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Present Status of Quail Farming in Africa: A Review

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Abstract

Although quail farming is still in its infancy in Africa, it is commonly practiced in Asia, with China producing about 38% of global production. About 10% of the world's egg production comes from quail, while their meat represents about 0.2% of the global poultry meat production. This review presents the status of quail farming in Africa and highlights the sub-sector's challenges and opportunities. Quail farming is one of the least exploited poultry sub-sectors on the African continent; hence, there is limited production and consumption data. The consumption of quail meat and eggs is still low in Africa, but these have the potential to flourish as people become more aware of their nutritional and health benefits. As an evolving industry with great potential, quail farming faces many challenges, including a lack of access to markets, lack of access to credit, inadequate extension support, unavailability of specific quail feeds, and poor housing. Many opportunities exist in feed manufacturing, expanding existing hatcheries and establishing new ones, establishing breeding and rearing facilities, and further processing of quail meat and eggs. Some potential identified challenges include intensifying farmer education, forming cooperative societies to improve market access, developing support programs to encourage farmers to venture into quail farming, and investing in affordable and durable housing to mitigate theft, predation and escaping. We conclude that African governments should consider encouraging quail farming, as it has the potential to play an important role in income generation, job creation and food and nutrition security.

Introduction

Quail (*Cortunix cortunix*) belongs to the Phasianidae family, the largest and the most diverse gallinaceous birds (Shanaway, 1994). The Bible describes how quails were used as a valuable food source (meat) during the migration of Israelites from Egypt to the promised land. Although the earliest known representation of quail can be found in Egyptian hieroglyphics dating from 2000 BC, no evidence suggests that quails were bred in captivity in Egypt (Shanaway, 1994). The author stated that quail was domesticated in the Orient, not the Near East. Mondry (2016) reported that the most frequently farmed quail species, the Japanese quail *(Coturnix japonica),* was domesticated over 700 years ago in Japan.

In the 14th century, quails were tamed primarily for their singing and, thereafter, for their meat and eggs (Chang *et al*., 2005). Moreira *et al.* (2022) reported that quail eggs have nutritional, therapeutic, and functional potentials, though they are still not widely consumed globally. In Africa, quails are farmed for their eggs (intended for consumption, decoration, and remedies) and meat, which is in high demand among high-income earners (Mondry, 2016). In Sub-Saharan Africa, urban and rural populations raise domesticated quail for commercial and subsistence purposes (Majoni *et al*., 2018). Ekpo *et*

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al. (2020) reported that in Benin quails are raised for their profitability, prestige, and the medicinal uses of their eggs.

Quail farming is one of the least explored farming sub-sectors in the poultry industry (Ekpo *et al.*, 2020), especially on the African continent. Quail farming in Africa is in its nascent stages, resulting in the paucity of literature on commercial quail farming on the continent. Therefore, this review endeavors to evaluate the quail farming systems in Africa and propose ways of improving their production.

Global quail egg and meat production

Egg production has been reported as a major factor of consideration in Japan and Southeast Asia for quail farming, whereas meat is the main reason for its production in Europe (Vali, 2008). In Africa, quails are farmed for their meat and eggs and production is predominantly carried out at the subsistence level, indicating that productivity levels are low compared to other regions where quail farming is well established. The major global producers of quail meat are China, Spain, France, Italy, and the United States (Katerynych & Pankova, 2020). Quail farming for meat and eggs is more common in Asia, with China accounting for about 38% of the global production (Bertechini & Oviedo-Rondón, 2023). FAOSTAT (2018) ranked quails second after chickens in the average share of domestic birds slaughtered annually worldwide. According to Lukanov (2019), about 10% of the global egg production comes from quail, while their meat represents about 0.2% of the worldwide poultry meat production. Bertechini & Oviedo-Rondon (2023) reported that the population of quail accounts for 11.8% of all domestic birds globally. Table 1 presents the top 10 quail egg-producing countries in the world. It is clear from Table 1 that only two countries (Brazil and Russia) are non-Asian, indicating that quail farming is predominantly an Asian activity. Data on the top 10 global quail meat producers could not be found in the literature.

Table 1: Top 10 global producers of quail eggs

Country	Annual. production (metric ton)	Average annual growth (%) in 5 years
China	4.9 million	+6.22
Thailand	400,000	-2.44
Indonesia	357,100	+7.55
Bangladesh	239,600	+61.42
Brazil	177,500	-22.74
Myanmar	55,000	+5.73
Philippines	50,500	+19.05
South Korea	32,000	-1.73
Russia	26,400	-15.28
Taiwan	25,200	-0.51

Source: Bertechini & Oviedo-Rondón (2023)

Main uses of quails

Quail farming is an evolving poultry sub-sector in Africa; therefore, there is a need for African countries to sensitize large numbers of their people who hope to make a living from the promising and seemingly profitable venture given that in countries such as Botswana, quail products are highly prized than chicken products. In Nigeria, Adeoti & Baruwa (2019) and Shalome & Nojuvwevwo (2021) reported that the cost and return estimate for quail farming indicates that it is a highly profitable venture. Previous studies by Sekumade & Owoeye (2017) and Ekpo *et al.* (2020) in Nigeria and Benin reported that quails are reared mainly by males than females. Although quail farms are present in several African nations, such as Kenya and Nigeria, quails are primarily wild birds across the African continent (Majoni *et al*., 2018).

Economic benefits

It is well-recognized that quail farming has several advantages, which include the ability to generate cash and employment, raise a healthy family, and provide an abundant supply of protein (Bakoji *et al*., 2013). According to Adeyemo & Omkoyi (2012), quail farming creates indirect employment for suppliers of goods and services, including feed, medications, and marketing, in addition to direct work for farmers and the people they hire to raise quails.

Quails are currently farmed for their meat and eggs (Onyewuchi *et al*., 2013; Saka *et al*., 2018) and as pets. They are the most efficient and ideal poultry species because they reach sexual maturity quickly, require less time to incubate eggs, and can produce 3 to 4 generations per year (Vali, 2008; Saidu *et al*., 2014). In addition, quails have low maintenance requirements associated with their small body size (80-300 g), are disease-resistant, and have high egg production (Vali, 2008). A recent study by Bhawa *et al*. (2023) found that 81% of respondents farmed quail for eggs and meat, 10% for meat production alone, and 9% for egg production alone. Furthermore, mixed-type quail farming (63.4%), that is, for meat and eggs, was reported in Bangladesh (Rahman *et al*., 2016). Egbeyale *et al*. (2013) in Nigeria reported that mixed-type quail farming is practiced worldwide and

that Japanese quails are well adapted for commercial egg and meat production when they are reared under an intensive system. This is due to their adaptability and ability to survive when they are confined (Odunsi *et al*., 2007), comparatively short generation intervals, and lower costs of production (Ojo *et al*., 2014).

Nutritional benefits

Quail meat has many nutritional benefits, including high protein, vital fatty acids, and minerals such as iron, potassium, sodium, and chlorine. However, due to their high metabolic activity, quail muscles store more glycogen, which produces superior-quality meat (Gecgel *et al*., 2015). Of all the poultry products, quail has the most flesh and the lowest bone-to-meat ratio; its carcasses are composed of 76% meat, 14% skin, and 10% bone (Gecgel *et al*., 2015), as opposed to broiler chicken's 74% meat, 15% skin, and 11% bone (Hayse & Marion, 1973). Since quail meat has thin skin and little fat accumulating between its tissues, it is recommended for human consumption as a low-fat meat since it has minimal fat and cholesterol levels (Wen *et al*., 2017; Faraq *et al*., 2021).

Table 2: Composition of quail and chicken meat

Nutrient	Quail meat (%)	Chicken meat (%)
Moisture	73.93	73.87
Protein	20.54	20.66
Fat	3.85	3.61
Carbohydrate	0.56	0.78
Minerals	1.12	1.08

Source: Arathy *et al.* (2022)

Scientific research

Quail is also used in scientific experiments. Scientific research in various fields, including developmental biology, endocrinology, aging, immunology, behavioral studies, and several human genetic illnesses, use the Japanese quail as a model laboratory animal (Baer *et al*., 2015). As an amniote with early developmental patterns strikingly similar to human development, quail embryos offer some important experimental advantages for the study of amniotes, including fast reproductive maturation, small breeding adult size, ease of breeding in laboratory settings, resistance to research manipulations, transgenic line availability, fully sequenced genome, and molecular manipulation tools (Harrington, 2015).

Traditional medicine and pharmacological potential of quails

Plant and animal derivatives have long been recognized for their ability to prevent diseases and heal wounds, and this is especially true in many African countries, where traditional medicine predated the advent of modern Western medicine (Alves, 2012). Jeke *et al*. (2018) posited that the verification of the traditional medical applications of quail meat and eggs in communities through the exchange of indigenous knowledge could encourage the consumption of Japanese quail products along with the hunting of wild quails in Africa for the same purpose.

Quail eggs are a good source of protein, fat, vitamin E, minerals (iron and zinc), and sex hormones (Tunsaringkarn *et al*., 2013). The authors also stated that quail eggs boost immunity, support memory, stimulate brain activity, and stabilize the nervous system. Muthoni (2014) in Kenya reported that eating quail eggs daily helps prevent stomach ulcers and other digestive tract disorders. Furthermore, the author reported that quail eggs aid in the treatment of anemia by raising hemoglobin levels and eliminating heavy metals and poisons from the body.

A study by Bhawa *et al*. (2023) in Botswana reported quail eggs used for hatching only at 38%, human consumption at 32%, and hatching and sales at 30%. In addition, 77% of the respondents stated that they slaughtered quail for their consumption while the remainder was used to honor guests. In another study, Ogunwole *et al*. (2015) in Oyo state of Nigeria reported that 55% of respondents consumed quail eggs because they considered them very nutritious and high-protein food. Table 2 shows that quail and chicken meat have a similar nutritional composition.

Japanese quail eggs have been shown to possess antibacterial, antifungal, antiviral, anti-inflammatory, and anticancer properties (Kovacs-Nolan *et al*., 2005). Quail meat and eggs are considered functional foods because the meat contains adequate amounts of high-quality nutrients that can heal specific illnesses (Kovacs-Nolan *et al*., 2005), such as cardiovascular diseases (Jeke *et al.*, 2018). Quail meat contains high oleic acid content, which has been linked to a reduced risk of cardiovascular diseases (Khalifa *et al.*, 2016; Saeed *et al.*, 2014). The eggs are rich in bioactive chemicals that could lead to the discovery of additional antimicrobials and better pharmacological treatments for a wide range of illnesses (Kovacs-Nolan *et al*., 2005; da Silva *et al*., 2009). Given that cardiovascular illnesses are the primary cause of death and morbidity globally, the capacity of quail egg components to prevent and treat these conditions is crucial for extending life expectancy (Miranda *et al*., 2015).

The high concentration of amino acids in quail eggs, particularly tyrosine, is beneficial for metabolism and the synthesis of pigment that

promotes a good skin tone. Mnisi *et al*. (2021a) reported the regular consumption of quail eggs helps to avoid several illnesses and serves as a natural treatment for digestive system ailments like stomach ulcers. Quail eggs have also been reported to increase hemoglobin levels in the body and flush out heavy metals and pollutants, thereby strengthening the immune system, supporting good memory, stimulating the brain, and calming the nervous system (Tunsaringkarn *et al*., 2013). Ekpo *et al.* (2021) mentioned that some studies have looked into the processing of quail eggs into powders which are used in the manufacture of drugs, cosmetics and other products, implying that quails have multiple uses.

Housing and production systems

Quail rearing can happen under different management and production systems, depending on the breed type, purpose of production, and the number of birds (Valencia, 2011). Quails can be reared in cages and deep litter, or a combination of both (Swain *et al.*, 2010). While the deep litter system appears to be predominant across the African continent, Akarikiya (2021) in Ghana found that the deep litter housing system was utilized by 6.7% of quail farmers, 88.3% used the battery cage-intensive system, where quails were housed in colony cages, whereas 5% used both battery cage and deep litter systems. These two systems of management are described in the sections below.

The housing of quail is simple and less expensive as the quails are small, grow faster, and have a short generation interval (Zambia AgriBusiness Society, 2019). Rearing quails with other poultry species is prohibited as quails can be killed or injured by other species (Mondry, 2016). Quail farmers in Africa use different housing types depending on the availability of materials and capital. Like other poultry species, quails are kept in deep litter or battery cages. The quail house must be well-ventilated, and light must be supplied to encourage feed consumption. Additionally, the house must exclude wild animals to prevent predation (Zambia AgriBusiness Society, 2019) and the spread of infections.

Deep litter system

In Africa, the deep litter system commonly found in market-driven small and medium-sized poultry operations dominates the quail farming production system. This is a system whereby the quail birds are reared on the floor covered with litter (wood shavings, sunflower husks, etc.) at a depth ranging from 10 to 12 cm (Karousa *et al.*, 2015). The litter is maintained dry, clean, and replenished when it accumulates moisture and dirt to prevent it from being a suitable environment for the development of micro-organisms.

Some researchers have suggested that when quails are reared in a deep litter system, floor pens are made to keep them in smaller groups. Research showed that spaces recommended in deep litter systems may differ with age. According to Mishra & Shukla (2014), six quails can be kept on a floor space of 0.55 m^2 (i.e., 11 birds/m^2). Lamba *et al.* (2022) evaluated the influence of two-floor spaces (i.e., 150 cm^2/ bird, 200 cm^2/bird, and 250 cm^2/bird) on the weight at sexual maturity and age at sexual maturity of Japanese quails and found that Japanese quails reared in 250 cm^2/bird floor space showed the best growth compared to their counterparts. However, Mnisi *et al.* (2021b) suggested that quails aged 0 to 4, 5 to 6, and more than 6 weeks require 75 cm^2, 200 cm^2, and 250 cm^2/bird, respectively. Farooq *et al.* (2001), reported that quails raised on thick, littered concrete floors have higher fertility than those raised in cages; nonetheless, standard concrete floor pens might not be the best choice for quails raised primarily for breeding. Furthermore, quail kept directly on concrete floors are typically known to bury their eggs in the litter (bedding material), thereby resulting in egg collection being more challenging and time-consuming, as well as, eggs becoming contaminated, and the birds ingesting the eggs or the eggs being damaged.

Battery system

Quails can also be reared in cages, which can be made of wooden, wire or plastic materials with unit dimensions of 1.8 m long and 0.3 m wide, which could be further subdivided into six subunits, if so required. Management of quails kept in cages is known to be easy and less time-consuming. For instance, quail diseases can be easily managed and controlled in cages compared to the deep litter system. According to Tauson (1998) and Rajendran & Mohanty (2003), the battery cage housing is preferred by quail farmers over the deep litter system since it makes managing quails easier, decreases dust and ammonia gas build-up, makes the collection of eggs easier, decreases feed wastage, and enhances feed utilization efficiency. When all the needs for the birds' growth are met with enhanced biosecurity precautions, raising quails in battery cages or deep litter systems can be done without negatively impacting the welfare, growth, or development of the birds (Ojedapo, 2013; Olawumi, 2015). El-Sagheer *et al.* (2012) in Egypt compared the productive and reproductive performance of quails raised at two densities in battery cages and deep litter and found that the body weight gain of females raised in batteries at both densities exceeded that of birds on litter floors at both densities. Similarly, the mortality rate decreased in battery cages compared to litter floor.

A flock size of 10 to 12 birds could be kept in a cage, and for breeding purposes, male quails can be introduced to female cages at a ratio of 1 male to 3 females (Mishra & Shukla, 2014). Cages require less space as they can be arranged in tiers of 5 to 6 in height. Removable wooden or metallic plates are placed at the bottom of the cage for easy collection and cleaning of bird droppings. However, the spacing requirements for quails reared in battery cages differ with age. Monika *et al.* (2018) suggested that quails aged 0 to 4, 5 to 6 weeks, and more than 6 weeks should be reared in battery cages in spaces of 75 cm^2, 150 $cm^{2,}$ and 175 cm^2/ bird, respectively. These findings suggest that quails reared in cages are more efficient in using space than those in deep litter. Razee *et al.* (2016) reported that quails reared in battery cage systems perform optimally because the cages reduce fight mode tendency and improve management. A previous study by Karousa *et al.* (2015) reported that different housing systems affect fertility, egg production, and hatchability.

Feeding and watering systems

Feed types

Quails can be fed on non-conventional feeds and/or commercial diets. They feed on both flesh and vegetables (omnivorous), as the birds primarily feed on a diet consisting of seeds, insects, grains, and vegetation, with their beaks adapted for pecking and probing the ground in search of food. This factor is very important for wild quails, whose means of survival depends on their foraging abilities; their beaks are well-developed since they are constantly digging the ground for insects and food (Agarwal *et al*., 2011). Quails have a reputation for being efficient foragers; hence, their ability to find and consume the required feed is crucial to their performance and survival. Nasaka *et al.* (2017) found that the most non-conventional protein feed resources for quails in Uganda were all plant protein sources such as cocoyam, sweet potatoes, cassava, Amaranthus, *Braceca oleracea*, and *Hoslutia opposita* leaves.

Similarly, Qureshi *et al.* (2012) observed that plant contents represented the major food items of the common quail. Feeding accounts for about 70-80% of the total production costs in quail production. The feed consists mainly of grains such as sorghum, millet, and maize. An adult quail consumes about 14 to 18 g of feed per day and up to 25 g per day during the laying period (Mondry, 2016). The protein requirement for quails is 25 to 28%, suggesting that quails need a high-protein feed for optimum growth and performance (Mondry, 2016) compared to chickens.

Feeding of quails in Africa is currently one of the most limiting factors because there is not enough feed or specifically formulated diets for quails (Redoy *et al.,* 2017; Gadam *et al.,* 2019; Kawser & Bin-Ta, 2020). As a result, quail farmers across Africa use different diets depending on the availability of feed ingredients. For example, in Botswana and Nigeria, most quail farmers feed commercial broiler and layer diets indicating that the nutrient requirements of quails are not met, as quails have higher protein requirements compared to chickens. The exception is on-farm feed formulation when experts guide farmers to formulate their feed on the farm. However, farmers in some neighboring countries use turkey diets, which contain about 25 to 28% protein content, similar to the protein requirements of quails. Indrayani *et al.* (2019) in Indonesia found that some farmers mixed quail feed by themselves based on the predetermined formula, while other farmers used a combination of complete and self-mixed feed. In another study, Nasaka *et al.* (2018) revealed a high variation in the chemical composition of diets used for feeding quails in urban and peri-urban areas of Uganda, indicating non-conformance to the recommended specifications for tropical conditions. The authors found that the starter and grower diets contained far lower crude protein and energy contents than the minimum specifications leading to poor productivity of quails.

The majority of Ghanaian quail farmers (68.3%) are reported to feed their birds with conventional chicken feed from the chick stage to the adult stage (Kasule *et al*., 2014). The authors reported that only 26.7% utilized the proper commercial quail feed. The low use of commercial quail diets could be attributed to their high cost compared to chicken feed since quails have higher crude protein requirements than chickens. Akarikiya (2021) reported that 48.3% of quail farmers in Ghana, compared to 37.2% in Kenya (Muthoni, 2014), fed quails with non-conventional plant-based feed sources such as the bitter leaf, orange peels, mango bark, cabbage, watermelon fruits, etc. The feeding practice common to backyard quail farming is feeding garden waste (i.e., lettuce and cabbage, fruits) and some kitchen leftovers (i.e., cooked rice).

Some studies aimed at reducing feed costs owing to competition for cereal grains between feed industries (livestock), humans and biofuels are being conducted in some parts of Africa. For instance, Malik *et al.* (2018) in Nigeria evaluated the growth performance and egg production of Japanese quails fed diets containing graded levels of sun-dried cassava peel meal (SCPM). The authors concluded that SCPM can replace maize in quail diets up to 50% and 25% for optimum growth performance and egg production, respectively. Given that quail farming is still in its infancy, research relating to this poultry species science is still limited, especially in the African context; hence for its intensification to support farmers.

Feeding methods

For optimal growth, quail feed should be made into smaller particles, clean, dry, and must be fed *ad libitum* (Zambia AgriBusiness Society, 2019). For quails reared in cages, the feeding troughs are usually placed in front of the cages, thus allowing for easy access. On the other hand, for quails reared on deep litter, feeding troughs are placed on the floor half-filled to reduce feed spillage compared to when the troughs are full (Mondry, 2016), as quails tend to become agitated when fed. Akarikiya (2021) showed that quail farmers use feeding troughs made from different materials, such as metals (25%), plastics (51.7%), wood (3.3%), and other materials (20%). The availability, ease of washing or cleaning, and stage of growth of the birds were the main factors considered by the farmers when selecting the material and design of watering and feeding troughs.

Watering systems

Clean water, being the most important nutrient is provided *ad libitum*. Water deficiency can lead to low feed intake, thus affecting growth performance, egg production, and health. Quails consume water twice as much as they need in a dry diet. They consume more water when the diet is salty or when temperatures are high. Water troughs are cleaned and disinfected twice a week or when dirty and placed at the back of the cages when automated water systems are used. In the deep litter system, the drinkers are manually filled with clean water daily. Drinkers differ in size; small drinkers are used when quails are 0 to 2 weeks to prevent them from drowning, while bigger drinkers are used when the quails are mature. Noman (2018) recommended nipple drinkers and cups, consisting of one nipple or cup per five birds, as the most effective drinking troughs for mature quails.

Reproductive performance of quail

The performance of quail in terms of reproduction is critically important for the survival and growth of the quail populations. Quails are known for their rapid breeding with high reproductive output, short breeding seasons, and ability to produce multiple clutches of eggs in a year if properly managed. The female quail lays eggs in a well-hidden nest on the ground, and both hen and cock may share incubation and rearing duties. Female quails mature from 6 to 8 weeks and can begin to produce eggs shortly after maturity (Ratriyanto *et al*., 2020). Mondry (2016) reported that though the male and the female quails start to reproduce at approximately 6 weeks of age, it is advisable to wait until they are 8 weeks old to ensure that they produce fertile eggs. Egg production is known to be normally highest during the first year of laying and thereafter declines with age (Ratriyanto *et al*., 2020). The reproductive performance of quail is summarized in Table 3.

Table 3: A summary of the reproductive and production characteristics of quail

Parameter	Number	References
Normal egg weight, g	10.8-12	Ahmed & Al-Barnzinji (2020); Coelho *et al.* (2021)
Weight of one-day-old chick, g	8-9	Swain *et al.* (2010); Agarwal *et al.* (2011)
Average body weight at 5-6 weeks, g	180-200	Swain *et al.* (2010); Kostaman & Sopiyana (2021)
Number of eggs per quail hen per year	280-300	Swain *et al.* (2010); Ogada *et al.* (2022)
Number of eggs per clutch	8-15	Coelho *et al.* (2021)
Age at sexual maturity, weeks	6-7	Rodriguez-Teijeiro *et al.* (2005); Alkan *et al.* (2010; Swain *et al.* (2010);
Mating ratio, male: females	1:3	Mishra & Shukla (2014); Kostaman & Sopiyana (2021)
Fertility, %	71.64-75.76	Obi *et al.* (2018)
Hatchability, %	70-80	Coelho *et al.* (2021); Kostaman & Sopiyana (2021)
Age at first egg, days	51-53	Ashok & Reddy (2010)
	55-58	Aikins *et al.* (2019)

The number of clutches of eggs that a quail hen can produce in a year can vary depending on the species, geographical location, and environmental conditions (Rodriguez-Teijeiro *et al.,* 2005; Hassan & Alsattar, 2015; Ahmed & Al-Barnzinji, 2020). These authors also reported that quail species have the potential to produce multiple clutches in a breeding season. Bobwhite quail (*Colinus virginianus*) is known to have a breeding season that extends from late spring to early summer. During this period, females can lay multiple clutches, usually spaced 2-3 weeks apart. Each clutch may consist of 10-16 eggs and in favorable conditions, they may produce 2-3 clutches in a breeding season. Gambel's quail (*Callipepla gambelli*) typically breeds from late spring to early summer and can produce multiple clutches, with each clutch consisting of 8-12 eggs. About 2-3 clutches may be produced in a breeding season. The number of clutches a quail species produces in a year can be influenced by factors such as food availability, habitat quality, and environmental conditions.

Diseases and pests

Although Mnisi *et al.* (2021b) in South Africa reported that quails have strong immunity and resistance against several poultry diseases, they are affected by many diseases, leading to their performance and productivity being adversely affected. The strong immunity

observed in quails suggests limited usage of antibiotics or vaccines in their production compared to chickens. Infectious diseases are prevalent in quails reared under intensive production systems, with many of the diseases affecting quails being the same as those that affect chickens and turkeys (Talwana *et al.*, 2016). Viral infections in quails can lead to respiratory and nervous diseases, neoplasia, and pox (Barnes, 1987). Ali *et al.* (2021) highlighted the prevalence of viral infections such as quail bronchitis, avian influenza, and Newcastle disease, which can lead to poor feed conversion efficiency and increased mortality.

Quails are affected by parasitic and infectious diseases, including intestinal parasites, bacteria, and protozoa (Kellogg & Calpin, 1971). Mohammed & Ejiofor (2015) reported some diseases that affect quails in Nigeria to include staphylococcosis, blackhead, chronic respiratory disease, pullorum, colibacillosis, trichomoniasis, ulcerative enteritis, omphalitis, coccidiosis, and aspergillosis. Ulcerative enteritis is particularly known to be acute in captive quail and requires them to be maintained on wire-bottom pens or preventive medication (Adebayo *et al.*, 2023).

The common external parasites of quail include fleas, lice, mites, and ticks, while internal parasites are large roundworms, caecal worms, capillaria, and tapeworms (Nagarajan *et al.*, 2012). Anthraquinone-treated granular pesticides have been successfully used to reduce mortality in quail chicks, indicating the potential pest control strategies for quail populations (DeLiberto & Werner, 2016). However, insecticides have been implicated in contributing to declining quail populations, highlighting the need for sustainable pest management practices (Gobeli *et al.*, 2017).

Marketing

In most African countries, quail farming is still practiced at the subsistence level. Countries such as Kenya, Nigeria, Ghana and South Africa have seen increases in quail farming activities (Kwesisi *et al.,* 2022). The use of quail for both meat and egg production has gained popularity, offering a sustainable source of protein and additional income for farmers. However, there is still a lack of proper marketing channels for quail products, hindering the industry from achieving its full potential. Santhi & Kalaikannan (2017) stated that the value-addition of quail meat is an important avenue to improve marketing opportunities.

The current trends in quail marketing in Africa are limited due to the infancy of the quail subsector in most countries. Several studies have suggested potential marketing strategies to promote the growth of quail production in Africa. For instance, Mnisi *et al*. (2021b) suggested building a local market niche area for the quail subsector, adopting cost-effective quail farming systems, and developing awareness programs for successful marketing. Marareni & Mnisi (2020) reported that the lack of a pre-existing local market for quail meat and eggs has led to most farmers, especially in South Africa, exporting their products, albeit with low profit margins.

To fully realize the potential markets for quail meat and eggs in Africa, effective marketing strategies and the development of a solid local market base are essential. Quail producers should consider market diversification by promoting quail products through various channels, such as farmers' markets, supermarkets, and digital platforms. Digital marketing can also play a significant role in promoting quail production in Africa. The effectiveness of digital marketing has been highlighted, indicating that marketers are faced with new opportunities within the digital age (Yasmin *et al.*, 2015). Mkwizu (2020) posited that leveraging digital media content and mobile advertisement can be instrumental in marketing quail to tourists, thereby contributing to the growth of the quail subsector. In the opinion of Sheth (2011), the emerging markets in Africa require a combination of traditional marketing perspectives with digital marketing. Furthermore, there is a need to develop organized marketing associations to streamline the distribution and sale of quail products. African governments and non-governmental organizations can help to establish marketing networks and provide market information to farmers.

Challenges to quail farming in Africa

Quail farmers across the African continent face a myriad of challenges, which are summarized in Table 4. These challenges are related to feeds, housing, extension, production, marketing, policy, and research. It is, however, apparent that the major challenges, in order of importance, are related to marketing, extension, housing, production, and feed.

Opportunities

Quail farming offers some economic opportunities or benefits. Compared to other poultry species, Japanese quail have the advantages of being smaller, having a shorter life cycle, faster growth rates, having good reproductive potential, a high fecundity rate, and a shorter incubation period (ElKatcha *et al*., 2015), and tolerance to diseases and parasites (Muthoni, 2014). The author found no significant pests or diseases that impacted quail productivity. These attributes make quail farming an ideal agricultural activity in Africa, where protein consumption is low compared to other continents. According to Brice (2022), the average *per capita* protein consumption, particularly animal protein, is low across most of sub-Saharan Africa, as many countries within the region experience high rates of food insecurity and undernourishment.

Table 4: Reported challenges to the advancement of quail farming in Africa and globally

Challenges	Category	References	Country
High feed/input costs	Feed	Siddique & Mandal (1996); Rahman *et al.* (2016); Nasaka *et al*. (2017); Sathiya *et al.* (2017); Mnisi & Mlambo (2018); Adeoti & Baruwa (2019); Sekumade & Owoeye (2017); Mnisi *et al.* (2021a); Shalome & Nojuvwevwo (2021); Kwesisi *et al.* (2022)	Bangladesh, Uganda, India, Nigeria, Kenya, South Africa
Poor quality feeds	Feed	Nasaka *et al*. (2017)	Uganda
Lack of quail-specific diets	Feed	Muthoni (2014); Redoy *et al.* (2017); Gadam *et al.* (2019); Kawser & Bin-Ta (2020); Bhawa *et al.* (2023)	Kenya, Bangladesh, Nigeria, Botswana
Inadequate housing facilities	Housing	Majoni *et al.* (2018)	Zimbabwe
Insufficient space	Housing	Majoni *et al.* (2018)	Zimbabwe
Theft	Housing	Sekumade & Owoeye (2017); Majoni *et al.* (2018); Adebayo *et al.* (2023); Bhawa *et al.* (2023)	Nigeria, Zimbabwe, Botswana
Predation	Housing	Majoni *et al.* (2018); Saka *et al.* (2018); Adebayo *et al.* (2023); Bhawa *et al.* (2023)	Zimbabwe, Nigeria, Botswana
Escaping	Housing	Bhawa *et al.* (2023)	Botswana
Lack of incubation facilities to hatch eggs	Production	Islam *et al.* (2018)	Bangladesh
Difficulties of quail parent stock collection	Production	Rahman *et al.* (2016)	Bangladesh
A paucity of establishment stock	Production	Adebayo *et al.* (2023)	Nigeria
Lack of available day-old chicks	Production	Redoy *et al.* (2017); Kawser & Bin-Ta (2020)	Bangladesh
Poor health care	Extension	Mnisi *et al.* (2021b); Bhawa *et al.* (2023);	South Africa, Botswana
Lack of proper knowledge of quail farming	Extension	Oyalinka *et al.* (2014); Iwuchukwu *et al.* (2015); Rahman *et al.* (2016); Majoni *et al.* (2018)	Nigeria, Bangladesh, Zimbabwe
Lack of awareness about the benefits of quail products	Extension	Nasaka *et al.* (2017); Sekumade & Owoeye (2017)	Nigeria
Lack of training in quail farming	Extension	Siddique & Mandal (1996); Diomande *et al.* (2023)	Bangladesh, Côte d'Ivoire
Diseases and parasites	Extension	Saka *et al.* (2018); Kwesisi *et al.* (2022), Bhawa *et al.* (2023)	Nigeria, Kenya, Botswana
Inadequate extension support	Extension	Iwuchukwu *et al.* (2015); Aromolaran *et al*. (2016); Adebayo *et al.* (2023)	Nigeria
Poor brooding practices	Extension	Nasaka *et al*. (2017); Saka *et al.* (2018); Adebayo *et al.* (2023)	Uganda, Nigeria
Short shelf-life of quail eggs	Extension	Nasaka *et al*. (2017)	Uganda
Outbreak of endemic diseases	Extension	Mohammed & Ejiofor (2015); Rahman *et al*. (2016); Abd El-Ghany (2019); Adebayo *et al.* (2023)	Nigeria, Bangladesh
Inadequate biosecurity practices	Extension	Rahman *et al*. (2016)	Bangladesh
Limited access to veterinary care	Extension	Siddique & Mandal (1996); Rahman *et al*. (2016)	Bangladesh
Low technological knowledge	Extension	Kwesisi *et al.* (2022); Adebayo *et al.* (2023)	Kenya, Nigeria

Table 4: Reported challenges to the advancement of quail farming in Africa and globally

Challenges	Category	References	Country
Drowning, smothering and cannibalism	Extension	Mohammed & Ejiofor (2015)	Nigeria
High mortality rate	Extension	Redoy *et al.* (2017); Sekumade & Owoeye (2017); Islam *et al.* (2018); Adeoti & Baruwa (2019): Kawser & Bin Ta (2020)	Nigeria, Bangladesh
Poor quality of one-day-old chicks	Extension	Adeoti & Baruwa (2019)	Nigeria
Inadequate knowledge of feed formulation	Extension	Saka *et al.* (2018); Adebayo *et al.* (2023)	Nigeria
Difficulty in meat handling and processing	Extension	Saka *et al.* (2018); Adebayo *et al.* (2023)	Nigeria
Covid-19 pandemic	Extension	Mnisi *et al.* (2021a); Bertechini & Oviedo-Rondón (2023)	South Africa, USA
Inadequate research on quail	Research	Iwuchukwu *et al.* (2015)	Nigeria
Fluctuations in market prices	Market	Majoni *et al.* (2018)	Zimbabwe
Inability to access credit / Inadequate institutional credit	Market	Siddique & Mandal (1996); Sathiya *et al.* (2017); Sekumade & Owoeye (2017); Majoni *et al.* (2018); Ekpo *et al.* (2020)	India, Nigeria, Zimbabwe, Benin
Poor access to the market of quail and its products	Market	Saka *et al.* (2018); Adeoti & Baruwa (2019); Shalome & Nojuvwevwo (2021); Kinyua (2022)	Nigeria, Kenya
Unreliable quail market	Market	Muthoni (2014); Kinyua (2022)	Kenya
Low market prices	Market	Saka *et al.* (2018); Adebayo *et al.* (2023)	Nigeria
Limited access to markets	Market	Rahman *et al.* (2016); Adebayo *et al.* (2023; Mnisi *et al.* (2023)	Bangladesh, South Africa
Lack of market information	Market	Muthoni (2014); Kinyua (2022)	Kenya
Inadequate product marketing facilities	Market	Siddique & Mandal (1996); Islam *et al.* (2018)	Bangladesh
Poor marketing channel	Market	Redoy *et al.* (2017); Kawser & Bin-Ta (2020	Bangladesh
Lack of organized marketing associations	Market	Muthoni (2014); Kinyua (2022)	Kenya
Fluctuations in market prices	Market	Majoni *et al.* (2018)	Zimbabwe
Low local demand for quail products (meat and eggs)	Market	Moonga (2012); Nasaka *et al*. (2017); Sekumade & Owoeye (2017); Mnisi *et al*. (2021a)	Zambia, Uganda, Nigeria, South Africa
Misconceptions in Urban Agriculture Policies	Policy	Majoni *et al.* (2018)	Zimbabwe
Getting a license	Policy	Sathiya *et al.* (2017)	India,
Bureaucratic processes to acquire export permits	Policy	Nasaka *et al*. (2017)	Uganda

Bakoji *et al*. (2013) observed that quail production and consumption are still relatively new practices in Africa but have the potential to flourish as people become more aware of the nutritional benefits associated with quail farming.

Quail farming yields immediate returns with minimal initial investment. Furthermore, quail farming offers a greater cost-benefit ratio than chicken production (Saka *et al*., 2018). As commercial quail farming is in its infancy on the African continent, many opportunities exist in feed manufacturing, the expansion and establishment of hatcheries, breeding, and rearing facilities, as well as further processing of quail meat and eggs into various products. Therefore, African governments and development agencies should consider promoting quail production by developing support programs to encourage more citizenry to exploit this resource. Governments and private sectors can collaborate to provide subsidies or micro-loans to support commercial quail farming. The subsidies or micro-loans could be used to improve quail housing infrastructure, feeding and health care.

There is a need to strengthen technical support to quail rearers as this is a relatively new agricultural activity across Africa. The extension services could be enhanced by offering regular training programs to farmers on quail farming practices, including feeding and nutrition, health management, and biosecurity measures. In addition, the use of digital platforms to reach more farmers and provide continuous education must be considered. Furthermore, low-cost methods of rearing quail, such as traditional methods, should be promoted alongside commercial rearing methods in rural and urban areas. Investment in affordable and durable housing solutions is also necessary to reduce losses due to theft, predation, and escaping. Governments and the private sector can collaborate to provide subsidies or micro-loans to improve housing infrastructure. As quail farming is a new agricultural activity, there is a need to intensify research on feeding, breeding, and housing. Governments could support this by providing subsidies or tax breaks to local feed manufacturers. The establishment of breeding facilities should ensure a regular supply of breeding stock and chicks to farmers.

Conclusion

Quail farming is in its infancy in Africa. Quail meat and eggs have nutritional and ethnomedicinal benefits, indicating that quails can play an important role in food and nutrition security. Therefore, African governments must consider integrating quail farming into national agricultural development plans. As in some countries, quail is regarded as a game, governments must develop policies that reduce bureaucratic hurdles and provide clear guidelines for quail farming. Therefore, governments should consider simplifying the processes of acquiring permits to encourage increased participation of farmers in quail farming. There is a need to invest in research and development to enable universities and research institutions to develop appropriate technologies relevant to farmers in Africa. These technologies should innovate and improve quail farming practices. In addition, there is a need for African governments to develop export strategies that comply with international standards to gain access to international markets. Furthermore, value addition of quail products must be supported and promoted.

Quail farming on the African continent faces a myriad of challenges that must be overcome if the benefits of rearing quails are to be realized. These include *inter alia* a lack of access to markets, lack of access to credit, and inadequate extension support. With the right strategies and support, quail farming could become a major contributor to food and nutrition security in Africa. To popularize quail farming, public awareness campaigns about the nutritional benefits of quail meat and eggs must be increased through workshops, seminars and social media. In addition, collaboration with health institutions (e.g., the Ministry of Health) to include quail products in nutritional programs. Furthermore, efforts must be explored to process eggs and meat into various products. To attract premium prices, African governments must promote sustainable farming practices such as organic farming and integrated pest management practices. Additionally, entrepreneurs in the food processing sector must be supported through grants and training. Furthermore, there is a need to develop training and certification programs for farmers that can be adopted. To realize the benefits of quail farming, there is a need to leverage digital marketing strategies Embracing digital marketing strategies and e-commerce platforms can help to expand market reach. In addition, mobile applications for farm management, market information, and veterinary support can be employed.

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