

Review Article

Review on phenotypic characterization and breeding objective traits of indigenous chicken in Ethiopia

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Abstract

For local chicken ecotypes, knowledge of the distribution of genetic diversity will be useful for optimizing conservation and utilization strategies. In Ethiopia, rural chickens are found in huge numbers distributed across different agroecological zones under a traditional family-based scavenging management system. However, due to the prevalence of diseases and predators, low genetic potentials, feed shortage, and limited feed resources, constraints related to the institutional, infrastructural, socio-economic, and economic contribution of local chickens are not proportional to their huge number. Therefore, the aim of this review was to describe the production system, phenotypic characterization, and breeding objective traits of local chicken ecotypes. Overall desired traits by farmers are body weight, comb type, breeding ability, plumage color, body conformation, egg number, and size, adaptive trait, and mothering ability. Generally, these traits are considered important for selecting chicken in a market for meat and egg consumption and for breeding purposes in Ethiopia. Therefore, these preference traits and breeding objectives of farmers are important to improve the genetic part of chickens in Ethiopia.

Introduction

Agriculture is the key driver for mass poverty reduction and rural development for most of the developing world (World Bank, 2008). It is the main economic pillar of the Ethiopian economy and the overall economic growth of the country is highly dependent on the success of the agriculture sector. The sector represents 4.2 % of the GDP of the country and about 85% of the population gains their livelihood directly or indirectly from agricultural production [1].

In Ethiopia, local chickens are found in huge numbers distributed across different agro-ecological zones under a traditional family-based scavenging management system and variations in morphological and morphometric traits are common among local chicken populations. However, the local chickens that have mainly been selected naturally or by the farmers who keep them for their adaptive fitness to a specific area are often poor in their egg production and characterized by late maturation as well as long broodiness due to the

prevalence of diseases and predators, low genetic potentials, feed shortage and limited feed resources, constraints related to institutional, infrastructural, socio-economic and the economic contribution of local chicken is not proportional to their huge number (Bekele, et al. 2015).

Therefore, characterization, identification of breeding objectives, utilization, and conservation of indigenous genetic resources are paramount, improvement and conservation of indigenous chicken resource demand characterization of the available genotype (Getachew, et al. 2015).

Objective

To review phenotypic characterization and identify breeding objective traits of indigenous chicken ecotypes in Ethiopia.

Local, Exotic, and hybrid chicken population in Ethiopia: At the national level, the entire local chicken population is estimated to be about 16,307,775 chickens in Amhara, 14,902,847 chickens in Oromia, 1,495,272 chickens in Sidama,



1,110,430 chickens in Benishangul, 5,284,885 chicken in SNNP, 4,917,075 chicken in Tigray, 318,437 chicken in Somali, 298,830 chicken in Gambela, 122,880 chicken in Harari, 99,3561 chicken in Dire Dawa and 83,138 chicken in Afar region [2].

According to the CSA [2], the entire chicken population in Ethiopia is assessed to be includes cocks, cockerels, pullets, laying hens, non-laying hens, and chicks. Most of the poultry are laying hens (34.26%), followed by chicks (32.86%). The others are non-laying hens 2.61 million which constitute about 4.59% of the whole chicken populous in the country (Table 1).

Husbandry and breeding practices of local chicken

In Ethiopia, the poultry sector is based on some selected parameters such as breed, flock size, housing, feeding, health, technology, and bio-security. According to the FAO [3], the poultry production systems of Ethiopia are classified into industrial, medium, and family poultry production systems. Whereas, an extensive production system with the integration of other farming systems is well known in Ethiopia.

Feeding and feed resources

In Ethiopia, the free-range scavenging production system is the most commonly practiced type of local chicken production system. Under a scavenging system, most chickens are raised in small flocks where under household refuse, crop residues, homestead pickings, herbage, and seeds are provided by the flock producers as feed resources for chickens. Derby [4] reported that the majority of the respondents (96.1%) in Ankober woreda of the North Showa zone practiced a scavenging system with supplementation. Similarly, Bosenu and Takele [5] also reported that all (100%) of the respondents in Haramaya Woreda of Eastern Ethiopia practiced a scavenging system with supplementary feeding. Overall, different authors reported that feeding practices and feed resources of local chickens in rural areas of the country are almost comparable whereas most producers rear their chickens under a scavenging system and certain farmers provided supplementary feed for their chickens.

Housing system

In rural villages of Ethiopia, often there is no special housing constructed for birds. Shishay [6] reported that in the Western zone of the Tigray region, 59.5% of the entire respondents constructed isolated houses for their chickens,

and a consistent result was reported by Fikadu [7] who suggested that out of sampled households, about 47.5% of the farmers' prepared separate overnight houses for their birds in Kersa district of Jimma zone. The major problems were a lack of awareness about poultry houses, weak extension support, and capital shortage associated with the constraints of building separate chicken houses. A similar result has been reported in the different areas where farmers keep their chickens in the family dwelling, perches in the house, perches in the kitchen, and perches on the veranda due to a lack of awareness, construction materials, and fear of predators.

Mating system, culling, and selection criteria

Even though controlling the mating of local chickens in the free extensive production system is difficult, farmers have their Indigenous knowledge of culling and selection criteria for breeding based on body weight, egg production, comb type, and body plumage color. The finding conducted by Melak, et al. [8] in Dawro and Konta districts showed that most of the respondents cull their chickens which are body diseases with an index value (of 0.54) in the midland and 0.27 in the lowland. Based on important culling criteria (age) they also culled decreased egg production chicken with an index of (0.21) in midland and (0.44) in lowland altitude. The next culling criteria were comb-type with an index value of 0.07, and 0.02 in the midland and lowland altitude, respectively. Multiple authors like Melaku [9], Fitsum [10], and Andualem, et al. [11], reported that farmers culled their chickens because of poor productivity, old age, low body weight, and bad plumage color, and poor egg quality in different parts of the country.

Birhan, et al. [12] reported that due to the extensive production system, only 29.5% of farmers tried to improve their local chicken by controlling mating by selecting the best male and female for the breeding purpose from their flock (25%), culling poor performance of chickens (62.5%) and cull at an early age (12.5%) whereas, most of the households (70.5%) were practiced uncontrolled mating system in three districts of Western Amhara region. Gutu and Yosef [13] reported that respondents in the BakoTibe district selected hens and cocks for breeding mainly based on criteria such as high egg production, body size or weight, brooding ability, and growth rate. In the same way, Hailemichael, et al. [14], also reported the majority of farmers selected breeding hens based on egg production, brooding ability, large body size, plumage color, and comb type in the Southern zone of Tigray.

Table 1: Estimated number of poultry by type and breeds in Ethiopia.

Type of Poultry	All		Indigenous		Exotic		Hybrid	
	Number	%	Number	%	Number	%	Number	%
All type	56,992,987	100	44,940,924	78.85	5,194,345	9.11	6,857,718	12.03
Cocks	6,380,732	11.2	5,160,983	9.06	398,452	0.7	821,296	1.44
Cockerels	3,268,614	5.74	2,364,747	4.15	316,885	0.56	586,982	1.03
Pullets	6,474,755	11.36	4,688,266	8.23	675,687	1.19	1,110,802	1.95
Non-layer	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
Layer	19,523,972	34.26	14,287,489	25.07	2,353,446	4.13	2,883,037	5.06

Source: [2]

In general, an uncontrolled mating system is predominant due to the free extensive production system in most of Ethiopia, and chicken owners gave the greatest emphasis to the trait of economic importance and functional trait for the selection criteria of breeding hen and cock.

Marketing systems and practices

Eggs and live chickens are sold on an ordinary day in Ethiopia. Whereas, seasons, phenotypic natures of chickens, and holidays influence the value of chickens. Owners get better prices from matured chickens of both live female and male chickens in the usual market in the North Gondar zone [15]. Specific colors and comb types with corresponding age and sex are high in demand for particular traditional and religious festivals and fetch higher prices as compared to birds with the same color and comb type [16]. Depending on the location of the farm-dwelling village chicken and eggs are sold in local and urban markets to traders or directly to consumers [17].

Most farmers sell local chicken and eggs to purchase household consumption materials like onion, salt, kerosene, etc. Egg and chicken marketing are informal and underdeveloped in Ethiopia. Informal marketing of chicken and chicken products at open markets is common in most rural Ethiopia and sold at roadside stops [18].

Flock size and composition

A survey carried out in the East Hararghe of Oromia regional state by Asmelash, et al. (2018) revealed the average flock composition of chickens per household is Layer (42.29%), chicks (23.16%), cocks (14.23%), pullets (15.53%) and spent chickens (4.77%). The higher proportion of layers in the flocks is an indication of a strong desire for egg and chick production. Getachew, et al. [19], reported that the overall number of hens, cocks, cockerels, and chicks in the Gambella region was 4.89, 1.71, 1.52, and 3.44 respectively.

Derbie [4] suggested that the average local chicken holding in Ankober woreda was 11.12 and the mean holding per household for hens, cocks, pullets, cockerels, and the young chicken were 3.43, 1.16, 1.81, 1.57, and 3.16, respectively. Overall, variations of flock structure size reported in different parts of the country might be due to the occurrence of the prevalence of disease, predators, availability of feed resources as well as the overall husbandry and socio-economic status of the household that regularly sells chickens to meet their immediate financial needs.

Constraints of local chicken production

The productivity of local chickens is lower than exotic breeds. Melak, et al. [8], reported that the major constraints of chicken production in the Dawro and Konta districts were disease, predators, unknown causes, and drought. Amanuel, et al. [20], also suggested that poultry diseases are widely spread and serious disease outbreaks devastate the flock in the Buno Bedele zone. The commonest disease outbreak was reported to be Newcastle disease. A similar finding conducted in the Asagrit district, Northern Shewa zone [21] revealed that disease,

predators, feed shortage, marketing system, and lack of training and extension service were the major identified problems of chicken production. In general, different authors reported that poor veterinary health services, diseases, predators, shortage of feed, low genetic potential, and chicken housing problems were the major identified constraints of chicken production in many parts of Ethiopia.

Effective population size and level of inbreeding

The variability of genetics within a population is estimated by effective population size (N_e). More variability suggested large values of N_e in the flock and small values indicated less genetic variability [22,23]. Inbreeding is the probability that two alleles at any locus in an individual are identical by descent relative to a base population (Falconer and Mackay, 1996). The maximum acceptable level of inbreeding is 0.06 [24] inbreeding higher than this value may decrease genetic diversity because the gene pool narrows.

Hailemichael [14] reported 0.16, 0.15, and 0.14 rates of inbreeding for the Endamehari, Ofla, and Raya-Azebo districts of the chicken population, respectively. But, higher than the finding of Abiyu, et al. [25], who reported a rate of inbreeding (0.11%) in the Kaffa zone, Ethiopia.

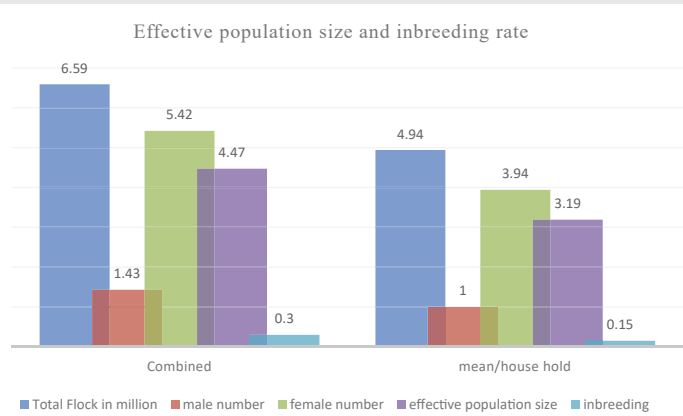
Nigusie, et al. [26], reported that from 31% to 55.6%, of the farmers of different regions of Ethiopia did not own breeding males. Most of them shared breeding males with neighbors. The largest effective population size was recorded in Konso with the subsequent lowest inbreeding coefficient.

The overall mean effective population size (N_e) and the rate of inbreeding (ΔF) for the local chicken flock reported by Fitsum (2016) in the central zone of the Tigray region were 3.99 and 0.13, respectively. According to Tadele, et al. [27], reported that the overall effective population size (N_e) was found to be 4, 8, and 6 while the respective rate of inbreeding was 0.07, 0.126, and 0.13 % in the Decha, Chena, and Gimbo districts of Kaffa zone, South-Western Ethiopia.

Fikadu [7] reported that the effective population size (N_e) estimated in highland, midland, and lowland altitudes were 6.92, 5.64, and 6.79, respectively whereas the rate of inbreeding per generation (ΔF) was 0.07, 0.09 and 0.07, respectively in Seka, Chekorsa, and Kersa districts of Jimma zone. Generally, the following graph shows the actual number of breeding females and males in the flock influences the effective population size (N_e) at a given time and is thus subject to change due to variation in the flock size, and type of rearing practice. The rate of inbreeding coefficient per generation changes with any change in the effective population size Graph 1.

Importance of local chickens and their characteristics

Local chicken breeds are generally hardy, adaptive to rural environments survive on little inputs, adjust to fluctuations in feed availability, are resistant to some diseases, and have good meat flavor and egg [16]. Village chicken represents a source of cash income for immediate household expenses and nutrition in most parts of Ethiopia for rural household



Graph 1: Effective population size and inbreeding rate of indigenous chickens at the national level.

Source: CSA 2021 [2].

livelihoods [28]. Both chicken meat and egg production have certainly been associated with reducing the gap in the supply of animal protein for human consumption. However, their advantage is largely limited to the generation of small cash income and home consumption in rural households. But, they have a great value in the cultural and religious life of rural communities than exotic ones. The local chickens in Ethiopia show a great difference in their comb type, body size, plumage color, conformation, and feather cover [29]. Broody hens are the sole means of egg incubation and brooding young chicks in the Southwest Shewa and Gurage zones of Ethiopia [16].

Phenotypic characterization of local chicken

Identifying morphological characteristics of distinct populations and describing their production within a given production environment; including the description of breeds' production environments and recording of their geographical distributions are generally referred to as phenotypic characterization of AnGR (FAO, 2015). Many researchers have done their research for phenotypic characterization and identification of the available genetic resources of non-descriptive chicken ecotypes in Ethiopia. Bogale, et al. [30], reported the phenotypic characterization of indigenous chicken ecotypes in three districts of the West Hararghe zone, Oromia region. Whereas the majority of chickens had white and black plumage color in Odabultum (22.3%), light brown in Habro (16.4%), and black and brown in Darolabu (13.2%). Among the comb type, the rose comb type was predominant in all districts followed by single and pea. Mustefa, et al. [31], suggested that the majority of chickens in Southern Ethiopia were red plumage, earlobe, and eye color combined with yellow skin and shank color, dominantly observed in all districts (Bena Tsemay, Hamer, and Male). On the other hand, the plumage color of Male district and Hamer hens was dominated by grey color while brown, red, and black were observed in the majority of Bena Tsemay hens.

Red plumage color in the highland and midland and Gebshima (greyish) colors in the lowland was the predominant color of the local chickens reported by Andualem, et al. [11] in the Awi zone and the average body weight of local chickens in

highland, midland, and lowland agro-ecologies were 1.47, 1.75 and 1.71kg respectively, while the respective values for mature cocks and hens were 1.78 and 1.51kg. Variations were also observed in shank length, chest circumference, body length, neck length, wingspan, wing length, comb width, comb length, and shank circumference.

Overall, different scholars have reported that quantitative traits (body length, body weight, shank circumference, shank length, neck length, chest circumference, wattle length, comb length, wattle length, comb height, and keel length) and qualitative traits such as plumage color, comb color, comb type, shank color, ear lobe color, absence and presence of spurs, body shape and head shape as well as production and productive performance of indigenous chicken in different parts of the country. However, because of their large population size and wide distribution, only a small portion of Ethiopian local chicken is characterized and identified Figure 1.

Breeding objectives and selection criteria

The traits to be improved, the cost of production, and the income from the product sales related to a genetic change in each trait are referred to as breeding objectives. Thus, a top awareness of the production environments and production systems enables breeders to identify trait preferences and breeding objectives of flock owners and to plan effective and sustainable agroecological-based breeding programs.

Asmelash, et al. [32] reported that the main objectives of local chicken raised in Eastern Hararghe of Ethiopia were: sale for income (1st rank), for banking or means of saving (2nd rank), egg production (3rd rank), and for meat (4th rank). This finding contradicted the finding of Shishay, et al. (2016) who reported that farmers keep chickens for the ceremony (1st), home consumption and ceremony (2nd), and sales for income



Figure 1: Different body plumage colors of local chicken ecotypes in Ethiopia.



(3rd) in the midland agro-ecology of Western Tigray. Addisu, et al. [15], also reported that home consumption (30.4%), replacement (23.18%), and market reasons (18.1%) were the first, second, and third main rearing purposes of chickens in the North Wollo zone of Amhara regional state. The variation of breeding objectives reported by different authors indicated that farmers keeping chickens for different purposes and objectives are based on socioeconomic, trait preference, culture, and value of communities raising birds in various environments.

The trait preference of local chickens is different from region to region and production environment to production environment. For example, farmers in the Southern region of Ethiopia (*Konso* and *Sheka*) preferred the live weight of chicken as the first trait of interest whereas farmers in the Oromia (*Horro*) and Amhara (*Farta*) regions give the highest intensity for color plumage.

Farmers are interested in chickens that can fast grow and have a large body size for both sales to get cash income and home consumption [33]. A similar finding by Getachew, et al. [34], reported that desired traits for chicken in the index were physical appearance (0.17), weight (0.19), and comb-type (0.2) in South Wollo Ethiopia. Zelalem, et al. [35], also reported that farmers prefer chickens that have large numbers of eggs per clutch, large body size, good mothering ability, good meat and egg taste, and good disease resistance in Ethiopia.

The majority of farmers select chickens for traits, such as hatchability, egg production, large body size, good sitter and brooder (mothering ability), comb type, and plumage color in Southern Ethiopia. The most preferable trait by farmers was egg production because of its obvious benefits of selling eggs, hatching for replacement stock, and home consumption in Northern Ethiopia [36].

In general, for the choice of breeding females and males, chicken producers prefer traits with different emphasis categories such as growth rate, body size, feather color, shank length, wingspan, comb shape, chick production rate, clutch length, egg size, or weight, heat or drought tolerance, temperament, scavenging ability, brooding or hatching ability, egg productivity, and rearing or mothering ability.

Production and reproduction performance of local chickens

In Ethiopia, the production and productive ability of local scavenging chickens is generally low and characterized by the production of small-sized eggs, slow growth rate, low egg production performance, late maturity, an instinctive inclination to broodiness, and high mortality of chicks.

The average number of eggs per clutch per hen was 13.38 and the average number of times hens hatch in a year was 3.58 with an estimated average egg number of 47.90 per year in the Western Oromia region [13]. Similarly, Chenchu and Hailemichael (2016) [36] reported that the average number of eggs per clutch per hen was 14.09 in the Southern zone of Tigray. Tarekegn (2020) reported that the average age at first mating of local cockerels in the West Hararghe zone was 6.9 months and the average age at first egg lay of local pullets

was 7.4 months. Another finding carried out by Melaku [9] suggested that the age of the first egg of a pullet is 5.68 months in Southern Wollo for the beginning egg lay of pullets. Also correspondent with the finding of Tsegaye and Gebreegziabher [37] who reported that the age at the beginning egg was 7, 6.2, and 6.3 months in highland, midland, and lowland respectively in the Wolaita zone.

Conclusion

In general, the review showed that village chicken production systems are characterized by their low input-low output levels and the wide presence of phenotypic variation among chickens in Ethiopia. The variation observed in phenotypic trait, production performance, trait preferences, chicken production constraints, breeding practice, breeding purpose, and indigenous knowledge of farmers to culling their chicken, incur different diseases and techniques to survive feed shortage, and would indeed justify the need for designing breed improvement strategies for local chickens. To improve the living condition of rural farmers in terms of egg and meat production, selected breed, management practice, and breed improvement were useful, and dual-purpose breeds would be suitable to maximize the low level of farmer income. On the whole, the productive and reproductive of local chicken in Ethiopia were relatively low probably due to poor husbandry practice, diseases, predation, and low genetic potential. The significant differences in some performance traits of the indigenous chicken in Ethiopia are an indication of possible genetic and management diversity existing, hence there is a need to exploit this attribute for the planning of breeding programs for the improvement of future indigenous chicken.

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