7 African Domestic Poultry Genetic Resources, Diversity, and Unique Features

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Abstract

This chapter provides a detailed account of African domestic poultry genetic resources, their diversity, and unique features. It aims to bring together information to provide a comprehensive picture of the topic. Section 7.1 introduces African poultry genetic resources, their importance, and previous interventions conducted to better utilize this important resource. Section 7.2 deals with the origin of poultry genetic resources and their dispersal into Africa. The introduction of domesticated chickens into Africa is not well documented. Although indigenous birds have several adaptive traits and associated genes that are important in the tropics, the real value of indigenous chicken breeds is often underestimated. They have a poor appearance, relatively low productivity, and are consequently considered to have low value compared to their improved commercial counterparts. Chicken genetic resources are endangered and underconserved. However, there has been recent emphasis on local chicken breed development and conservation, which has gained attention. The section demonstrates how chickens have become a key part of the African poultry production system and how they can remain vital and instrumental, considering the current climate change. Sections 7.3, 7.4, 7.5 and 7.6 describe the available chicken and duck resources in different parts of Africa and out-

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line their unique features and population estimates. Considering the population size of these genetic resources, conservation efforts to support their utilization are addressed in Sect. 7.8. Furthermore, the importance of conserving poultry genetic resources using germplasm cryobanking (cryoconservation) is described. Section 7.10 describes genetic improvement attempts in Africa involving indigenous chicken populations. The information appears to be limited to a few examples, as not many improvement programs are ongoing, and information on some programs is not available. Section 7.11 describes the major constraints of poultry production in Africa, followed by the economic contributions in Sect. 7.12. The last chapter implies the way forward in the utilization of poultry genetic resources in Africa.

Keywords

Poultry · Genetic resources · Cryoconservation · Africa

Abbreviations

AU-IBAR	The African Union—InterAfrican Bureau for Animal Resources
CTLGH	The Centre for Tropical Livestock Genetics and Health
DAGRIS	Domestic Animal Genetic Resources Information System
DNA	Deoxyribonucleic acid
ESCs	Embryonic Stem Cells
FAO	Food and Agriculture Organization of the United Nations
FAO DAD-IS	FAO – Domestic Animal Diversity Information System
GDP	Gross Domestic Product
ILRI	International Livestock Research Institute
iPSCs	Induced Pluripotent Stem Cells
KALRO	Kenya Agricultural and Livestock Research Organization
NARS	National Agricultural Research Systems
MSCs	Mesenchymal Stem Cells
PGC	Primordial Germ Cell
SFRB	Scavenging Feed Resource Base

7.1 Introduction

7.1.1 Overview of African Poultry Genetic Resources

Poultry genetic resources have existed for thousands of years and many generations. They are found in a diversity of environments and production systems, and they were subjected to breeding improvement and natural selection (FAO 2014). The chickens, once domesticated, have adapted to specific environmental and farming conditions, resulting in within-population unique gene combinations. When direct measures of genetic diversity are unavailable, the number of breeds and ecotypes may provide a first indication of the farm species' genetic diversity. Breeds are commonly classified as indigenous or exotic, with indigenous populations often present in low-input–low-output production systems and exotic ones referring to commercial lines and imported fancy breeds. The poultry genetic resources, the entire chicken populations, exotic and commercial, contain genetic material of present or future value. The diversity of poultry genetic resources reflects a long history of natural and human selection as well as crossbreeding among not only domestic chickens but also, as recently discovered, with wild *Gallus* populations outside the center(s) of domestication (Lawal et al. 2020; Wang et al. 2020; Lawal and Olivier 2021).

Beyond their potential use as inputs to improve productivity and other traits of interest, understanding the resources and designing interventions to conserve and utilize species, breeds, and ecotypes is vital to benefit the households that depend on them. The poultry genetic resources are a starting material for breeding activities to improve the traits of interest. Conserving genetic resources is a means of safeguarding the resources

further to be utilized as food and other purposes considered necessary by the users. While in situ in vivo, we may call it conservation through utilization. Here, the utilized genetic resources are a warranty for their conservation. Conservation efforts should ensure broad-based genetic diversity to ensure availability for use by present and future generations. This can only be possible by knowing the within-species diversity and keeping important information in an orderly manner in breed databases such as the (DAGRIS 2021; DAD-IS n.d.).

Domestic chickens first appeared in Africa many centuries ago and are now an established part of the African agricultural landscape (Alders and Pym 2009). There are about 126 poultry genetic resources regarded as varieties or ecotypes in Africa (http://dagris.ilri.cgiar.org/). Most of them are hardly studied to show their actual worth, but some studies have revealed their potential as better-performing and adapted chicken populations. There has still been little effort in African countries to conserve the local chicken breeds or lines (Manyelo et al. 2020). Although African poultry genetic resources are resistant to prevalent disease, they are also known for low productivity (Dessie 2003). Poultry genetic resources in Africa are admired for their tolerance to common poultry diseases and uncertainty in feed quality and availability. They exist with minimal input supply (Desta and Wakeyo 2012). However, any improvement in the productivity of local chickens will require close attention to nutritional, breeding, and health aspects. Smallholders in Africa are the custodians of poultry genetic resources, and they kept them under a traditional scavenging system (Magothe et al. 2012a; Desta et al. 2013). Interventions to introduce high-performing chicken strains into Africa have been largely unsuccessful (Tadelle et al. 2003; Wondmeneh et al. 2016). Poultry keepers in African villages cannot afford the high input requirements (housing/shelter, commercial diets, and strict disease control/vaccination programs) associated with more genetically efficient breeds (Tadelle et al. 2003).

7.1.2 Importance of African Poultry Genetic Resources

Although indigenous birds have several adaptive traits and genes with utility in the tropics (Horst 1989a), the real value of indigenous chicken breeds is often underestimated, primarily due to their poor appearance, relatively low productivity, and alleged low "commercial" values. African poultry genetic resources are neglected, and relatively little attention has been given to them in the research and development agendas. Hodges (1990) stated that developing countries, in most cases, opt for high-performing commercial breeds from developed countries to increase animal productivity through crossbreeding or, if conditions allow, by breed substitution without adequately investigating the production system and potential of the indigenous birds. Although poultry (both meat and eggs) is an essential source of food and a means of investment that is important to the welfare of women and children in traditional and low-input systems, an alarming 34% of all chickens in Africa are at risk of being lost (FAO 2000).

7.1.3 Initiatives to Utilize Indigenous Poultry Genetic Resources

Emphasis on local chicken breed development and conservation has gained attention through several pioneering programs led by national institutions. For example, independent indigenous chicken improvement programs have been established involving promising local chicken breeds in Kenya (KALRO 1 and KALRO 2) (Miyumo et al. 2023), Ethiopia (Horro and Tilili) (Mulugeta et al. 2020), Tanzania (Horasi) Esatu 2022 (a) (Esatu et al. 2022), Nigeria (Noiler and Funaab-alpha) (Bamidele et al. 2019), and Cameroon (IRZ (Van Marle-Köster and Casey 2001)). They aim to improve egg production, growth, survival, and age of the first egg. These chicken strains were identified through previous characterization

and evaluation studies and possessed qualities appreciated by the poultry producers and consumers. Five of these programs were established through the support of the ILRI-led African Chicken Genetic Gains (ACGG) and Tropical Poultry Genetic Solution (TPGS) programs, while the programs in Nigeria and Cameroon were started earlier. Seven of these programs are applying mass selection supported by BLUP (Best Linear Unbiased Prediction) techniques to select the best-performing chickens based on the estimated breeding values. Further, there is the potential in the future of applying genomic selection with the characterization of the breeds at the genome level. This is currently being explored through collaboration between the newly established Center for Tropical Livestock Genetics and Health (CTLGH) and national partners. The CTLGH poultry program also includes the identification of local ecotypes and ex situ PGC (Primordial Germ Cell) conservation initiatives (see Sect. 7.8).

7.2 The Origin and Purpose of African Poultry in Relation to African Farming Systems: A Historical and Production Systems Perspective

7.2.1 Origin of Domestic Chicken and Its Dispersal to Africa

Domestic chickens are assigned to the genus *Gallus,* which includes four extant wild species. Several studies support Asia as the continental origin of chicken (Wang et al. 2020; Fumihito et al. 1994; Peters et al. 2022; Clutton-Brock 1993) with the specific geographic domestication center likely in Southeast Asia (Wang et al. 2020; Fumihito et al. 1994). One of the red junglefowl subspecies, i.e., *Gallus gallus spadiceus,* is the primary ancestor from which the chicken was domesticated about 8000 years ago (Lawal et al. 2020; Fumihito et al. 1994; Peters et al. 2022). However, subsequent genetic introgression after domestication from different *Gallus* species (*G. lafayettii, G. sonneratii*, *G. varius*) and the other four *Gallus* subspecies (*G. g. bankiva, G. g. gallus, G. g. jabouillei*, *G. g. murghi*) have been reported[2,325]. The consequence of these introgression episodes may explain the observed high genetic diversity seen today in modern chickens and, perhaps, also their rapid adaptation to new environments. From Southeast Asia, the domestic chicken migrated, as human livestock commensal, to other parts of the world, adapting to different environmental conditions.

The introduction of domesticated chickens into Africa is not well documented. Clutton-Brock (1993) and Mwacharo et al. (2013) have summarized the archaeological findings on the domestic fowl in Africa. It is worth emphasizing here that Egypt played a key role in chicken introduction to the African continent. First, its connection to the Fertile Crescent presented an important trading network between Africa and South Asia. Second, the early civilization of Egypt attracted international diplomatic relationships with the Persians and with the North of the Mediterranean Sea, especially during the Egyptian Greek and Roman reigns. Egypt was therefore an important route of entry and dispersion of chicken to the continent, either through the Mediterranean coast or overland.

Domestic chicken bones have been found in Ethiopia as early as 1055–825 BC (D'Andrea et al. 2011). In East Africa, they have been found in two Iron Age sites in Mozambique and South Africa from the eighth century. In South Africa (Plug 1996), mentions that they were uncommonly found in early Iron Age sites. In West Africa, they have been excavated from the Iron Age site of Jenne-Jalo in Mali, dating from 500 to 800 AD.

Also, multiple lines of evidence support different timescales and patterns of chicken dispersion to the African continent (Adebambo et al. 2010; Muchadeyi et al. 2008; Mwacharo et al. 2011; Razafindraibe et al. 2008). Two migration waves and entry points have been proposed. (i) An overland entry following possibly the Berbers and the Phoenician expansion along the North of Africa and across the Sahara (Kiple and Ornelas 2000), with most domestic chickens on the North, West, East, and South parts of the continent likely

originating from this wave. This wave might be characterized by a single mitochondrial DNA haplogroup present in all African countries but also commonly found on the Indian subcontinent (Adebambo et al. 2010; Muchadeyi et al. 2008; Mwacharo et al. 2011; Hassaballah et al. 2015). (ii) A more recent arrival of chickens to Africa likely followed the Indian Ocean maritime trading routes along East Africa, the Red Sea, India, and Southeast Asia coastal areas (Fuller and Boivin 2009).

Today, chickens play significant roles in the cultural life of rural people. In Africa, different indigenous chicken types are valued for cultural, social, and religious functions (Sonaiya 1999). Basic features with sociocultural significance are the color, sex, and comb type of the bird, and these are often related to the spirituality of their owners(Sonaiya 1999; Tadelle 1996).

7.2.2 Domestic Chickens as a Key Part of the African Farming Systems

At the onset of domestication, chickens were likely kept for cultural and recreational purposes, including cockfighting. In Africa, the precise time of transition from a cultural to a food-producing animal is unknown, but it may have followed urbanization and/or cultural habit changes as observed in Europe around 1000 AD (Loog et al. 2017). Since then, chickens have remained a key part of the African farmyard, and globally, they have become the most important poultry species (FAO 2014). It is the most common domestic animal on the African continent, and it is now kept primarily for meat and eggs and mostly under the custody of women and children.

There are two major poultry production systems in Africa: commercial (intensive) and indigenous village chickens (extensive). In Africa, the cost of raising commercial chickens is high. As a result, most poor African farmers keep indigenous village chickens within a small-scale farming system. In Tanzania, indigenous chicken represents 94% of the chicken population (R.I.U 2012), a proportion similar across the continent. Like their wild ancestors, indigenous village chickens are natural scavengers. They are raised under an extensive system of production where they forage on free range and under natural environmental conditions. Though the productivity of the extensively raised village chickens is less than the commercial chickens, the overall input is minimal, especially for housing, disease control, management, and supplementary feeding (Alders et al. 2018). Thus, it is economically efficient to be kept by farmers. Indigenous chickens represent an important genetic resource for breed improvement programs in Africa. They are characterized by high genetic diversity, adaptation to common poultry diseases, and poor-quality feed (Bettridge et al. 2018; Lyimo et al. 2014). Hence, they represent a key resource to enhancing food security, nutrition improvement, and economic growth (Alders and Pym 2009; Melesse 2014).

7.2.3 Challenges with Small-Scale Backyard Farming

Small-scale farming systems are faced with multiple risks, including a high mortality rate associated with predator attacks and disease outbreaks. A sudden change in the weather cycle affecting the availability of feed resources due to droughts can also increase mortality (Ayanlade et al. 2017; Debela et al. 2015). As part of their survival instinct, indigenous village chickens mostly roost in trees, high fences, or other elevated structures. However, deforestation, urbanization, and climate-induced fire outbreaks constitute a current threat to them. The lack of an organized marketing system, capital, and, in the event of a disease outbreak, the lack of adequate vaccination programs are key challenges facing backyard farming. All these pose risks to productivity, economic growth, and general rural development.

7.2.4 The Impact of Climate Change on Poultry Farming in Africa

Smallholder farmers significantly contribute to the food supply in Africa (Kamara et al. 2019). Their daily survival is also dependent on the livestock they keep, both for food and income. Though Africa, as well as poultry farming, contributes the least to greenhouse gases, compared to other continents and ruminant livestock species (Abioja and Abiona 2020), the impact of climate change is expected to be severe on the continent, disrupting natural ecosystems (Ngaira 2007), causing famine, starvation, and death. For instance, a warmer climate will lead to drought, creating competition for water, forages, heat stress, and disease outbreaks. Heat stress, for instance, has a direct impact on growth, productivity, and mortality rate of poultry (Liverpool-Tasie et al. 2019; Tankson et al. 2001). Though this may be severe, indigenous village chickens can serve as a key model to mitigate against the impact of climate crises on the continent through adequate breeding improvement programs. Their genomes have adaptively evolved to better cope with extreme climatic variations, as shown, for example, by a recent study including 245 Ethiopian indigenous village chickens from different agro-ecologies (Gheyas et al. 2011).

7.3 The Current State of Knowledge on Poultry Genetic Resources: Introduction and Distribution in Africa

According to (AU-IBAR 2019), a diversity of both local and exotic poultry breeds is found on the continent. Chickens have the largest number of "breeds" (329), followed by ducks (41) and guinea fowls (40); other species, like domestic ostriches and turkeys, are also present but in much lower numbers. Local breeds follow the path of smallholding in rural communities, while exotic breeds are for commercial production, and they are common in peri-urban areas. The increased proportion of exotic breeds observed across the continent reflects the demand for livestock products following the population size increase. Except for dual-purpose breeds that are used in crossbreeding programs, exotic strains are usually raised in confinement following an all-in-all-out system. In this respect, they do not pose a threat to local breeds. According to (DAD-IS n.d.), West and Southern Africa host the largest number of described "breeds," followed by East and Central Africa, with a lower number of breeds reported for North Africa. A high number of plumage and morphological phenotypes may be found within the indigenous chicken population, some of which have been associated with specific breed types (Table 7.1). Also, there are genes in indigenous chicken populations that may be associated with adaptation to tropical conditions (Table 7.2).

7.4 Examples of African Indigenous Chicken Breeds

Most poultry in Africa are chickens, ducks, and other species. Africa is home to various local and exotic chickens. The various chicken and duck breeds were introduced from the Southeast Asian region and adapted to the African conditions for thousands of years. In this and the next section, we present information on chicken breeds according to the regions of Africa. It should be noted that information regarding the indigenous chickens of Africa is limited. Most of the information is only available (DAD-IS n.d.).

7.4.1 Chicken Breeds in North Africa

A few indigenous chicken breeds in North Africa are characterized and studied. Although most indigenous chicken breeds are nondescript, some show morphological differences; they may be considered breeds or ecotypes (Negash et al. 2023). Such breeds as Fayoumi (Egypt), which is adapted to North Africa's harsh and dry conditions, can be used in future breed improvement programs. Descriptions of significant North African indigenous chickens are given below.

Table 7.1 Identified characteristics of some African indigenous chicken breeds

Country	Local name	Identifiable characteristics	Mature male weight (kg.)	Mature Female weight (kg.)	References
Burkina Faso (DAD-IS n.d.)	Cou nu, Joub-kole	Na: naked neck F: frizzle	1.5	1.2	DAD-IS (n.d.)
Chad (DAD-IS n.d.)	Chicken of Moulkou	P: pea comb	1.5	1	DAD-IS (n.d.)
Chad (DAD-IS n.d.)	Dijded	P: pea comb	1.5–2.0	1.0–1.5	DAD-IS (n.d.)
Ghana (DAD-IS n.d.)	Local Ghanaian	Na: naked neck, F: frizzle, P: pea comb	1.2	1.1	DAD-IS (n.d.)
Lesotho (DAD-IS n.d.)	Basotho	P: pea comb	1.8	1.6	DAD-IS (n.d.)
South Africa (DAD-IS n.d.)	Kaalnekke	Na: naked neck	–	–	DAD-IS (n.d.)
Swaziland (DAD-IS n.d.)	Inkhukhu	Na: naked neck	2.1	1.6	DAD-IS (n.d.)
Sudan (DAD-IS n.d.)	Large balady	Na: naked neck	–	–	DAD-IS (n.d.)
Ethiopia (DAD-IS n.d.)	Melata	Na: naked neck	–	–	DAD-IS (n.d.)
Cameroon (DAD-IS n.d.)	Sudano–Sahelian, Forest zone chicken, Northwest/West chicken	Na: naked neck F: frizzle C: Crested S: feathered shanks, T: feathered tarsus, N: normal feathered	1.4–1.7	1.2–1.3	

Table 7.2 Examples of genes in indigenous chicken populations that may be linked to the adaptation to tropical conditions

Gene	Mode of inheritance	Direct effects	Indirect effects
Dw: Dwarf	Recessive, sex-linked, multiple allele	Reduction of body size between 30 and 10% from the normal size	Reduced metabolism, improved fitness, disease tolerance
Na: Naked neck	Incomplete dominant	Loss of neck feathers, reduction of pteryla width, reduction of secondary feathers	Improved ability for convection, reduced embryonic livability (hatchability), improved adult fitness
F: Frizzle	Incomplete dominant	Curling of feathers, reduced feathering	Decreased fitness under temperate conditions, improved ability for convection
K: Slow feathering	Dominant, sex-linked, multiple allelic	Delay of feathering	Reduced protein requirement, reduced fat deposition during juvenile life, increased heat loss during early growth
Id: Non-inhibitor	Recessive, sex-linked, multiple allelic	Dermal melanin deposition in the skin and shanks	Improved ability for radiation from shanks and skin
Fm: Fibro-melanosis	Dominant with multifactorial modifiers	Melanin deposition all over the body, sheaths of muscles and nerves, and blood vessel walls	Protection of skin against UV radiation, improved radiation from the skin, increased packed cell volume, and plasma protein
P: Pea comb	Dominant	Change of skin structure, compact comb size, reduction of pterylae width, development of breast ridges	Decreased frequency of breast blisters, sex limited, improvement of late juvenile growth

Source: Horst (1989b)

7.4.1.1 Beheri

Distribution and Population Statistics: The breed originated in the Northern region and the Delta of Egypt with an estimated population size of 800,000 (DAD-IS n.d.).

Physical Characteristics: Detailed description of the breed is unavailable; however, the average body weight of mature Beheri chicken weighs 1.7 and 1.3 kg for the cocks and hens, respectively.

Adaptive and Special Genetic Characteristics: Beheri chickens are resistant to leukosis and spirochetosis, have high fertility (more than 95%), and are early maturing for cocks (4.5 months) and hens (5 months).

Typical Production Systems, Husbandry Practices, and Production Characteristics: Information regarding the production system, husbandry practices, and production characteristics is unavailable. However, being an adaptive local chicken, the Beheri chicken would suit low-input and low-output production conditions.

7.4.1.2 Dandarawi

Distribution and Population Statistics: Dandarawy is an indigenous chicken from Egypt, genetically the closest to the other Egyptian ecotypes (Sabry et al. 2021). According to (DAD-IS n.d.), Dandarawi is a locally adapted breed with an estimated population of 20,000.

Physical Characteristics: The cocks are heavier than the hens, with an average body weight of 1.7 kg (cocks) and 1.2 kg (hens). Hens are pinkish with white breast feathers and a Colombian pattern, with black markings on the neck, wing, and tail.

Adaptive and Special Genetic Characteristics: Like Beheri chickens, they have high fertility (95%). Hens are also good layers with 185 eggs/hen/year. They mature early at the average age of 4.5–5 months for the cocks and hens, respectively.

Typical Production Systems, Husbandry Practices, and Production Characteristics: Information regarding the production system is unavailable; however, being early maturing and good layers, they must be suitable for environments where ideal management conditions are challenging.

7.4.1.3 Dokki-4

Distribution and Population Statistics: Dokki-4 is a cross between Fayoumi and Barred Plymouth Rock with an estimated population of 20,000 (DAD-IS n.d.). It is developed in Egypt.

Physical Characteristics: Being crossbred, the average body weight for cocks and hens is 2.4 and 1.7 kg, respectively. Adult birds have blue plumage; neck feathers are silvery-white and red ear lobes; day-old chicks have grayish-brown stripes.

Adaptive and Special Genetic Characteristics: No unique, adaptive, bad, or special genetic characteristics were reported. However, Dokki-4 is a crossbred expected to perform better with many adaptation qualities from Fayoumi.

Typical Production Systems, Husbandry Practices, and Production Characteristics: Dokki-4, although not reported, is expected to suit the smallholder to semi-commercial production systems.

7.4.1.4 Fayoumi (Fig. 7.1)

Distribution and Population Statistics: Fayoumi breed originated in the Fayoum Province of Egypt (Hossaryl and Galal 1994).

Physical Characteristics: The cocks and hens weigh 2.2 and 1.6 kg, respectively. Fayoumi chickens resemble the silver Campine breed in body shape and plumage color.

Adaptive and Special Genetic Characteristics: Fayoumi chickens mature early cocks (5 months) and hens (5.5 months). They are fertile (95%) and produce 205 eggs/hen/annually on average. They lay eggs of good shell quality and a high percentage of yolk/albumin. They also resist such diseases as spirochetosis and leukosis.

Typical Production Systems, Husbandry Practices, and Production Characteristics: Fayoumi chickens are widespread in the tropics, where the temperature is high. Reports

Fig. 7.1 Fayoumi chicken. (Courtesy Dr. Wondmeneh Esatu)

show their suitability for smallholder poultry production systems.

7.4.1.5 Gimmizah

Distribution and Population Statistics: Gimmizah is a crossbred between the White Plymouth Rock and Dokki-4 (Galal 2007). It is considered a local chicken of Egypt.

Physical Characteristics: The average body weight for the cocks and hens is 2.2 kg and 1.6 kg, respectively.

Adaptive and Special Genetic Characteristics: Identification of chick sexing is possible for this breed at day old. They reach sexual maturity at 5.5 and 6 months for the cocks and hens, respectively. They lay, on average, 195 eggs annually. The breed resembles the Barred Plymouth Rock in its shape and color. The feathers are light gray and are barred with a darker gray. The Gimmizah showed an improvement in the local breeds in their productive and reproductive abilities.

Typical Production Systems, Husbandry Practices, and Production Characteristics: Detailed information regarding the production system is scarce.

7.4.1.6 Alaraby

Distribution and Population Statistics: Alaraby is distributed in the West and South of Libya. According to (DAD-IS n.d.), it has an estimated population of 50,000.

Physical Characteristics: They have yellow skin color, single comb type, red and black plumage color, gray shank, and feet. Hens lay cream, white, or pale grayish eggs. The average body weight of mature chickens is 1.9 kg for cocks and 1.9 kg for hens.

Adaptive and Special Genetic Characteristics: Alaraby chickens resist heat and diseases and adapt to dry and poor environments. The age at the first egg for hens is 6.6 months, and they lay 138 eggs annually.

Typical Production Systems, Husbandry Practices, and Production Characteristics: The Alaraby chickens are a good option for smallholder production conditions and can survive by scavenging available feed resources.

7.4.1.7 Moroccan Beldi

Distribution and Population Statistics: Moroccan Beldi (Beldi meaning "native" in Arabic) is an indigenous breed population with an estimated population of one million. The Beldi chicken is raised in rural areas of the Khenifra Region of Morocco.

Physical Characteristics: Beldi chickens have large phenotypic variability. They appear in black, brown, gray, and white colors, pure or mixed. Sexual maturity is 154 days for roosters and 168 days for hens in chickens. The age at first egg averaged 5.8 months for hens. The number of eggs laid per hen per year was 78 for the hens with a hatchability rate of 78%. The chickens weigh 1.9 kg (male) and 1.5 kg (female).

Adaptive and Special Genetic Characteristics: No adaptive and unique genetic characteristics were reported. However, being a chicken from drier areas, they may possess the ability to withstand harsh environments.

Typical Production Systems, Husbandry Practices, and Production Characteristics: The Moroccan Beldi can be a good chicken

for drier areas of the tropics, where feed supply can be challenging.

7.4.1.8 Large Sudanese Baladi

Distribution and Population Statistics: Sudanese native chicken breed is one of the main ecotypes (Yousif and Eltayeb 2011).

Physical Characteristics: The average body weight for cocks and hens is 1.9 kg and 1.4 kg, respectively.

Adaptive and Special Genetic Characteristics: Large Sudanese Baladi is a hardy breed, able to thrive under very harsh conditions; on average, hens mature late (8 months) and lay 50 eggs annually.

Typical Production Systems, Husbandry Practices, and Production Characteristics: Large Sudanese Baladi chickens can be kept under smallholder production conditions in drier areas.

7.4.1.9 Sudanese Bare Neck Baladi

Distribution and Population Statistics: Estimated population of 1,000,000 (DAD-IS n.d.).

Physical Characteristics: The chickens are naked neck, with an average body weight of 1.1 kg in hens, and they lay on average 106 eggs annually and are an important local chicken in Sudan (Binda et al. 2012).

Adaptive and Special Genetic Characteristics: Being naked neck, they exhibit adaptation to heat stress.

Typical Production Systems, Husbandry Practices, and Production Characteristics: They can produce in areas of high heat stress.

7.4.2 West and Central Africa

Various colors and conformations phenotypically characterize local chickens in West Africa. Despite this phenotypic diversity, West African local chickens have many traits in common with wild chicken populations (Guisso et al. 2022). Their local adaptation calls for conservation and utilization strategies.

7.4.2.1 Naine

Distribution and Population Statistics: Naine is an indigenous breed from Burkina Faso with a small population of 10,000 (DAD-IS n.d.).

Physical Characteristics: They are lightweight, with an average of 1.1 kg cocks and 0.8 kg hens. Sometimes they exhibit frizzle feathers.

Adaptive and Special Genetic Characteristics: The average age of maturity for cocks and hens is seven and 6 months, respectively. The hens lay 60 eggs per year.

Typical Production Systems, Husbandry Practices, and Production Characteristics: With frizzle feathers and light body weight, Naine is suitable for harsh hot environments where feed supply is challenging.

7.4.2.2 Naked Neck

Distribution and Population Statistics: This is an indigenous breed, southern and central Burkina Faso, with an estimated population of 10,000 (DAD-IS n.d.).

Physical Characteristics: The average body weight for cocks and hens is 1.5 kg and 1.2 kg, respectively. The flock exhibits both naked-necked and frizzled feathers. The average age of maturity for both cocks and hens is 6 months. Hens produce 60 eggs annually.

Adaptive and Special Genetic Characteristics: They are resistant and tolerant to some diseases like mycoplasmosis, pseudo avian plaque, and pasteurellosis. They show remarkable thermotolerance.

Typical Production Systems, Husbandry Practices, and Production Characteristics: They are suitable for harsher and drier areas of the tropics.

7.4.2.3 Souche Kondé

Distribution and Population Statistics: The origin of this strain is not known, but it is widely available in southern Burkina Faso.

Physical Characteristics: Both the cocks and hens are heavy, with the average weight for males and females of 2.5 kg and 1.5 kg, respectively. They mature at 6 months. Hens produce 60 eggs annually.

Adaptive and Special Genetic Characteristics: No unique qualities were reported.

Typical Production Systems, Husbandry Practices, and Production Characteristics: Although information regarding the production system is unavailable, they are a good candidate for a smallholder production system.

7.4.2.4 Ghanian Fowl

Distribution and Population Statistics: This is an indigenous chicken widely present in Ghana; the estimated population size is about four million (DAD-IS n.d.).

Physical Characteristics: Most of the local chickens are usually feathered (96%), with a small proportion of naked neck (2%) and frizzled (2%). The average body weight for cocks and hens is 1.2 kg and 1.1 kg, respectively.

Adaptive and Special Genetic Characteristics: Local chickens are disease-tolerant and excellent scavengers. The hens are broody all year round, start egg laying at 5.5 months, and lay 150 eggs annually.

Typical Production Systems, Husbandry Practices, and Production Characteristics: As good scavengers, disease-tolerant, and good mothers, the local chickens of Ghana are suitable for smallholder production conditions.

7.4.2.5 Poule De Benna

Distribution and Population Statistics: This is an indigenous chicken found in the Region Du Benna of Guinea. According to (DAD-IS n.d.), the population is estimated to be 10,000.

Physical Characteristics: Poule De Benna is a big chicken with long shanks, a naked neck, and black eyes. Both cocks and hens weigh, on average, 2.3 kg.

Adaptive and Special Genetic Characteristics: Poule De Benna chickens are resistant to Newcastle disease. The hens are very broody, start egg laying at 6.5 months, and produce 80 eggs per year.

Typical Production Systems, Husbandry Practices, and Production Characteristics: Poule De Benna are suitable for smallholder poultry production systems.

7.4.2.6 Poule du Guinea

Distribution and Population Statistics: An indigenous chicken from Guinea with a population of 15 million (DAD-IS n.d.).

Physical Characteristics: These chickens are variable in size but short beaks and single combs are dominant; they are multicolored, but red, white, and black are dominant. The average body weight of mature chickens is 1.5 kg for cocks and 1 kg for hens.

Adaptive and Special Genetic Characteristics: Hens have a robust brooding instinct and produce, on average, 60 eggs per annum.

Typical Production Systems, Husbandry Practices, and Production Characteristics: These chickens are suitable for the village poultry production system.

7.4.2.7 Nigerian Normal Feathered Chicken

Distribution and Population Statistics: Might have originated from the junglefowl of Java and the Indonesian islands. It is distributed throughout Nigeria.

Physical Characteristics: The hens, on average, weigh 1.07 kg. The hens start egg laying at 25 weeks. With five clutches, they produce 180 eggs per year, weighing 23–38 g.

Adaptive and Special Genetic Characteristics: No unique characteristics were reported.

Typical Production Systems, Husbandry Practices, and Production Characteristics: As most indigenous chickens, the chickens can be kept in village management conditions.

7.4.2.8 Poule du Sénégal

Distribution and Population Statistics: This is an indigenous breed distributed throughout Senegal. According to (DAD-IS n.d.), the estimated population size is about 29 million.

Physical Characteristics: Poule du Sénégal are small, rustic birds usually uni-colored (light brown or white). The Senegal chicken varies in color, but the most frequent colors are brown (13.8%), white (12.4%), yellowish (8.4%), white and brown (8.4%), and light brown (7.8%) (Missohou et al. 1998). The

cocks weigh 1.5 kg, the hens 1 kg. Hens lay 60 eggs annually.

Adaptive and Special Genetic Characteristics: Small size, rustic bird, unicolored. Hens have 3–4 egg laying cycles per year, laying between 6 and 15 eggs per cycle.

Typical Production Systems, Husbandry Practices, and Production Characteristics: Chickens are reared by all ethnic groups in Senegal.

7.4.2.9 Cameroon Chicken

Distribution and Population Statistics: Cameroon national poultry flock was estimated at 35 million, 70% being indigenous chickens (Fotsa et al. 2011).

Physical Characteristics: Males average 1.4–1.7 kg, while females average 1.2–1.3 kg.

Adaptive and Special Genetic Characteristics: Across all agro-ecological zones, the presence of genes for naked neck, frizzle, normal feathered, feathered shanks, crested, and rose comb is indicated.

Typical Production Systems, Husbandry Practices, and Production Characteristics: In all the agro-ecological zones, family/backyard production systems are the norm.

7.4.3 Eastern Africa

Local chicken in East Africa shows extensive phenotypic diversity. Chickens appeared in the region relatively late, around ~700 BC, with their geographic origin remaining unknown, with the Indian subcontinent, Southeast Asia, and North Africa as possible primary centers of origin (R.I.U 2012). Local chickens in East Africa are found across the entire region and in all agro-ecological zones; they show large within-population phenotypic diversity in plumage color, feather morphology, pattern, skin color, comb type, etc. (Msoffe et al. 2001; Dana et al. 2010).. Large maternal genetic diversity in the region could potentially support genetic improvement programs (Mwacharo et al. 2013).

Fig. 7.2 Horro chicken. (Courtesy Dr. Wondmeneh Esatu)

7.4.3.1 Horro (Fig. 7.2)

Distribution and Population Statistics: Indigenous breed, Oromia regional state in western Ethiopia, Horro is an indigenous chicken type named after the geographic region of origin, located in the western part of Ethiopia near the Blue Nile gorge. There are about 30,000 chickens restricted to this original environment (DAD-IS).

Physical Characteristics: Horro chickens are predominantly brown, and hens lay about 178 eggs annually that weigh 52–58 grams. They also have crests.

Adaptive and Special Genetic Characteristics: Horro chickens are hardy and resist diseases.

Typical Production Systems, Husbandry Practices, and Production Characteristics: Horro chickens are suitable for smallholder poultry production systems. They are good scavengers and excellent mothers.

Fig. 7.3 Konso chicken. (Source: Dana et al. 2010), Food and Agricultural Organization, reproduced with permission)

7.4.3.2 Konso (Fig. 7.3)

Distribution and Population Statistics: Konso chickens are indigenous chickens found in the Southern Region of Ethiopia.

Physical Characteristics: Adult cocks weigh about 1.4 kg and hens 1.0 kg; most cocks have red body plumage, whereas brown, zigrima, and black are the prominent plumage colors in hens. Both white and yellow skin colors exist. The shape of the head is mainly flat (DAD-IS n.d.).

Adaptive and Special Genetic Characteristics: No unique features were reported.

Typical Production Systems, Husbandry Practices, and Production Characteristics: Reared under scavenging management. Konso chickens are suitable for smallholder/village poultry production conditions.

7.4.3.3 Mandura

Distribution and Population Statistics: The breed is available in the western part of Ethiopia in Benshangul Gumuz regional state, with a small population size of 21,000 (DAD-IS n.d.).

Physical Characteristics: Brown is the most predominant plumage, and complete red is typical of cocks but absent in hens. Almost all chickens have normal feather distribution. The average shank length of adult males is 8.4 cm, and that of females is 7.1 cm; adult cocks weigh about 1.6 kg, and hens 1.4 kg.

Adaptive and Special Genetic Characteristics: No unique features were reported.

Typical Production Systems, Husbandry Practices, and Production Characteristics: As the breed adapted to the drier areas of western Ethiopia, where feed supply is a challenge.

7.4.3.4 Tepi (Fig. 7.4)

Distribution and Population Statistics is an indigenous breed adapted to the southwestern parts of Ethiopia.

Physical Characteristics: The population of the breed is estimated to be about 50,000 (DAD-IS n.d.).

Adaptive and Special Genetic Characteristics: No unique features were reported.

Typical Production Systems, Husbandry Practices, and Production Characteristics: The breed can suit village or smallholder poultry production conditions.

7.4.3.5 Tililli (Fig. 7.5)

Distribution and Population Statistics: An indigenous breed that originated from and is widely spread in the Sekela areas of Ethiopia near the source of the Blue Nile (DAD-IS n.d.).

Physical Characteristics: This ecotype is known for its better growth and egg production (1.2 kg and 147 eggs/hen/year).

Adaptive and Special Genetic Characteristics: No unique features were reported.

Typical Production Systems, Husbandry Practices, and Characteristics: Suit smallholder poultry production systems.

7.4.3.6 Kenyan Chicken

Distribution and Population Statistics: Kenyan chicken is an indigenous breed adapted to rural and peri-urban areas of the country, with an estimated population of about 33 million (DAD-IS n.d.).

Fig. 7.4 Tepi chicken. (Courtesy: Dr. Wondmeneh Esatu)

Fig. 7.5 Tilili chicken. (Courtesy: Dr. Wondmeneh Esatu)

Physical Characteristics: Average body weight for cocks and hens is 2.2 kg and 1.6 kg, respectively. No unique pattern within the feather, yellow skin color, single comb type, various plumage colors, various shank and foot colors, cream white to pale grayish eggshell color.

Adaptive and Special Genetic Characteristics: No unique features were reported.

Typical Production Systems, Husbandry Practices, and Characteristics: They are suitable for smallholder poultry production systems.

7.4.3.7 Rwandan Chicken

Distribution and Population Statistics: Indigenous breed from Rwanda.

Physical Characteristics: Rwandan indigenous chickens have four comb types (strawberry—most dominant, whiteness of earlobes, rounded ear lobe shape, and curved beaks), varied beak color (green, black, yellow, and brown), evenly distributed feathers (most common), and naked-neck phenotypes (this was rare, occurring in about 0.2% of chickens), brown eyes, yellow-colored thick skins, and yellow-colored shanks (Fig. 7.6). The chickens are small and rustic and produce 50 eggs annually.

Adaptive and Special Genetic Characteristics: No unique features have been reported.

Typical Production Systems, Husbandry Practices, and Characteristics: The breed can suit village or smallholder poultry production condition.

7.4.3.8 Ugandan Chicken (Fig. 7.7)

Distribution and Population Statistics: This is an indigenous chicken breed widely distributed in the eastern and northern regions of Uganda. The population is estimated to be more than 22 million (DAD-IS n.d.).

Physical Characteristics: Both the cocks and hens are heavy, with an average body weight of 4 and 2 kg for females and males, respectively. The hens show five clutches of 10–12 eggs.

Adaptive and Special Genetic Characteristics: No unique features were reported.

Typical Production Systems, Husbandry Practices, and Characteristics: The breed can suit village or smallholder poultry production condition.

Fig. 7.6 Indigenous Rwandan chickens. (Source: Hirwa et al. 2019, licensed under CC BY 4.0)

Fig. 7.7 Ugandan chicken. (Source: Yussif et al. 2023) (Licensed under C-C By 4:0)

Fig. 7.8 Ovambo. (Source: Grobbelaar et al. 2010, Food and Agricultural Organization, reproduced with permission)

7.4.4 Southern Africa

South African domestic chickens are a significant bird genetic resource, and more conservation efforts are being made to save these unique genotypes. South African chickens are the result of multiple introductions and dispersion, with their high genetic diversity potentially originating from China, Southeast Asia, and the Indian subcontinent (Mtileni et al. 2011).

7.4.4.1 Ovambo (Fig. 7.8)

Distribution and Population Statistics: The population is small and limited to 10,000.

Physical Characteristics: Dark in color and small in body size.

Adaptive and Special Genetic Characteristics: Very aggressive and agile and can catch and eat mice and young rats. Can fly and roost on the top of trees to avoid predators.

Typical Production Systems, Husbandry Practices, and Production Characteristics: Scavenging and semi-scavenging chicken production system.

7.4.4.2 Potchefstroom Koekoek (Fig. 7.9)

Distribution and Population Statistics: Northwest Province and Gauteng Province of South Africa (DAD-IS n.d.).

Fig. 7.9 Potchefstroom Koekoek chicken. (Courtesy: Dr. Wondmeneh Esatu)

Physical Characteristics: Average height for cocks and hens 2.51 kg and 1.7 cm, respectively; light and dark gray with a white barred pattern within the feather (barred, sex-linked), skin color (yellow), comb type (single), plumage color (gray and white), shank and foot color (yellow), eggshell color (light brown). The average age at the first egg for a hen is 4.27 months, body weight at the hatch for both sexes is 35 g, and annual egg production is 196 eggs.

Adaptive and Special Genetic Characteristics: The breed has a specific resistance or tolerance to poultry diseases, adaptability to cold and heat, wet and drought, high egg production, brooding well, and the ability to hatch their offspring.

Typical Production Systems, Husbandry Practices, and Production Characteristics: Scavenging and semi-scavenging chicken production system.

7.4.4.3 Venda (Fig. 7.10)

Distribution and Population Statistics: Discovered in Limpopo province, Vhembe, and Capricorn district, and other parts of Gauteng, Mpumalanga, Free State Province, of South Africa, with a small population of 10,000 (DAD-IS).

Physical Characteristics: The average body weight for cocks and hens is 2 and 1.9 kg, respectively. They have a single comb type and lay cream white to a pale grayish egg.

Fig. 7.10 Venda chicken. (Source: Grobbelaar et al. 2010, Food and Agricultural Organization, reproduced with permission)

Adaptive and Special Genetic Characteristics: Ability to fly away from predators and to roost in the tree, resistance or tolerance to diseases and parasites, adaptability to the high temperate area and harsh environment, good quality egg production, brooding, and good mothering instincts. Hens lay, on average, 153 eggs annually (Grobbelaar et al. 2010).

7.4.4.4 Boschveld (Fig. 7.11)

Typical Production Systems, Husbandry Practices, and Production Characteristics: The breed suits village or backyard production conditions. They are good scavengers too.

7.5 Local and Exotic Duck Breeds in Africa: Characteristics, Distribution, and Features

7.5.1 Indigenous and Exotic Duck Breeds of North Africa

Duck breeds in North Africa are limited in numbers and almost entirely imported from abroad. They are less popular as compared to chickens

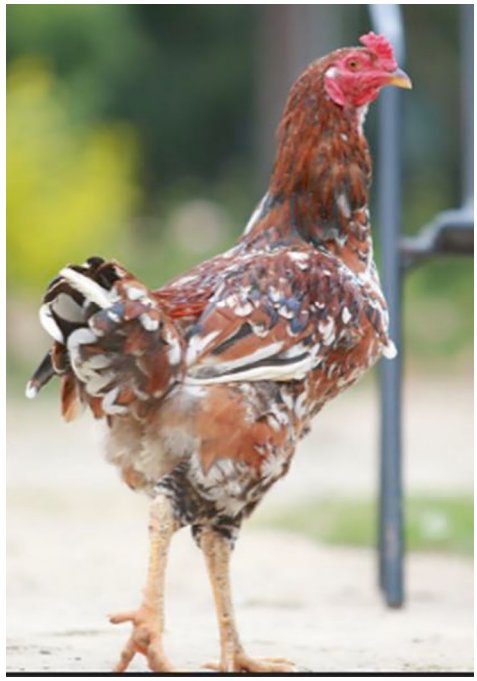

Fig. 7.11 Boschveld chicken. (Source: http://boschveld.co.za/)

that are widely kept. Below, the description of duck strains is given.

7.5.1.1 Domiati

Distribution: Domiati is widely distributed in the north of Egypt (DAD-IS n.d.).

Physical Characteristics: Females are small.

Adaptive and Special Genetic Characteristics: No unique features were reported.

Typical Production Systems, Husbandry Practices, and Production Characteristics: Information regarding the production system is not available.

7.5.1.2 Pekin

Distribution and Population Statistics: It is an imported breed into the lower Egypt and delta regions (DAD-IS n.d.).

Physical Characteristics: The plumage is creamy white; the legs and feet are a yellowish orange. The beak is yellow, short, and almost straight.

Adaptive and Special Genetic Characteristics: Disease resistance, good adaptation to local conditions, and known for its hardiness.

Typical Production Systems, Husbandry Practices, and Production Characteristics: Raised at the commercial and village levels.

7.5.2 West and Central Africa

7.5.2.1 Ghanaian Duck

Distribution and Population Statistics: This is an indigenous breed with a country-wide distribution. The estimated population size is 200,000 (DAD-IS n.d.).

Physical Characteristics: Average body weight for cocks and hens is 2.4 and 1.7 kg, respectively.

Adaptive and Special Genetic Characteristics: Resistant to various diseases, the average age of maturity for hens is 6 months, and they lay about 60 eggs per year.

Typical Production Systems, Husbandry Practices, and Production Characteristics: They are raised in smallholder production conditions.

7.5.3 Eastern Africa

7.5.3.1 Albet

Distribution and Population Statistics: Gambella and Benishangul regions of Ethiopia (DAD-IS n.d.).

Physical Characteristics: White and black colors are dominant, and they lay 57 eggs annually.

Adaptive and Special Genetic Characteristics: No unique features were reported.

Typical Production Systems, Husbandry Practices, and Production Characteristics: They can be raised in smallholder production conditions.

7.5.3.2 Ugandan Duck

Distribution and Population Statistics: Crossbreeds of the original Muscovy ducks imported from Britain (DAD-IS n.d.). They

are distributed throughout Uganda, especially in urban and peri-urban areas, with an estimated population of about a million.

Physical Characteristics: Large bird with an average body weight for cocks and hens is 10 and 6 kg, respectively.

Adaptive and Special Genetic Characteristics: No unique features were reported.

Typical Production Systems, Husbandry Practices, and Production Characteristics: They are raised scavenging feed resources available in the household and backyards.

7.5.4 Southern Africa

7.5.4.1 Aylesbury

Distribution and Population Statistics: Aylesbury is imported and locally adapted to all agro-ecological zones of Zambia (DAD-IS n.d.).

Physical Characteristics: The Aylesbury duck is a breed of domesticated duck, bred mainly for its meat and appearance. It is a large duck with pure white plumage, orange legs, and feet. On average, the body weight of cocks and hens is 4.5 and 4 kg, respectively. They are unicolored (white).

Adaptive and Special Genetic Characteristics: No unique features were reported.

Typical Production Systems, Husbandry Practices, and Production Characteristics: Can be raised under smallholder production conditions.

7.5.4.2 Madada

Distribution and Population Statistics: This is an indigenous breed from Zambia with an estimated population of 100,000 (DAD-IS n.d.).

Physical Characteristics: Average weight for cocks and hens is 2.5 and 1.8 kg, respectively.

Adaptive and Special Genetic Characteristics: This breed resists most duck diseases. The hens mature at the age of 6 months and produce 40 eggs per year.

Typical Production Systems, Husbandry Practices, and Production Characteristics: Can be raised under smallholder production conditions.

7.6 Exotic Chicken Breeds in Africa

Introduction Although not well developed, the poultry sector in Eastern African countries has grown from a backyard poultry-keeping operation to a more commercial-oriented system (Vernooji et al. 2018). However, the introduction of exotic genetics into smallholder-intensive chicken production has yet to prove competitive in sub-Saharan Africa because of management issues and high costs of feed, veterinary, and energy inputs (Tabler et al. 2023). Africa's leading countries in chicken meat production are Algeria, Egypt, Morocco, South Africa, and Nigeria (DAD-IS n.d.), which mainly depend on chicken strains. The broiler chicken strains include Arbor Acres, Cobb 500, Cobb 700, Ross, and Ross Indian River. The layer chicken breeds are Hy-Line Brown, Hy-Line Silver Brown, ISA Brown, ISA White, Lohmann Brown, Lohmann Silver, and Lohmann White. Breeds such as white and brown Leghorns, Rhode Island Red, New Hampshire, Cornish, Australorp, and Light Sussex were crossed with local chickens to improve the genetic potential of indigenous breeds (Dana et al. 2011).

Physical Characteristics The exotic African chicken breeds originated from combining different worldwide chicken strains. Most of the inputs to develop are dual-purpose chicken strains, such as Rhode Island Red and white leghorn. Mostly, the broilers are white in color and heavy in body weight, while the layers are either white in the white egg layer or brown in the case of the brown egg layer. Layers are generally small to medium-sized.

Adaptive and Special Genetic Characteristics The commercial chickens, layers, and broilers are meant for improved management conditions where good management and

proper feeding, health, and housing are provided. Such strains have been less efficient in Africa as the breeds lack adaptation traits for harsh environments. There are efficient feed converters (broilers) or layers (laying hens).

Typical Production Systems, Husbandry Practices, and Production Characteristics The standard production system for such chicken strains and commercial management conditions; however, farmers in Africa keep them with less sophisticated management conditions. The broiler birds attain 2–2.5 kg live weight at 6–7 weeks and are ready for the market, while layer birds reach 16 weeks before the pullets start laying eggs. The average industry egg production is 230–250 eggs/layer/year (Kusi et al. 2015). Most of the exotic chicken breeds introduced into Africa are commercially mainly kept and managed by medium to big farms.

7.7 The Importance and Role of Poultry for Smallholders

Most of the poultry population in Africa exists in villages with low-input, low-output systems (Guèye 2000; Gilbert et al. 2015). Although large-scale commercially produced poultry products are available, the indigenous chicken remains vital (Wondmeneh 2015), as an example of food sovereignty, where communities prefer a sustainable production system that supplies healthy, culturally appropriate food (Patel 2009; Wong et al. 2017). African consumers prefer eggs and chicken meat from indigenous stocks to those derived from commercial flocks of imported ones, and they, therefore, fetch premium prices (Gueye 2009). Rural poultry supply 70–90% of poultry products in Africa (Alabi et al. 2006; Branckaert and Guèye 2000; Kitalyi 1998; Mack et al. 2005); income from poultry products is often the primary source of income for female-headed households. In contrast, male-headed families usually have multiple income sources and even take over the poultry business when they realize financial feasibility (Aklilu et al. 2008; Muchadeyi et al. 2004). Small-scale poultry production systems have been integrated with human livelihoods for thousands of years, enhancing the rural poor's diet, income, and food and nutrition security (Alders and Pym 2009). The potential contributions and impacts of extensive, small-scale scavenging poultry production systems in rural, resource-poor areas differ significantly from more intensive systems in urbanized settings (Wong et al. 2017). Poultry in Africa has several roles. Some of the roles have direct economic implications, while others have more social implications. Below are some detailed important roles of poultry production in Africa, namely, contribution to food security, income generation and employment, GDP contribution, and sociocultural.

(a) *Role in Food Security*: Food security remains a severe challenge for many households in Africa (Silvestri et al. 2015). Mild to moderate protein-energy malnutrition is common throughout the developing world, which contributes to poor growth, diminished mental development, and *illness* in children (Neumann et al. 2002). Animal source foods address malnutrition by supplying the essential nutrients that are lacking in plant-sourced foods, such as micronutrients like iron, zinc, vitamin B-12, riboflavin, and conjugated linoleic acids (Ndlovu 2010). Farmers in rural areas have better access to poultry products as compared to others. Poultry contributes 20–32% of total animal protein intake (Tadelle et al. 2003; Kitalyi 1998).

(b) *Roles in Income Generation and Employment*: Increasingly, with the impact of climate change, including on crop productivity, farmers need to look for alternative sources of income (Vermeulen et al. 2012). Chickens can adapt to drier areas with the potential to cope with feed shortages. A scavenging chicken produces eggs with little or no supplementation. Few eggs can be collected and sold to the local markets to support the family income, to meet some basic needs, such as buying clothes for children or for meeting some financial obligations of learners in school. Women have better access to the income from chicken, although men take

over with better prospects of income from poultry. Poultry can serve as an income-generating activity, providing sustainable employment for rural households (Pica-Ciamarra and Otte 2010). The better the level of inputs used, the higher the production will become. The need for better interventions, such as tropically adapted and yet productive chicken strains and supporting packages, might be the first step to transforming the existing system.

(c) *Roles in GDP Contribution*: The economic contribution of poultry at a household level cannot be overlooked. The sector employs 80–85% of the population and contributes 40% to the total GDP. Rural chicken in Ethiopia represents a significant part of the national economy in general and the rural economy and contributes to 98.5% and 99.2% of the national egg and chicken meat production, respectively (Asresie et al. 2015). Apart from that, poultry in villages serves as disposable cash at any need and is named poor men's "ATM" (Pal et al. 2020). The ability of the live product to be 'stored' for a more extended period is a unique characteristic. Regardless of its enormous impact, the actual contribution of the village poultry to the national GDP is barely quantified. Considering the size of the population keeping village chickens, the contribution to the national GDP is significant.

(d) *Roles in Sociocultural Issues*: Apart from the monetary and food terms, poultry in Africa has other functions. The sociocultural importance of poultry is age-old. Keeping poultry by village communities throughout Africa has been practiced for many generations. More than 85% of rural families in sub-Saharan Africa support some poultry species. For example, approximately three chickens for every two people (Gueye 2009). In addition to providing farmers with eggs and meat for their home consumption, poultry products' sale (or swap) enables poultry keepers to obtain money to spend on their own and family specific needs. Moreover, poultry is symbolic in many social activities and religious ceremonies (Akinola and Essien 2011). In Zimbabwe, the preferred taste of chicken meat is available and reserved for special guests or ceremonial gatherings (weddings or funerals) (Muchadeyi et al. 2004). In Kenya, chickens are helpful in several social, cultural, and spiritual activities such as entertainment, gifts, funeral rites, and spiritual cleansing (Magothe et al. 2012b).

7.8 Indigenous Poultry Breeds Conservation Efforts and Biobanking in Africa

A speedy and constant decline in animal species populations has been recognized in recent years (IUCN 2010). The chicken genetic resources are the most endangered and under-conserved (Hoffmann 2009). At the global level, more than 1600 local chicken breeds have been identified; 33% are considered endangered to critical breeds, and another 40% have unknown risk status (FAO 2007). The 126 indigenous breeds recognized for Africa are most often generalized under the name of local chicken despite their great variability and specific traits (DAGRIS 2021). These breeds contain vast ranges of phenotypic and genetic diversity resulting from the diversity of environmental and human selection pressures. Regrettably, many of these local breeds are classified as at risk due to the introduction and adoption of exotic breeds, acceptance of intensive chicken production systems, changes in the environment, disease conditions, and adverse development policies. The conservation of African indigenous poultry breeds is vital in light of their rapid loss through commercial dilution and breed replacement. All varieties of these breeds are important candidates for conservation. While in situ in vivo conservation strategies are highly relevant to conserving diversity, other complementary conservation strategies, such as germplasm cryopreservation, are needed not only to conserve unique adaptations and gene combinations but also to be able to respond to the needs of future generations. To

reduce this genetic erosion, it is crucial to improve knowledge of local breeds and production systems, improve planning, and raise awareness of the threat at the policy level. New innovations in genetic preservation technologies for chickens are also needed. All African indigenous chicken populations with economic potential, scientific use, and cultural or aesthetic interest should be part of the conservation efforts.

7.8.1 Conservation Efforts of Indigenous Poultry Breeds in Africa

Conservation of poultry genetic resources engages numerous activities, including strategies, management, planning, policies, and effective actions, intended to ascertain that the diversity of the genetic resource is maintained to contribute to current and future agricultural and food production (Rege and Gibson 2003). Conservation of genetic resources encompasses characterization, identification, monitoring, and utilization to ensure management for the best short-term use and longer-term availability (Moyo 1995). The economic framework for the sustainable use and conservation of animal genetic resources, including poultry, is outlined in Chap. 25.

7.8.1.1 In Situ Conservation Programs

In African countries, there has been little effort to conserve the local chicken breeds or lines (Manyelo et al. 2010). It is alleged that 33% of indigenous chicken breeds are facing extinction (FAO 2007; Manyelo et al. 2010). Most poultry genetic resources are conserved in situ in the living populations, which are facing. The challenges of epidemics and climate (Assan 2015). In situ conservation programs for indigenous chickens in Africa mostly involve various individual smallholder farmers and farmers associations. Unfortunately, this category of custodians is not benefiting from enough support for their contribution to the conservation effort.

7.8.1.2 Ex Situ Conservation Programs

In vivo ex situ conservation of chickens is mainly practiced by breeding and dissemination centers, held by national research institutions, universities, and industrial poultry farms, as important reservoirs of indigenous chicken biodiversity through the collection of frozen semen. These are generally targeted poultry populations collected from their natural environment and transferred to breeding centers for research or development purposes. Ex situ protection programs may have some sustainability challenges in Africa. Most often, they may be coupled to cryopreservation and reproduction technologies for the conservation and dissemination. These introduce the aspects of biotechnology applications and the need for gene banks as biorepositories where representative samples of genetic resources are preserved. This should be supported by data banks where metadata related to the attributes of breeds are stored in a systematic way. The technological advancement of poultry reproductive technologies and precision breeding provides insight into ex situ conservation as it facilitates the capture of the entire genetic makeup of the populations.

7.8.2 Poultry Germplasm Biobanking in Africa

African poultry germplasm is a live information source for all the genes present in the African indigenous poultry breeds, which can be conserved for long periods and regenerated whenever required in the future. The conservation of these genetic resources through cryopreservation, referred to as biobanking, is an important component for the conservation and revival of rare or endangered species. Germplasm cryobanking, or cryoconservation, is the most successful method to conserve the genetic traits of endangered and commercially valuable species. Germplasm cryobanking involves the harvesting and freezing of gametes, embryos, gonadal tissues, somatic tissues, or PGCs of species threatened with extinction. There is considerable diversity in the cryobiological conditions among cell types and tissues of each species. Research

done by scientists from the Centre for Tropical Livestock Genetics and Health (CTLGH) at the Roslin Institute, University of Edinburgh, has focused on developing techniques for the conservation and recovery of the genetic material of chickens. This is an attractive complement to the indispensable maintenance of genetic diversity through living animals. However, research is needed to effectively apply these techniques in a multidisciplinary program aimed at the preservation of the numerous subpopulations of animals that exist within a given species. Previously, it has not been possible to biobank chicken genetic material, but the recent innovation at the Centre for Tropical Livestock Genetics and Health (CTLGH) and International Livestock Research Institute (ILRI) using Primordial Germ Cells (PGCs) has changed that. There is now a way forward to preserve the future biodiversity of African poultry breeds.

7.8.3 Biobanking Using Stem Cell Techniques

Cryopreservation of stem cells is valuable to offer storage of high cell numbers, fast transport, and to preserve cells for long periods. Due to the increased level of endangered poultry breeds, it is important to preserve genetic material for future applications. Conservation of poultry breeds and genetic lines poses challenges. Most poultry genetic resources are maintained in situ in living populations. However, this conservation approach of genetic resources always carries the risk of losing the population owing to pathogen outbreaks, genetic problems, breeding cessation, and/or natural disasters. Biobanking, whereby sperm, eggs, or zygotes are conserved, is the ex situ alternative. Common in mammalian species, the approach does not work well for avian species in females due to the large amount of lipid deposited in the oocyte (Petitte 2006; Whyte and McGrew 2015). Other genetic preservation and propagation techniques, such as cloning using somatic cell nuclear transfer, are not possible because embryo transfer cannot be done in avian species (Kjelland et al. 2014). Cryobanking of germplasm in birds has been mainly limited so far to the use of semen.

7.8.3.1 Primordial Germ Cells (PGCs) Technique

As an alternative, avian primordial germ cells (precursor cells for gametes, which temporally circulate in the vasculature during early development) can be incorporated into the gonads (Yasuda et al. 1992) and differentiated into functional gametes following transplantation to recipient embryos (Tajima et al. 1993; Ono et al. 1998). An avian PGC transplantation technique has been established and is readily available now at ILRI. To date, several techniques for PGC manipulation, including purification, cryopreservation, depletion, and long-term culture, have been developed in chickens. PGC transplantation combined with recent advanced PGC manipulation techniques has enabled ex situ conservation of poultry genetic resources in their complete form. In collaboration with AU-IBAR, the poultry PGC technologies for conservation have been introduced to African NARS scientists and are ready for deployment.

7.8.3.2 Induced Pluripotent Stem Cells (iPSCs) and Mesenchymal Stem Cells (MSCs) Techniques

Induced pluripotent stem cells (iPSCs) are somatic cells reprogrammed by ectopic expression of transcription factors or small molecule treatment, which resemble embryonic stem cells (ESCs) (Zhang et al. 2014). They represent a great promise for conserving and generating genetically improved and locally adapted poultry genetic resources. Numerous reports emphasize the importance of chicken iPSCs as well as MSCs for their self-renewal potential and multilineage differentiation as well as current knowledge concerning their usefulness for conservation, various biological properties and health studies, and the use of MSCs as a feeder layer or as a very promising tool for immunomodulatory cell therapy in immune-mediated diseases (Zhao et al. 2016). Hence, stem cells beyond conservation purposes provide a useful model in the field of chicken biological studies.

7.9 Chicken Production Systems

Chickens in Africa are in different management and production systems. Most classifications follow the breed type, input and output level, mortality rate, type of producer, production purpose, length of broodiness, growth rate, and number of chickens reared. There are four poultry production systems in the world, as identified (FAO 2014; Alders et al. 2018). For producers to benefit from the poultry production systems and continue to ensure positive and sustainable contributions, production and marketing should be tailored to local conditions and important value chain nodes while maintaining genetic diversity (Table 7.3).

7.10 Chicken Breed Improvement Programs in Africa

Breeding programs for chickens started several decades ago in the tropics. Most attempts were to improve the production performance of local chickens with better adaptation, but with poor production potential. The most common approach was to consider crossbreeding in the form of a cockerel exchange scheme and the direct intro-

Table 7.3 FAO chicken production systems classification

Criteria	Small-extensive scavenging	Extensive scavenging	Semi-intensive	Small-scale intensive
Production/farming system	Mixed, poultry, and crops, often landless	Mixed, livestock, and crops	Usually poultry only	Poultry only
Other livestock raised	Rarely	Usually	Sometimes	No
Flock size	1–5 adult birds	5–50 adult birds	50–200 adult birds	>200 broilers
				>100 layers
Poultry breeds	Local	Local or crossbred	Commercial, crossbred, or local	Commercial
Source of new chicks	Natural incubation	Natural incubation	Commercial day-old chicks or natural incubation	Commercial day-old chicks or pullets
Feed source	Scavenging; almost no supplementation	Scavenging; occasional supplementation	Scavenging; regular supplementation	Commercial balanced ration
Poultry housing	Seldom; usually made from local materials or kept in the house	Sometimes; usually made from local materials	Yes; conventional materials; houses of variable quality	Yes; conventional materials; good-quality houses
Access to veterinary services and veterinary pharmaceuticals	Rarely	Sometimes	Yes	Yes
Mortality	Very high, >70%	Very high, >70%	Medium to high, 20–>50%	Low to medium <20%
Access to reliable electricity supply	No	No	Yes	Yes
Existence of conventional cold chain	No	Rarely	Yes	Yes
Access to urban markets	Rarely	No, or indirect	Yes	Yes
Products	Live birds, meat	Live birds, meat, eggs	Live birds, meat, eggs	Live birds, meat, eggs
Time devoted each day to poultry management	<30 min	<1 h	>1 h	>1 h

Source: FAO (2014), Alders et al. (2018)

Table 7.4 Examples of chicken genetic improvement programs in Africa

Country	Species	Blood level	Use
Ethiopia	Horro (Mulugeta et al. 2020)	Pure local	Dual
	Tilili (Esatu et al. 2022)	Pure local	Dual
	DZ-white (Mulugeta et al. 2020)	Composite	Dual
Kenya	KALRO 1 (Miyumo et al. 2023)	Composite	Dual
	KALRO 2 (Miyumo et al. 2023)	Composite	Dual
Nigeria	Noiler (Bamidele et al. 2019)	Composite	Dual
	Funnab Alpha (Bamidele et al. 2019)	Pure local	Dual
	Shika-Brown (Bamidele et al. 2019)	–	Layer
	Fulani (Bamidele et al. 2019)	Pure local	
South Africa	Boschveld (Van Marle-Köster and Casey 2001)	Composite	Dual
	Koekoek (Van Marle-Köster and Casey 2001)	Composite	Dual
Cameroon	Northwest (IRZ 1986)	Local and composite	Dual

duction of exotic chicken strains. As exotic chickens could not survive in African settings and required continuous importation, countries have focused on developing their chicken strains using locally available chickens. The need for better management practices is also a problem. In recent years, new breeding programs (see Sect. 7.1.3) are now bearing fruit. The table below shows some of the successful chicken breed improvement programs in Africa. It is good to note that more programs have yet to be reported (Table 7.4).

7.11 Challenges and Opportunities of Chicken Production in Africa

Poultry production in tropical countries is based on the traditional scavenging system. The share of family poultry to the total poultry population in developing countries in Africa is estimated to reach 70–80% (Sonaiya 1990; Gueye 1998; Sonaiya et al. 1999).

7.11.1 Diseases and Predations

Estimates show that about 60% of chicks die before 8 weeks. Incidence of mortality continues at significant rates even during adult stages. A considerable proportion of loss in adult birds is associated with diseases, although losses due to predators also contributed substantially (Gueye 1998). The significant challenges related to an infection at the producer household level include farmers' inadequate knowledge and awareness of better health care practices and insufficient veterinary services.

7.11.2 Improved Genetics

Poor productivity of local breeds and lack of access to productive and adaptable chicken breeds are the other most critical challenges to increasing the economic contribution of the sub-sector. Most of the chickens kept by smallholder farmers are unimproved indigenous flocks with slow growth rates and poor egg productivity (Sonaiya et al. 1999). Attempts to increase the productivity of the sub-sector are mainly focused on introducing high-yielding exotic chickens to replace indigenous stocks, which have generally failed due to the failure of imported breeds to adapt to local conditions. On the other hand, efforts to develop productive species adaptive to local circumstances have borne fruit in recent years (Wondmeneh 2015). Crossbreeding selected local breeds with selected exotic breeds could produce adapted and productive breeds.

7.11.3 Feeds and Nutrition

The backyard or village chicken production system, the leading practice in Africa, mainly depends on a scavenging feed resource base (SFRB) that is minimally supplemented with household feed scraps. The availability and quality of the scavenging feed resources are highly seasonal, and the carrying capacity of the SFRB can only support a minimal number of chickens (Sonaiya et al. 2002). Similarly, feed, accounting for about 70% of the production cost of commercial chicken meat and egg production, could be supplied more and of better quality. Apart from that, the price of imported items such as premixes and locally produced central feed raw materials such as maize and soyabean is exceptionally high due to the inadequate supply of these grains (Negash 2020).

7.11.4 Training and Extension Support

Lack of awareness and knowledge of smallholder producers on modern chicken production practices is another critical challenge to backyard chicken production.

7.11.5 Institutional Constraints

The development of the chicken sector should be viewed in the context of addressing the entire value chain. Engaging and mobilizing the multiple arrays of actors, both public and private, involved in the value chain is critical to address the many issues involved in developing the sector, such as marketing, delivery of inputs, provision of services and credit facilities, and building capacities of research and relevant development institutions, etc.

7.12 Economic Contribution of Chickens in Africa

Village chickens make substantial contributions to household food security throughout the developing world. Indigenous chickens serve as an investment and source of security for households in addition to their use as sources of meat and eggs for consumption and income (Muchadeyi et al. 2007). Chicken production can be regarded as an investment, contributing to the welfare of women and children in traditional, low-input farming systems in the tropics. According to Ref. (Dana et al. 2010), an average flock of five adult chickens helped women in Central Tanzania to have an additional income equivalent to 10% of the average annual income. In the Niger Delta family, poultry husbandry contributes 35% of household women's income, representing about 25% of the Nigerian minimum wage and 50% of the per capita income (Alabi et al. 2006). Village poultry can be used as an effective means of empowering women and as a tool for poverty alleviation. Experiences in many other developing countries have been reported (Kitalyi 1998).

7.13 Implication and Ways Forward

Poultry production in Africa and beyond is an essential source of food, income, and employment. The African poultry sector is so underdeveloped that the demand for poultry products still needs to be met. Previous interventions by governments and nongovernmental organizations have not been fully applied. The introduction of exotic blood into the harsh environment cannot be successful. The problems involve the threat to the existence of the local chicken that the farmers heavily depend on. Future interventions should work on the balance: the need for more meat, eggs, and income on one side and the utilization of local and exotic chicken in appropriate breed combinations coupled with animal recording.

The plans should start with knowing what Africa has and strategically approaching the problem.

7.14 Conclusion

An extensive indigenous poultry conservation and biobanking program will not only support research and development to prevent problems with inbreeding and preserve at-risk poultry breeds but also reduce the large number of live animals needed to be kept for research across the world. It could also have an important role within poultry breeding companies to maintain important parental lines of mainstream poultry breeds used in commercial poultry production without the need to keep large populations of live birds. It is important to note that more work needs to be undertaken, and it should be government policy to encourage the conservation of these breeds to avoid extinction. Therefore, conservation strategies and genetic improvement can be developed and implemented simultaneously in a coordinated approach. This strategy will allow new progeny to be developed and studied while the original breed is preserved.

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