

Poultry Genetic Resource Conservation and Utilization: A review article on Current Status and Future Prospects in Ethiopia

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ABSTRACT

The present review article is intended to provide detail information on poultry genetic resource conservation and utilization: Current status and future prospects in developing countries (Ethiopia). Poultry genetic resources in Ethiopia, particularly indigenous chicken breeds, represent a valuable asset for sustainable agriculture, food security and rural livelihoods. These breeds have evolved over generations, adapting to diverse ecological niches and demonstrating resilience to local environmental challenges and diseases. The conservation and sustainable utilization of these genetic resources are paramount to safeguarding biodiversity, preserving cultural heritage and enhancing agricultural productivity. Efforts to conserve poultry genetic resources in Ethiopia face significant challenges, including habitat loss, genetic dilution through crossbreeding and limited institutional support. Despite these challenges, various conservation strategies, both *ex-situ* and *in-situ*, have been implemented to preserve genetic diversity and promote sustainable breeding practices. *Ex-situ* conservation methods, such as gene banks and cryopreservation, offer potential solutions for safeguarding genetic material from endangered poultry breeds, while *in-situ* conservation focuses on maintaining populations within their natural habitats and integrating indigenous knowledge with modern breeding techniques. The utilization of poultry genetic resources involves incorporating diverse genetic traits into breeding programs to develop improved breeds that are well-adapted to local conditions, disease-resistant and productive. Integrating genetic diversity from indigenous chicken breeds into commercial poultry production systems can enhance resilience and sustainability, benefiting smallholder farmers and contributing to national food security goals.

KEYWORDS

Poultry genetic resources, indigenous chickens, genetic conservation, conservation strategies, breeding programs

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INTRODUCTION

Poultry genetic resources are pivotal for ensuring food security, livelihoods and biodiversity conservation globally¹. In developing countries, particularly in Africa and Ethiopia, these resources are crucial for smallholder farmers, contributing significantly to income generation and nutritional needs. Animal genetic resources encompass the breeds and strains of domesticated animals developed through selective



breeding from approximately 40 wild species over the past 10,000 years². These resources are essential for sustaining and improving life quality on Earth. Poultry meat and eggs are highly popular animal-source foods worldwide. In Ethiopia, poultry production is a significant component of the livestock industry. The estimated poultry population in Ethiopia is currently around 57 million, with the majority being laying hens (34.26%) and followed by chicks (32.86%). The country is estimated to have about 6.47 million pullets. In terms of breed, 78.85% of the total poultry are indigenous, 12.02 and 9.11% are hybrid and exotic, respectively³.

The majority of the country's poultry meat and eggs are generated through traditional family poultry production methods, utilizing low-yielding native breeds. Nevertheless, the use of exotic breeds in intensive production methods is leading to a growing portion of the overall production. Ethiopia boasts one of the lowest rates of per capita poultry product consumption globally, with an annual consumption of 57 eggs and 2.85 kg of chicken meat, significantly lower than the average in East Africa. Indigenous chickens possess significant genetic diversity and a strong capacity for local adaptation, which serves as the foundation for selective breeding and genetic enhancement strategies that emphasize informed decision-making^{4,5}. Although various authors have phenotypically and genetically characterized certain chicken breeds, numerous nondescript populations remain undocumented in the literature. The present review article is designed to provide compressive information on poultry genetic resource conservation and utilization with emphasis on the current status and future prospects in Ethiopia.

IMPORTANCE OF POULTRY GENETIC DIVERSITY

Genetic diversity studies in livestock species are crucial for understanding their significance and for conservation and enhancement in various production settings⁶. Indigenous chickens in developing areas seem to exhibit greater genetic diversity compared to commercial breeds, therefore, comprehension of their genetic makeup can aid in preserving the genetic variation and distinct phenotypic characteristics of each population⁷⁻⁹. The genetic diversity within poultry species is critical for their resilience and adaptation to changing environmental conditions, diseases and production challenges. Different chicken breeds exhibit unique traits such as disease resistance, heat or cold tolerance, efficient egg or meat production and foraging abilities. Maintaining this genetic diversity ensures that farmers have options to breed chickens that are well-suited to local conditions. This approach reduces dependence on narrow genetic traits that may be vulnerable to disease outbreaks or environmental changes. Moreover, many chicken breeds hold cultural and historical significance, preserving traditions associated with local agriculture and cuisine.

Genetic diversity allows chicken populations to adapt to various agro-ecological conditions prevalent in Ethiopia. Local chicken breeds have evolved over generations to withstand challenges such as diseases, extreme temperatures and scarce resources typical of different regions¹⁰. It provides a reservoir of genes associated with disease resistance. In Ethiopia, where diseases like Newcastle disease and fowl typhoid are prevalent, local chicken breeds often exhibit natural resistance due to their diverse genetic backgrounds^{10,11}. This resilience is crucial for reducing mortality rates and ensuring sustainable poultry production. Cross breeding may improve total genetic diversity by introducing new genes and genotypes into the population¹².

Local chicken breeds in Ethiopia are often integral to cultural practices and traditions. They play significant roles in rituals, ceremonies and community livelihoods, preserving cultural heritage through their unique genetic traits and historical significance¹⁰. Indigenous chicken production contributes significantly to rural economies in Ethiopia. These breeds are typically well-suited to smallholder farming systems, providing a sustainable source of income and nutrition for households¹³. The genetic diversity inherent in local chicken breeds serves as a valuable resource for future breeding programs. It provides a basis for developing improved breeds that combine local adaptation with traits such as higher egg or meat production, which can enhance the economic viability of poultry farming in Ethiopia¹⁴.

PHENOTYPIC AND MOLECULAR CHARACTERIZATION LOCAL CHICKEN ECOTYPES

Local chicken breeds in Ethiopia exhibit a wide range of phenotypic traits that are adapted to various agroecological zones and farming systems. They are categorized based on color (e.g., black, red, white), feather morphology (e.g., silky, normal), comb type (e.g., single, rose) and body shape (e.g., blocky, triangular). The names of these local ecotypes often derive from the places where they are found. Phenotypic characteristics vary due to agro-climatic conditions, ethnic groups, socio-economic factors and cultural influences¹⁰. Phenotypic characterization involves detailed observations and measurements of these traits, which are essential for breed identification, selection and conservation efforts. The phenotypic analysis of indigenous chicken breeds in Ethiopia demonstrates characteristics including strong maternal instincts, sluggish development, delayed reproductive maturity and moderate productivity. Most local chicken characterization has been done in Ethiopia by students at various districts and zonal levels with specific objectives rather than including all necessary breeding objectives, simply for the seek of graduation purposes. So, it requires comprehensive and inclusive phenotypic characterization with feed resources at the national level with collaborations of different stakeholders to utilize the landrace chicken based on results and recommendations of studies.

Molecular characterization, using techniques like microsatellite markers, provides deeper insights into genetic diversity independent of environmental influences. These methods help researchers to identify unique genetic markers associated with desirable traits, genetic relationships among populations and levels of genetic variability within and between breeds¹³. Studies in Ethiopia have utilized molecular markers like microsatellites and single nucleotide polymorphisms (SNPs) to assess the genetic diversity of indigenous chicken populations across different regions^{13,14}. Such molecular analyses contribute to the conservation and sustainable utilization of genetic resources by guiding breeding programs aimed at preserving valuable genetic traits. However, comprehensive data on the genetic diversity of Ethiopian local chickens are still lacking, hindering the design of effective conservation and breeding strategies.

CONSERVATION METHODS FOR CHICKEN GENETIC RESOURCES

Efforts to conserve poultry genetic diversity encompass *in-situ* and *ex-situ* conservation approaches. *In-situ* conservation involves maintaining populations within their natural environments through on-farm management. This method allows for ongoing utilization and adaptation of breeds, though it risks genetic drift and inbreeding. *Ex-situ* methods involve conserving genetic materials like semen, ova and embryos, which mitigate risks associated with disease and natural disasters but limit breed adaptation to changing environmental conditions.

***In-situ* conservation:** In Ethiopia, *in-situ* conservation involves maintaining indigenous chicken populations within their natural habitats and farming systems. This method leverages traditional farming practices and local knowledge to preserve genetic diversity. Farmers play a crucial role in conserving native chicken breeds by allowing them to freely interact and reproduce within their ecological niches¹¹. *In-situ* conservation ensures that genetic traits associated with adaptation to specific environments, disease resistance and resilience to climatic variability are maintained over generations.

On-farm conservation: The on-farm conservation integrates genetic resource conservation with agricultural production. Smallholder farmers in Ethiopia often keep indigenous chicken breeds as part of their livelihoods, allowing for natural selection and adaptation to local conditions¹¹. Efforts to promote on-farm conservation include training farmers in sustainable breeding practices, disease management and the maintenance of genetic purity. This approach not only supports the livelihoods of rural communities but also enhances the resilience of chicken populations to environmental stresses.

Community-based conservation initiatives: The community-based conservation initiatives involve collaboration among farmers, researchers and local institutions to safeguard indigenous chicken genetic resources. In Ethiopia, such initiatives may include establishing community gene banks or breeding

programs aimed at preserving unique genetic traits¹¹. Community participation fosters ownership and responsibility for conservation efforts, ensuring the sustainability of genetic diversity in chicken populations.

Establishment of gene banks: Gene banks serve as repositories for genetic material, such as semen, embryos, or DNA samples, from diverse chicken breeds. In Ethiopia, establishing gene banks allows for the long-term preservation of genetic diversity and facilitates research and breeding programs¹¹. These facilities are equipped with cryopreservation technologies to maintain the viability of genetic resources over extended periods, mitigating the risk of genetic erosion due to environmental or socio-economic changes.

Selective breeding programs: Selective breeding programs aim to enhance desirable traits in indigenous chicken breeds while preserving their genetic diversity. In Ethiopia, these programs often focus on traits such as disease resistance, egg production, growth rates and adaptability to local conditions¹⁰. By identifying superior breeding stock and implementing controlled mating strategies, breeders can improve the overall performance and sustainability of native chicken populations.

The continuing chicken breeding programs should not solely depend on importing non-adapted exotic chickens; instead, enhancing indigenous chickens through selective breeding can better achieve the goal for low input and tropical systems¹⁵. Therefore, new methods to enhance performance and preserve local chickens have been introduced: Selective breeding of indigenous Horro chicken and the creation of DZ-white synthetic chicken. Selective breeding was first implemented in 2008 in the Debre Zeit agricultural research center, Bishoftu to enhance local chicken productivity through selective breeding for higher productivity and adaptability compared to the unselected Horro ecotype¹¹. The initial breeding objective of the ongoing program was to genetically enhance indigenous Horro chickens for egg production and growth characteristics while maintaining their ability to adapt to challenging environments^{11,15}. The Horro selective breeding research successfully increased the average body weight at 16 weeks by about 74% and the number of eggs at 24 weeks after the start of egg-laying by 21% from the fourth to the sixth generation¹⁶, showing a promising trend in the desired traits. Currently, the candidate Horro chicken breed has reached the 14th generation and is set to be released in the market within a few years. Crossbreeding activities were also conducted at Debrezeit Agricultural Research center to carefully choose the candidate breed and mating design for the advancement of synthetic chicken breeds in semi-intensive production systems¹⁷⁻¹⁹. The studies aimed to identify potential candidates from both exotic breeds and local ecotypes, focusing on their growth and egg production performance, to develop a resilient dual-purpose chicken breed suitable for specific production systems.

CHALLENGES OF CHICKEN GENETIC RESOURCES IN ETHIOPIA

Genetic erosion due to hybridization and crossbreeding: One of the primary challenges facing indigenous chicken populations in Ethiopia is genetic erosion through hybridization with commercial breeds and crossbreeding programs. Commercial breeds, selected for high productivity traits such as egg or meat yield, are often introduced without adequate consideration for their impact on local genetic diversity¹¹. This hybridization can lead to the dilution of unique adaptive traits found in local ecotypes, reducing their resilience to local diseases and environmental stresses. The loss of genetic diversity not only undermines biodiversity but also diminishes potential sources of resilience in poultry production systems. Extensive and random introduction of exotic breeds before appropriate characterization, utilization and conservation of indigenous genetic resources is believed to be the main cause of the loss of indigenous resources^{20,21}. Improving the local chicken population through selective breeding is a better option than mixing with non-adaptive exotic breeds²². Unregulated mating within native chicken populations and unplanned crossbreeding with exotic breeds can lead to a notable rise in inbreeding levels and genetic dilution¹⁶. Ethiopian indigenous chickens exhibit a wide range of diversity, providing a significant opportunity for the development of sustainable breeding improvement strategies through selection¹⁵.

Loss of indigenous breeds and traditional knowledge: The rapid adoption of commercial poultry farming practices has contributed to the decline of indigenous chicken breeds in Ethiopia. These local breeds, adapted over generations to specific agro-climatic conditions and cultural practices, are increasingly marginalized in favor of more productive but genetically uniform commercial strains¹⁰. Alongside the loss of breeds, traditional knowledge associated with breeding, management practices and cultural significance is also at risk of disappearing.

Inadequate conservation strategies and infrastructure: In Ethiopia, conservation efforts for poultry genetic resources are often constrained by inadequate infrastructure and limited institutional support. *In-situ* conservation approaches, which involve maintaining breeds within their natural environments through local farming practices, face challenges such as lack of funding, access to veterinary services and awareness among farmers about the importance of biodiversity conservation¹¹. *Ex-situ* conservation efforts, such as cryopreservation of genetic materials, are also underdeveloped and not widely implemented.

Climate change and environmental pressures: The effects of climate change, including unpredictable weather patterns and changing disease dynamics, pose additional threats to indigenous poultry breeds in Ethiopia. These breeds, adapted to local conditions over centuries, may struggle to cope with new environmental stresses such as heat waves, droughts and emerging diseases²³. Intensive farming practices associated with climate change mitigation, such as increased use of energy-intensive technologies and feed imports, further marginalize extensive local farming systems reliant on indigenous breeds.

FUTURE PROSPECTS CHICKEN GENETICS RESOURCES

Advancements in genomic technologies, such as massively parallel DNA sequencing, offer promising tools for enhancing the conservation and utilization of poultry genetic resources. These technologies enable cost-effective whole-genome sequencing and the identification of unique alleles and adaptive variants. Integration of genomic data into breeding programs can optimize selection strategies for improving traits like disease resistance, growth rate and environmental adaptation. Moreover, such advancements support the development of SNP panels and other markers essential for diversity studies and conservation prioritization.

Utilization of indigenous genetic diversity: Ethiopia possesses a rich diversity of indigenous chicken ecotypes adapted to various agroecological zones and traditional farming systems. These local breeds exhibit unique traits such as disease resistance, tolerance to harsh environmental conditions and suitability for scavenging under extensive management practices¹¹. Harnessing and conserving this genetic diversity not only supports sustainable poultry production but also preserves cultural heritage and enhances food security among rural communities. Crossbred chickens that combine the blood of exotic and local breeds tend to perform relatively better than indigenous chickens, which are typically characterized by low production due to genetics. The frequent production of F₁ crossbred demands in subsequent importation of exotic parents due to produced offspring chicken are terminal genetically²³.

Enhancement of productivity traits through selective breeding: There is significant potential to enhance the productivity of indigenous chicken breeds in Ethiopia through selective breeding programs. By identifying and selecting for traits such as improved growth rates, egg production and feed efficiency, breeders can develop strains that meet both local market demands and environmental challenges¹⁰. Integrating traditional breeding practices with modern genomic tools offers opportunities to accelerate genetic improvement while preserving unique genetic characteristics.

Promotion of sustainable poultry farming systems: The sustainable poultry farming systems, including free-range and semi-intensive management practices, provide avenues for enhancing the economic viability of indigenous chicken production in Ethiopia. These systems not only capitalize on the

natural foraging behaviors of local breeds but also promote ecosystem health through reduced reliance on external inputs²³. Supporting smallholder farmers with training in improved management practices, disease control strategies and market access can further strengthen the resilience and profitability of poultry enterprises.

Integration of climate-smart approaches: Addressing the challenges posed by climate change requires integrating climate-smart approaches into poultry breeding and management practices. Breeding resilient chicken strains capable of withstanding heat stress, diseases exacerbated by changing weather patterns and limited water availability is critical. Additionally, promoting resource-efficient technologies, such as solar-powered lighting and rainwater harvesting, can enhance the sustainability of poultry farming operations in a changing climate.

Community-based conservation and institutional support: Strengthening community-based conservation initiatives and enhancing institutional support are essential for safeguarding Ethiopia's chicken genetic resources. Collaborative efforts involving farmers, researchers and policymakers can facilitate the documentation, characterization and conservation of indigenous breeds¹¹. Establishing gene banks, training programs on genetic resource management and incentivizing farmers to participate in conservation efforts are pivotal for ensuring the long-term viability and utilization of Ethiopia's diverse chicken genetic resources.

CONCLUSION AND RECOMMENDATIONS

Poultry genetic resources in Ethiopia, particularly indigenous chicken breeds, represent a valuable asset for sustainable agriculture, food security and rural livelihoods. These breeds have evolved over generations, adapting to diverse ecological niches and demonstrating resilience to local environmental challenges and diseases. Comprehensive characterization and conservation strategies, supported by genomic technologies and sustainable breeding practices, are essential for safeguarding indigenous poultry breeds against the threats of genetic erosion and environmental change. Based on the present review paper the following suggestions/recommendations were drawn for all concerned bodies.

- Strengthening institutional frameworks and policy support for poultry genetic resource conservation in Ethiopia is essential. This includes establishing more gene banks, enhancing capacity building in cryopreservation techniques and ensuring sustainable funding mechanisms for long-term conservation efforts
- Encouraging community-based conservation initiatives that empower local communities to sustainably manage and utilize poultry genetic resources within their traditional farming systems
- Continued research into the phenotypic and molecular characterization of indigenous chicken breeds will provide valuable insights into their genetic potential and traits that can be harnessed for breeding programs
- Increasing awareness among farmers, policymakers and the public about the importance of poultry genetic resources and their conservation is crucial. Capacity-building initiatives should focus on training farmers in sustainable breeding practices and promoting the economic benefits of preserving indigenous chicken breeds
- Integrating genetic diversity conservation goals into national agricultural policies and strategies will ensure that poultry genetic resources are recognized and prioritized in broader agricultural development agendas
- This review article highlights the critical importance of poultry genetic resource conservation and utilization in Ethiopia, emphasizing the value of indigenous chicken breeds for sustainable agriculture, food security and rural livelihoods. Indigenous chicken breeds in Ethiopia possess unique genetic traits that have evolved to adapt to local environmental challenges, offering resilience against diseases and harsh climatic conditions. However, these valuable resources face threats from genetic erosion,

habitat loss and inadequate conservation efforts. The article provides a comprehensive analysis of current conservation strategies, including both *in-situ* and *ex-situ* methods and discusses future prospects for integrating genomic technologies to enhance breeding programs and safeguard genetic diversity. By addressing these challenges and leveraging indigenous genetic resources, Ethiopia can improve poultry productivity, support smallholder farmers and contribute to national food security.

SIGNIFICANCE OF STATEMENT

This review article highlights the critical importance of poultry genetic resource conservation and utilization in Ethiopia, emphasizing the value of indigenous chicken breeds for sustainable agriculture, food security and rural livelihoods. Indigenous chicken breeds in Ethiopia possess unique genetic traits that have evolved to adapt to local environmental challenges, offering resilience against diseases and harsh climatic conditions. However, these valuable resources face threats from genetic erosion, habitat loss and inadequate conservation efforts. The article provides a comprehensive analysis of current conservation strategies, including both *in-situ* and *ex-situ* methods and discusses future prospects for integrating genomic technologies to enhance breeding programs and safeguard genetic diversity. By addressing these challenges and leveraging indigenous genetic resources, Ethiopia can improve poultry productivity, support smallholder farmers and contribute to national food security.

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