Agree; **N** – Neither Agree nor Disagree; **D** – Disagree; **SD** – Strongly Disagree.

CONSTRAINTS		**SA**	**A**	**N**	**D**	**SD**
(i)	Lack of awareness and information about the advantages of eating quail meat and egg.					
(ii)	Lack of Government influence/support					
(iii)	Non-attractive size/color of quail eggs.					
(iv)	Short egg shelf life					
(v)	Delay in supply of feeds & other inputs					
(vi)	Delay in collecting eggs from farm					
(vii)	Higher transportation cost					
(viii)	Any other (specify)….....					

89. Please rank the factors you considered in Q88 above as transportation and marketing constraints.

CONSTRAINTS		**RANKS**							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
(i)	Lack of awareness and information about the advantages of eating quail meat and egg.								
(ii)	Lack of Government influence								
(iii)	Non-attractive color of quail eggs.								
(iv)	Short egg shelf life								
(v)	Delay in supply of feeds other inputs								
(vi)	Delay in collecting eggs from farm								
(vii)	Higher transportation cost								
(viii)	Any other (specify)…..								

Section F: Prospects for Quail Farming

90. Do you think sustainability of quail farming is necessary in Ghana? Yes [ ] No [ ]

91. (a) If yes, why? …….

(b) If no, why?.....

92. Do you consider the following as prospects for the quail industry in Ghana?

SA – Strongly Agree; **A** – Agree; **N** – Neither Agree nor Disagree; **D** – Disagree;

SD – Strongly Disagree.

PROSPECTS		**SA**	**A**	**N**	**D**	**SD**
(i)	Little investment is needed.					
(ii)	Feed intake is very low.					
(iii)	No special ration is needed.					
(iv)	Susceptibility to diseases is rare.					
(v)	Short generation interval.					
(vi)	Any other (specify)….....					

93. Where do you obtain your inputs (especially feed) for your quail farming?

(i) Rural areas [ ] (ii) Urban areas [ ] (iii) Semi-urban [ ] (iv) All the above [ ]

(v) Others (specify)…….

94. Are you getting regular income from quail business? (i) Yes [ ] (ii) No [ ]

95. If yes to 94, how regular are you getting income?

(i) Daily [ ] (ii) Weekly [ ] (iii) Monthly [ ] (iv) Yearly [ ]

96. Do you make profit from your quail business? Yes [ ] No [ ]

97. If yes to Q96, how do you rate your profit margin?

(i) Very Good [ ] (ii) Good [ ] (iii) Average [ ] (iv) Poor [ ]

98. If no to Q96, mention the reason(s)

…….

99. Is quail farming a profitable business within a short period?

(i)Yes [ ] (ii) No [ ] (iii) Not sure [ ]

100. If yes to Q99, how many years are required to get the profit in the quail business?

(i) Less than 1 year [ ] (ii) 1-2 years [ ] (iii) 2-6 years [ ] (iv) 7-8 years [ ] (v) 9-10 years [ ]

101. If no to Q99, mention the reason for doing this business then.

……

102. Rank your opinion regarding the importance of the following skills in starting and managing the quail business.

SKILLS REQUIRED TO MANAGE THE QUAIL BUSINESS	**RANK**				
	1	2	3	4	5
(i) Technical skills					
(ii) Leadership skills					
(iii) Entrepreneurial skills					
(iv)Marketing skills					
(v) Social contacts					

103. Quail farming has assumed an important place in the poultry industry of Ghana in terms of revenue generation. (i) Strongly agree [ ] (ii) Agree [ ] (iii) Neither agree nor disagree [ ] (iv) Disagree [ ] (v) Strongly disagree [ ]

104. There is equal demand for quail meat and eggs (i) Strongly agree [ ] (ii) Agree [ ] (iii) Neither agree nor disagree [ ] (iv) Disagree [ ] (v) Strongly disagree [ ]

105. If you disagree with Q104, which of the products do you think has more demand? (i) Quail meat [ ] (ii) Quail eggs [ ] (iii) Others (specify)……

106. In your opinion, why do people patronise the product you indicated in Q105 above? (i) Health benefits [ ] (ii) Nutritional benefits [ ] (iii) Income generation

107. The demand for quail meat and eggs is increasing fast.

(i) Strongly agree [ ] (ii) Agree [ ] (iii) Neither agree nor disagree [ ] (iv) Disagree [ ] (v) Strongly disagree [ ]

108. Do the following factors have an influence towards the prospects of the quail industry? **SA** – Strongly Agree; **A** – Agree; **N**– Neither Agree nor Disagree; **D** – Disagree; **SD** – Strongly Disagree

FACTOR	**SCORE**				
	SA	A	N	D	SD
(i) Government support / subsidies					
(ii) Intensifying public education on benefits of quail products					
(iii) Proper training of poultry farmers on quail production systems					
(iv) Technical support services to farms by government agencies					
(v) Geographical segmentation of poultry industry will boost export business.					
(vi) Any other (specify)……..					

109. Please indicate at least three (3) suggested ways to improve the quail business in Ghana

……

……

……