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A Review on Production, Reproduction, Morphometric, and Morphological Characteristics of Ethiopian Native Chickens

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ABSTRACT

Native chickens in Ethiopia are characterized in a fragmented manner for their performance characteristics and genotypes. This review aimed to explore the production and reproduction performance characteristics as well as the morphometric and morphological diversity of Ethiopian native chickens. The investigation was performed on four production performance characteristics, including average egg per clutch, average clutch/hen/year, average egg set/hen, and average egg/hen/year, as well as six reproductive performance characteristics, including age at first laying, age of male chickens at first bred, age at which female chickens are first bred, the reproductive life span of males and females, and fertility percentage in various parts of Ethiopia. Some economically practical morphometric characteristics of native chickens, such as shank length, chest circumference, comb length, body weight, body length, keel length, wattle length, neck length, back length, and morphological diversity, were also summarized. Regarding performance characteristics, there were some variations in eggs' average production performance per clutch (13.56-15.4 eggs) and clutch/hen/year (3.0-4.29) in Ethiopia. The average reproduction performance characteristics of Ethiopian native chickens for age at first laying (6.90-7.13 months), age of male chickens at first bred (5.87-6.15 months), female at first bred (5.20-5.93 months), the reproductive life span of males (3.79 years) and hens (3.56 years), and chicks hatched from set eggs revealed variation across Ethiopia. In various locations of Ethiopia, the average trait values reported for Ethiopian native chickens under the farmer's management differed in terms of morphometric and morphological features. The variation observed in performance characteristics, as well as morphometrics and morphological characteristics for Ethiopian native chicken ecotype population, can help the native breed classification, unique trait conservation, and breed improvement intervention programs.

Keywords: Ethiopia, Morphological trait, Morphometric trait, Native chicken, Performance

INTRODUCTION

Ethiopia is thought to have the largest livestock population in Africa, with a diverse range of animals, including poultry. Among these, Ethiopia's total number of chickens is estimated to be 57 million heads (CSA, 2021). The country's wide range of agro-climatic conditions results in one of the most diverse biological hotspots on the entire globe (Tegegne et al., 2010). The country's diverse agroecology and agronomic practices, combined with its large livestock population, particularly poultry, could contribute significantly to boosting the sector (Melesse, 2000).

Poultry is an essential part of the agricultural system in Ethiopia, where they are reared in all production systems (Alemu and Tadelle, 1997; Melesse, 2000; Demeke, 2004). Native chickens provide a significant portion of the chicken meat (99.2%) and eggs (98.5%) consumed in the country (Tadelle, 1996). According to Guèye (1998), the native chicken constitutes a sizable proportion of the flock in many African countries. These chickens are given fundamental care, with approximately

5-20 chickens per household and insufficient feeding, housing, and health care management (Guèye, 1998). These flocks are typically replenished with improved chickens supplied by governmental and non-governmental organizations (Demeke, 2008). As a result, the information gathered on native ecotypes must be documented and left intact so genetic materials are not lost to oblivion (Dessie et al., 2012). The identified genotypes must be conserved and studied for their production and reproduction abilities, followed by multiplication (Dessie et al., 2012). Knowledge and understanding of chickens' unique characteristics are critical in designing and implementing indigenous chicken-based development programs that can benefit rural societies in the long run.

Morphometric characteristics can be classified as either qualitative or quantitative. Qualitative morphometric characteristics are observable characteristics that can be described by color and categories. In contrast, quantitative morphometric characteristics are methods for extracting measurable characteristics from shapes. These characteristics are typically used as descriptors of type and function for various livestock, including chickens. Although there are no phenotypic standards for Ethiopian native chickens, they were classified based on their colors and the location where they were characterized. However, those native chickens are non-descriptive in morphometric and morphological characteristics and vary in production and reproduction performance. Thus, this review was done using various published journals on Ethiopian native chickens that were used to systematically characterize their production and reproduction performance characteristics and morphometric and morphological diversity characteristics in their ecotypes, where they are found initially, considering different parts of Ethiopia with different agroecology. This study also examined various documents and research reports from other African countries, as well as the livestock report from the central statistical agency in general and poultry in particular to gain insight into the different types of chickens in Ethiopia, grouped by breed and type of poultry. Therefore, this review provided an overview of organized information and efforts to describe production and reproduction performance characteristics, morphometric and morphological trait diversity, and the genetic resources of native chickens in Ethiopia.

Ethiopian poultry production, reproduction performance, and morphometric and morphological characteristics

The following sections present and discuss the findings and discussions on the production and reproduction performance characteristics and the morphometric and morphological diversity of Ethiopian native chickens. It also presents their evolution, population, distribution, ecotypes, and special features reported by researchers and scientists from various parts of Ethiopia, considering all agroecological types.

The evolution of chicken domestication

Today's chicken (*Gallus gallus domesticus*) is classified with its primary origin being the Red Junglefowl. Domestication probably occurred 7,000-10,000 years ago in Southeast Asia and Oceania. Archaeological evidence indicates that the first instance of chicken domestication dates back to as early as 3250 BC in the Indus River Valley, located in modern-day Pakistan. The wildfowl species that contributed to the development of the modern-day domesticated chicken, *Gallus varius*, include the Red Jungle Fowl, Grey Jungle Fowl, Ceylon Fowl, and Green Fowl. These species, among others, are examples of the Gallus family that conceivably played a role in domestication. Comparative analysis of morphological characteristics, such as comb and feather characteristics, has revealed striking resemblances between the Red Jungle Fowl and domesticated chickens. According to genetics experts, the archetypal ancestor of the domesticated chicken is commonly recognized as the Red Jungle Fowl, which can still be found in the wilds of Asia (Crawford, 1990; Horst, 1991). Therefore, it cannot be disputed that the origin of domesticated fowl is rooted in Asia, and the chicken's worldwide spread and distribution can be traced back to the region.

As described by Crawford (1984; 1990), the domestication of chickens around the world went through four stages of evolution. In the first phase of evolution, the utilization of animals for religious, cultural, and traditional purposes led to the selection of color and distinct morphological characteristics in chickens. The second phase involved the dissemination of chickens from their original centers of domestication to various regions, countries, and continents, leading to genetic changes through processes such as genetic drift, migration, and natural selection that facilitated adaptation to new environmental circumstances. The third phase was exemplified by the nineteenth-century phenomenon known as "hen crazy". Most existing breeds and varieties are the result of human intervention. The fourth phase occurred in the twenty-first century when the cultural phenomenon known as "hen crazy" gave rise to today's massive chicken meat and egg industry (Crawford, 1990). The

industry has moved quickly to incorporate cutting-edge technological, genetic, and breeding advances. A small number of breeds, varieties, and strains are now responsible for the vast majority of food production.

An overview of the poultry population in Ethiopia

All domesticated birds raised for human consumption (meat and eggs), including chickens, turkeys, ducks, geese, ostriches, guinea fowl, doves, and pigeons, are considered poultry. However, the phrase only applies to chickens in Ethiopia. Other species of birds, including ostriches, ducks, guinea fowls, doves, and pigeons found in their natural habitats are wild birds that have not been domesticated to produce meat and eggs (Molla, 2010).

Based on data from the Central Statistical Agency of Ethiopia (CSA, 2021), the country's total poultry population is approximately 57 million, including cocks, cockerels, pullets, laying hens, non-laying hens, and chicks. Indigenous poultry breeds account for the majority at 78.85%, while hybrid and exotic breeds make up 12.02% and 9.11% of the total poultry population, respectively (CSA, 2021) Among the different poultry types, laying hens comprise the largest share at 34.26%, followed by chicks at 32.86%. The number of pullets is estimated to be 6.47 million, while cocks and cockerels are also separately estimated at 6.38 million and 3.27 million, respectively. Non-laying hens constitute a relatively small portion of the total poultry population, accounting for around 4.59% or 2.61 million chickens. The data obtained (CSA, 2021) also reveals that the indigenous, hybrid, and exotic poultry breeds account for 78.85%, 12.02%, and 9.11% of total poultry, respectively. Table 1 provides a comprehensive summary of the estimated number and percentage of poultry by type and breed (indigenous, exotic, and hybrid/cross-breed) that offers an insightful overview of the poultry population in Ethiopia.

Table 1. Estimated number and percentage of poultry by type and breed in Ethiopia

Poultry type	All		Indigenous		Exotic		Hybrid	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Cocks	6,380,732	11.19	5,160,983	9.06	398,452	0.70	821,296	1.44
Cockerels	3,268,614	5.74	2,364,747	4.15	316,885	0.55	586,982	1.03
Pullets	6,474,755	11.36	4,688,266	8.23	675,687	1.19	1,110,802	1.95
Laying hens	2,614,965	4.59	2,117,083	3.71	205,449	0.36	292,433	0.51
chicks	18,729,950	32.86	16,322,355	28.64	1,244,426	2.18	1,163,169	2.04
Non-laying	19,523,972	34.26	14,287,489	25.07	2,353,446	4.13	2,883,037	5.06
Total	56,992,987	100	44,940,924	78.86	5,194,345	9.11	6,857,718	12.03

Source: CSA (2021)

Table 2. Some native chicken production performance comparison in Ethiopia, Ghana and Tanzania

Parameters	Average (Number)	Sites	References
Average egg per clutch	13.56-15.4	Ethiopia (Southeast, Metekel)	Negassa et al. (2014), Zewdu et al. (2013)
Average clutch per hen per year	3.0-4.29	Ethiopia, Ghana	Zewdu et al. (2013), Hagan et al. (2013)
Average egg set per hen	11.3-10.3	Ghana, Tanzania	Hagan et al. (2013), Guni et al. (2013)
Average egg per hen per year	45.2-59.51	Tanzania, Ethiopia	Guni et al. (2013), Zewdu et al. (2013)

Table 3. Estimated number of hen egg production per year of native or local chickens in some African countries

Country	Number of hen egg production per year	Reference
Ethiopia	> 80	Dessie and Ogle (2001), Zewdu et al. (2013)
Morocco	60- 80	El Houadfi (1990), Benabdeljelil and Arfaoui (2001)
Senegal	50 – 60	Boye (1990), Missohou et al. (2002)
Somalia	100 -144	Ahmed (1990)
Namibia	100-150	van Niekerk (1998)
Togo	80 -150	Aklobessi (1990)

Ethiopia native chicken ecotypes

Native chickens in many developing countries may include mixed (unspecified) breeds or ecotypes resulting from panmictic breeding (Mushi et al., 2005). Several ecotypes of chickens have been identified and characterized in Ethiopia, including *Tilili, Horro, Jarso,* and *Tepi,* as reported by Dessie et al. (2003). Additionally, *Gelila, Debre Elias, Melo-Hamusit, Guangua,* and *Mecha* were identified and characterized by Mogesse (2007), while *Farta, Konso, Mandura,* and *Sheka* were identified and reported by Dana et al. (2011), and *Hemete, Kukuate,* and *Yeberha Tsehaye* were reported by Getu (2014). Besbes (2009) found that improved genotypes were distributed in many countries to improve the livelihoods of beneficiaries. As indicated by Hassen et al. (2009), indigenous chickens in many parts of Africa have high genetic variability between and within ecotypes and populations, implying that genetic improvement of these chickens through selective breeding is possible.

Ethiopian native chickens' performance

Native chicken production performance

Backyard-reared chickens are generally low in productivity, producing (annually) around 40-60 small-sized eggs and varying degrees of hatchability, with low chick survival rate (Dana et al., 2010; Melesse and Negesse, 2011). According to some studies, approximately 40-60% of chicks that hatched, die within the first 8 weeks of life owing to various vaccine-preventable diseases and predators (Demeke, 2007; Molla, 2010; Moges et al., 2010). According to FAO (2010), there are no significant differences in the backyard chicken production system in five different zones of Ethiopia. Backyard-based chicken production needs less space and lower initial investment cost, compared to other livestock and thus plays an essential role in improving the livelihoods of resource-constrained families (Leta and Endalew, 2010). According to Moges et al. (2010), half of the eggs produced by laying hens must be incubated to replace those that have perished. The brooding period for these hens is relatively longer, and multiple cycles are required to make up for unsuccessful brooding attempts.

The smallholder system's productivity of village chickens is relatively inefficient, compared to on-station performance, characterized by low productive performance and high reproductive wastage, as indicated by some authors (Dessie and Ogle, 2001; Pedersen, 2002). Furthermore, Moges et al. (2010) assert that the production potential of native chickens is significantly constrained by their smaller egg size, reduced annual egg output, and lower body weight relative to exotic breeds. The available feed to the chickens also influences productivity, as quality and quantity vary erratically across seasons. On the other hand, these chickens can utilize locally available feed, including household waste, and they do not compete with humans for grain (Sonaiya, 1990).

Table **2** indicates the summary information of some native chicken production performance comparison in three African countries, namely Ethiopia, Ghana, and Tanzania.

Compared to their exotic counterparts, native hens have a strong maternal instinct and high broodiness (Dana et al., 2011). Research conducted by Dessie et al. (2003) revealed that the mean egg-laying performances of hens for their top three clutches were 17.0, 20.9, and 24.8, respectively. The Ethiopian Ministry of Agriculture (1980) also reported that under village conditions, native chickens produce 30 to 40 eggs, which can be doubled to 80 eggs per year with improved management such as feeding, watering, housing, and healthcare. The relatively lower productive performance of native chickens compared to the White Leghorn breed is attributed to their thicker eggshells. However, their fertility was higher when compared to the exotic chickens (Alemu and Tadelle, 1997).

Table 3 provides an overview of the estimated annual egg production for various indigenous chicken breeds from different African countries in comparison with that of native chickens in Ethiopia, presenting a comparative analysis of egg output per year among different groups. According to the summary review results, the average performance of egg production per hen per year in some African countries ranges from 20 to 150 eggs per year, which could be attributed to breed performance and management practices. Although the performance of Ethiopian native chickens per hen per year is comparable, the majority of them are scavenging chickens that are also poorly managed by the farmer community. Aside from improving breed performance, better management practices can increase the number of eggs harvested per year from individual chickens.

Average egg per clutch

Clutch size is the number of eggs laid in a single nest. The average egg per clutch is the number of eggs laid in a single nest when different chickens of similar ecotypes or breeds are considered. In the western region of Ethiopia, the average number of clutches per year is 2.67,

with an average of 10.07 eggs per clutch and a single clutch duration of 27.9 days. According to a study by Alewi et al. (2015), the average number of eggs per hen per clutch in Bure, Fogera, and Dale districts of Ethiopia was 15.7, 13.2, and 14.9 eggs, respectively.

Average clutch of a hen per year

According to Mogesse (2007), an assessment of local hens in Northwest Ethiopia for their production performance average clutch per hen per year shows that these local chickens are expected to produce 2 to 3 clutches per year. Based on the assumption of three clutches per year for each individual, the hen would have to be out of production for approximately 168 days each year in their reproductive life. Meanwhile, in Southern Ethiopia, hens produce an average of 4.6 clutches per year, with each clutch consisting of about 15.4 eggs, as reported by Alemu (2020). In the same study, they reported that the average duration of egg-laying periods among local, hybrid, and exotic breeds of hens was 21, 38, and 159 days, respectively. Another study by Alewi et al. (2015) indicated that local hens in Metekel, Northwest Ethiopia, typically produce an average of 13.6 eggs per hen per clutch, and they have about 4.3 clutch periods per year under farmer management conditions. According to a study conducted by Banerjee (2012), the observed variations in the number of clutches per hen per year may be due to the genotype by environmental interaction effects. In addition to genetic factors, the poor management of traditional household poultry production systems may also contribute to the low productivity of native breeds. It is worth noting that these factors can significantly influence the reproductive performance of avian populations and have significant implications for conservation effort.

Average egg of a hen per annum

According to Tesfay et al. (2018), native household poultry in Ethiopia typically lays approximately 36 eggs in three clutches per year, with each clutch consisting of 12-13 eggs and lasting about 16 days. Meanwhile, Litigebew et al. (2021) reported an average of 3.2 clutches per year for each indigenous hen in Northern Ethiopia, with a mean clutch length of 21.6 days. Cross-bred hens had an average of 3.1 clutches per year, ranging from 18 to 40 days, while exotic breeds had an average of 3.2 clutches per year, with a mean clutch length of 44.4 days. In Northern Ethiopia, Getu et al. (2014) found that under small-scale management, local chickens produced an average of 54.3 eggs per year, with an egg weight of 42.2 g. The total number of eggs produced per hen per year in the Bure, Fogera, and Dale regions of Ethiopia was reported as 60, 53, and 55, respectively. However, according to Tadesse et al. (2015), indigenous poultry in Northwest Ethiopia yielded an average of 59.5 eggs per year under household management conditions. Metanne and Afardual (2015) reported that a significant number of average eggs per hen per annum was 78 eggs for Moroccan hens, with a general mean egg size of 44.1 grams. Meanwhile, Getu and Birhan (2014) observed that the household management system typically resulted in low productivity of indigenous chickens due to high chick mortality rates prior to hatching. This lack of controlled breeding methods and management, along with uncontrolled breeding between different ecotypes of indigenous poultry, likely contributes to the variable performance of native breeds.

Table 4. Different reproduction performances of native chicken ecotypes conveyed in different parts of Ethiopia

Parameters	Average	Sites	References
Age at first laying (month)	6.9-7.13	BG, B	Sisay (2017), Moges et al. (2010)
Age of cockerels at first mating (month)	5.87-6.15	SW, B	Negasi and Melaku (2016)
Age of pullets at first mating (month)	5.20-5.93	BG, M	Sisay (2017), Zewdu et al. (2013)
The reproductive life span of males (year)	3.79	M	Zewdu et al. (2013)
The reproductive life span of hens (year)	3.56	M	Zewdu et al. (2013)
Fertility (%)	75-78.6	B, WG	Moges et al. (2010), Mogesse (2007)
Hatchability (%)	59.6-82.83	B, EG	Moges et al. (2010), Yitbarek and Zewudu (2014)
Brooding length (month)	3.5	EG	Yitbarek and Zewudu (2014)

BG: Benishangul-Gumuz, SW: South Wollo, M: Metekel, B: Bure, EG: Eastern Gojjam, WG: West Gojjam

Table 5. Linear body measurements of male and female indigenous chickens from different parts of Ethiopia

Parameters	Female	Male	Sites	References
SL	6.53 ± 0.13	7.42 ± 0.27	Arsi, Oromia	Negassa et al. (2014)
CHC	25.06 ± 0.06	24.98 ± 0.13	North Shewa	Yisma and Kebede (2015)
CL	2.48 ± 0.73	4.82 ± 1.70	Arsi, Oromia	Negassa et al. (2014)
BW	1.37 ± 0.02	1.63 ± 0.03	North Gonder	Getu et al. (2014)
BDL	22.65 ± 1.40	24.11 ± 1.11	Arsi, Oromia	Negassa et al. (2014)
KL	8.29 ± 0.02	8.34 ± 0.05	North Shewa	Yisma and Kebede (2015)
WL	1.48 ± 0.03	3.97 ± 0.10	South Wollo	Negasi and Melaku (2016)
NL	10.8 ± 0.05	11.1 ± 0.12	North Shewa	Yisma and Kebede (2015)
BKL	17.0 ± 0.05	17.3 ± 0.13	North Shewa	Yisma and Kebede (2015)

CHC: Chest circumference (cm), BKL: Back length (cm), SL: Shank length (cm), NL: Neck length (cm), KL: keel length (cm), CL: Comb length (cm), BDL: Body length (cm), WL: Wattle length (cm), and BW: Body weight (kg)

Native chicken reproductive performance

Age of sexual maturity and first mating

The information provided in Table 4 summarizes various studies conducted on the age at sexual maturity of male and female native chickens, including the number of eggs per clutch, the number of clutches per year, and egg production per hen per year in different regions of Ethiopia. Genetic and non-genetic factors may influence the observed differences. Guni et al. (2013) found differences in the age at first egg for pullets due to genetic and non-genetic factors. Native female chickens reach sexual maturity at 27.2 weeks or 6.8 months. Another report by Owoya et al. (2018) indicated that the average age for native chickens to reach sexual maturity is 23.48 weeks and 23.6 weeks, respectively. In contrast, Moges et al. (2010) reported the average age of initial mating for male and female chickens to be 24.6 and 27.5 weeks, respectively, in the Burie district of Ethiopia. In Beneshangul-Gumuz, western Ethiopia, male chicks reach initial mating age at 24 weeks (Sisay, 2017).

The average age of initial mating for native male chickens in the Metekel zone of Northwest Ethiopia was reported to be 20.8 weeks (Alewi et al., 2015). Similarly, Kamel (2016) found that the initial mating age for the crosses of Fayoumi and Naked-neck and the Rhode Island Red and indigenous white poultry was 26.1 and 26.4 weeks, respectively.

Age at first laying

According to Sisay (2017), native chickens in the western Amhara region of Ethiopia start laying eggs at 26 weeks of age. Furthermore, in Beneshangul-Gumuz, western Ethiopia, the average ages for female chickens' first mating and egg-laying are 23.7 and 28.5 weeks, respectively. According to Litigebew et al. (2021), native local breeds of chicken between 24 and 28 weeks of age laid their first eggs at an average age of 27.2 weeks compared to hybrids and exotics of the same age laid their first eggs at an average of 25.7 and 25.4 weeks, respectively. The findings of the research suggested that cross-bred and exotic chicken breeds have a shorter onset time for laying eggs compared to indigenous chicken ecotypes/breeds and can initiate the process at younger ages. According to reports from other parts of Ethiopia, the age of the first clutch of chickens is shortened as the breed's genotype is upgraded from a local low-yielding to an exotic high-yielding one.

Reproductive life span

According to Kibret (2008), the reproductive life span of native chickens is longer than that of exotic breeds. However, the author also noted that in terms of long-term reproductive performance, including life span, fertility, hatchability, and egg production, exotic breeds have a better performance than native breeds. The reproduction potential of native chickens is harmed because they mature later than exotic chickens (Pedersen, 2002). This condition could be attributed to selection goals, with native chickens primarily chosen for their adaptive characteristics from a socio-cultural angle. In contrast, exotic chickens were chosen for their production and reproductive abilities. According to Zewdu et al. (2013), the reproductive life spans of males and females in the Metekel zone of Northwest Ethiopia were 3.79 and 3.56 years, respectively.

Hatchability percentage

Hatchability percentage is the proportion of eggs that survive incubation and hatch into chicks. Hatchability is a crucial economic factor in the poultry industry because it significantly impacts chicken output Malik et al. (2015). From the early years to now, eggs from native chickens

were hatched by placing them under broody hens in Ethiopia. Moges et al. (2010) reported a natural hatchability percentage of 82.83% for native chickens from the Bure district of northern Ethiopia. The natural hatching percentage of local chickens in Ethiopia under the backyard management system is higher than the hatching percentage of local chickens (73.6%) under backyard management conditions in Pakistan (Farooq et al., 2003). This difference in hatchability could be attributed to differences in the genotype and husbandry practices of chickens in different parts of the world. In addition, as indicated by Kirunda and Muwereza (2011) and Yemane et al. (2013), the hatchability can be affected by a factor such as laying season, disease, nutrition, age, egg quality, genetic factors, hygiene, and the condition of incubation. Furthermore, the variation in hatchability may also arise from the incapacity of broody hens to generate sufficient heat when attempting to incubate a number of eggs that surpass their ability to accommodate beneath their wings.

Brooding length

In the poultry industry, the phrase "chicken brooding length" refers to young chicks (0-8 weeks old) that require additional warmth to maintain their average body temperature. Hassen et al. (2009) found that native hens in Northern Ethiopia have a brooding length of 56 days when raised under scavenging conditions. Conversely, Yitbarek and Zewudu (2014) reported a more extended brooding length (3.5 months) in the Eastern Gojjam region of Ethiopia, indicating a higher level of variability in brooding length in Ethiopia.

Morphometric and morphological characterization of Ethiopian native chickens

Morphometric characteristics of Ethiopian native chickens

According to the Food and Agriculture Organization (FAO, 2012), phenotypic characterization of livestock, which entails identifying diverse breed populations and characterizing their features and production conditions, is a word widely used to describe the process of studying chickens. The term "Indigenous breed" is used to refer to chickens that are raised under a complex system, scavenge in the wild, lack a distinct description, have multiple purposes, and are found in large numbers, as stated by Horst (1989). Indigenous chickens are known to possess variable morphological characteristics and genes with adaptive values to their environment and diseases. They have a variety of morphological qualities as well as genetic characteristics that aid in adaptation to various habitats and disease resistance. Certain local breeds, for example, may have developed inherent resistance to common chicken diseases prevalent in their region, allowing them to survive under certain conditions. Furthermore, morphological characteristics such as feather color, body size, and beak shape can change dramatically amongst indigenous chicken populations, indicating adaptations to local climates, predator avoidance, or other environmental factors. According to Horst (1989), indigenous chickens can also serve as a gene pool, especially for genes linked to adaptive values in tropical environments. The diversity of phenotypes observed in Ethiopian indigenous chickens is also a clear indication of their high genetic variability (Aklilu, 2013). Various researchers have reported some linear body measurements of indigenous chickens from Ethiopia, which are summarized in Table 5.

Morphological characteristics of Ethiopian native chickens

In Ethiopia, the plumage color of a chicken holds significant socio-cultural and religious value. According to Dessie and Ogle (2001), the red and white cock is sacrificed to invoke good rainfall and bountiful harvest, while the red and black spotted (Gurraacha) cock is offered during the New Year's celebration. Similarly, the white and black spotted (Gebsima) cock is sacrificed to avert evil and calamities, and the red pullet is offered as a sacrifice for deceased ancestors following animistic beliefs. The differences in plumage type are also related to adaptive features, with frizzled and naked-neck birds better adapted to tropical climates (Melesse and Negesse, 2011). Variations in morphology may impact the market value of chickens (Mengesha, 2012). The information provided in **Error! Reference source not found.** summarizes native Ethiopian chickens have distinct morphological characteristics and are found in various ecotypes of the country.

As mentioned by Nesheim et al. (1979), the size and color of a chicken's comb and wattles are closely linked to gonad development and the secretion of sex hormones. In hot tropical regions, the morphological characteristics of large combs, wattles, and long legs play a crucial role in dissipating heat, as emphasized by Horst (1989). Although they are not classified as major genes, these characteristics are the outcome of a combination of multiple genes and their intricate interplay. Therefore, when striving to breed high-performance local chicken species suitable for hot tropical climates, it is imperative to incorporate the coding genes responsible for these characteristics, as suggested by

Horst (1989).

Table 6. Some distinct morphological characteristics of Ethiopian native chickens' ecotype

Ecotype	Distinct morphological feature	Sites	References
Mecha	Plain and crest head shape, pea comp	West Gojjam	Mogesse (2007)
Farta	Crest head shape, pea comp type	South Gondar	Mogesse (2007)
Sheka	Flathead, pea comb, yellow shank color	SNNP region	Dana (2011)
Horro	Flathead shape, pea comb, yellow shank color	East Welega	Mogesse (2007)
Jarso	Red plumage color, no black eye color	East Hararghe	Aklilu et al. (2013)
Tepi	Naked neck, black eye, single combed	Tepi	Dessie Alemayhu (2003)
Tilili	Pea comb, lack of shank feather	West Gojjam	Mogesse (2007)
NN	Aggressive, absent of feather at neck	Quara	Getu et al. (2014)
Gasgie	Long-necked and red color	Alefa	Getu et al. (2014)
Sheka	Flathead, pea comb, yellow shank color	SNNP region	Dana (2011)

NN: Necked neck, SNNP: Southern Nations, Nationalities, and Peoples' Region

Figure 1. Morphological characteristics of some Ethiopian native chickens. A: Male and female chickens of Horro (Dana et al., 2010), B: Cock with red (Kei) plumage, southeastern Oromia, Ethiopia (Negassa et al., 2014), C: Wosera (yellowish brown) hen with a single comb and yellow shank of southeastern Oromia (Negassa et al., 2014), D: Sheka male chickens (Dana et al., 2010), E: Tikur (Black plumage color hen), a single comb and black shank, Southeastern Oromia, Ethiopia (Negassa et al., 2014) and F: A single comb 'Gebsima' male of the Farta (Dana et al., 2010).

According to Alemu and Tadelle (1997), local chickens in Ethiopia exhibit significant variation in their physical attributes, such as body size, conformation, and plumage color. The native chicken breeds are distinguished by different names like Netch (pure white), Tikur (black), Keyi (deep red), Gebsima (mix of grayish shades), Anbesima (multicolored), Serago (white with red stripes), Libework (white with golden breast color), Key teterima (red with white stripes), Netch teterima (white with black or red stripes), Tikur teterima (black with white stripes), Kokima (red-brownish). In addition to plumage color, Kibret (2008) states that when naming native chicken ecotypes, people consider body shape, kind of feathering, and further phenotypic characteristics. Figure 1 displays a list of some morphological features of Ethiopian native chickens, along with their corresponding descriptions.

CONCLUSION

This review has identified significant differences in the production and reproductive performance as well as morphometric and morphological characteristics among the different ecotypes of native chicken populations in Ethiopia, which are managed by hundreds of millions of rural smallholder farmers. Although the significant variability of Ethiopian native chicken across different agroecological zones of Ethiopia is reported by many researchers, each native chicken ecotype in Ethiopia is named after its color and place of discovery. Moreover, no distinct breed is reported. To preserve the genetic diversity of these native chicken population, a well-organized and comprehensive research approach is required. This should involve characterizing native chicken ecotypes in all Ethiopian agroecologies, under the same season, to reduce non-genetic variation in production and reproduction performance characteristics, as well as determining morphometric and morphological variation with the support of molecular characterization. The results of the present study can be used to categorize the different ecotypes among distinct breeds before they are entirely mixed with exotic or cross-bred chickens.

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Availability of data and materials

For this study, no new data were created or analyzed, instead, published research, articles, and other verified materials from multiple sources were used. As a result, the data supporting the context of this study are entirely extracted from the resources cited in the reference section of this research, and data sharing is not applicable to this article.

Authors' contributions

Kefala Taye Mekonnen and Kang-Seok Seo conceptualized the idea and Kefala Taye Mekonnen, Dong-Hui Lee, and Young-Gyu Cho wrote the first draft of manuscript. Kefala Taye Mekonnen, Dong-Hui Lee, Young-Gyu Cho, and Kang-Seok Seo reviewed and edited the writing and all authors have read and approved the final manuscript.

Ethical consideration

The authors have ensured that the research adheres to ethical principles such as avoiding plagiarism, obtaining consent to publish, avoiding misconduct, preventing data fabrication or falsification, refraining from double publication or submission, and avoiding redundancy.

Competing interests

The author declares that there is no competing interest with any financial organization regarding the materials discussed in the manuscript.

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