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Reviving Forgotten Foods: Agronomic Performance and Economic Potential of Underutilized Indigenous Crops in Sub-Saharan Africa

Nathaniel Kwawu[1] | Benjamin Yennuna Konyannik[1] | Funchious Paul Mensah[1] | Ebenezer Adukpo[1] |Godwin Mensah[1] | Bright Agbolosu[1] | Pius Yao Adenyo[1] |Hope Adeti Mensah[1] |Mike Akpatsu Kenin[1]|Kiven Leslie Larkai [2]

[1]Department of Agrobiotechnology, Institute of Agriculture, RUDN University, 117198 Moscow, Russia, Russian Federation,

[2] Department of Ecology and Environmental Management, Institute of Environmental Engineering, RUDN University, 117198 Moscow, Russia, Russian

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ABSTRACT

Crop diversification is increasingly recognized as a cornerstone of global strategies for sustainable agriculture, climate resilience, and nutritional security. In Sub-Saharan Africa (SSA), underutilized indigenous crops such as sorghum, millet, Bambara groundnut, fonio, and amaranth offer a unique combination of agronomic adaptability, nutrient density, and cultural relevance. These species have evolved under local agroecological pressures, conferring tolerance to drought, heat, and marginal soils while contributing to dietary diversity and rural income generation. Despite their potential, indigenous crops remain marginalized in research, policy, and markets. Current production systems are constrained by weak seed systems, limited agronomic research under field conditions, inadequate value addition infrastructure, and a lack of integration into formal agricultural policies. This systematic review addresses critical gaps by synthesizing evidence on yield potential across agroecological zones, tolerance to abiotic and biotic stresses, contributions to soil health, comparative economic viability with major staples, and their nutritional and cultural significance. Findings indicate that indigenous crops consistently outperform major staples under low-input and stress-prone conditions, provide competitive or superior nutrient profiles, and offer market opportunities in niche and health-conscious segments. However, their scale-up is hindered by limited policy support, data deficiencies, and low consumer awareness. The novelty of this review lies in linking agronomic performance with economic and cultural value, reframing indigenous crops as strategic assets for sustainable food systems rather than subsistence relics. The review recommends coordinated interventions involving academia, government, and industry to integrate indigenous crops into climate-smart agriculture frameworks, strengthen value chains, and expand consumer demand.

KEYWORDS: *underutilized indigenous crops, traditional crops, nutritional security, food security*

I. INTRODUCTION

Underutilized indigenous crops commonly referred to as neglected and underutilized species (NUS) are ancient plant species that once held central roles in traditional food systems but have since declined in prominence due to industrial agriculture's narrow crop focus. These crops, which include species like sorghum, fonio, amaranth, and African yam bean, are typically adapted to local environments and possess rich nutritional, medicinal, and cultural value (Wani et

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al., 2021; Bhatt et al., 2019; Sabreena et al., 2025). Despite their potential, they remain marginalized in agricultural research and policy, largely due to inadequate market structures, limited awareness, and minimal investment in genetic improvement and agronomic development (Wani et al., 2021).

Historically, indigenous crops have served as the foundation of resilient and biodiverse food systems across Africa and other regions (Table 1). They were integral to traditional farming systems such as intercropping, exemplified by the “Three Sisters” model of maize, beans, and squash practiced by Indigenous Peoples of the Americas, an approach that balanced soil fertility, resource use, and dietary diversity (Ngapo et al., 2021). The domestication of key crops like maize and potatoes by Indigenous communities during the pre-Columbian era continues to influence global food systems (Bruno, 2019). However, the globalization of agriculture has displaced many of these traditional food staples, contributing to a loss of agro-biodiversity and cultural identity.

The revival of indigenous crops is increasingly relevant today, particularly in the context of food and nutrition insecurity. These species are often nutrient-dense, rich in essential vitamins, minerals, and antioxidants that surpass those of many conventional crops (De & De, 2020). Their potential to alleviate malnutrition and hidden hunger in vulnerable populations has been well-documented (Kwarteng et al., 2024; Akinola et al., 2020). Moreover, their cultivation is associated with improved food security outcomes, especially when farmers access formal markets (Shelembe et al., 2024).

Beyond nutritional benefits, underutilized indigenous crops offer promising avenues for climate resilience. Their natural adaptation to drought-prone, low-input, and degraded environments enables them to thrive under the changing climatic conditions affecting Sub-Saharan Africa (Sambo, 2014). For instance, species such as Acha and Guinea corn require minimal water and exhibit tolerance to temperature extremes. When integrated with Indigenous Ecological Knowledge (IEK), these crops support agroecological practices that enhance food system sustainability and reduce vulnerability to environmental shocks (Sakapaji, 2022; Zuza et al., 2024).

Culturally, these crops are deeply embedded in local identities, rituals, and spiritual beliefs. In many African communities, specific crops are linked to ancestral heritage, and their cultivation and consumption are tied to sacred traditions (Kagawa-Viviani et al., 2018). The knowledge systems surrounding their cultivation including seed saving, soil management, and food preparation represent a wealth of inherited ecological understanding (Dongen, 2022). However, these cultural landscapes are increasingly threatened by modernization and the erosion of traditional knowledge (Soleri & Cleveland, 1993).

Economically, the revival of underutilized indigenous crops holds potential for rural development. These crops can provide alternative income sources for smallholder farmers and help diversify production systems in marginal lands (Wani et al., 2021; Thakur, 2014). Their promotion could create employment opportunities and stimulate local economies, particularly when linked to agri-food value chains (Shelembe et al., 2024).

In spite of their multifaceted benefits, significant gaps remain in research, policy, and market integration of underutilized crops. Current literature indicates a need for agronomic trials, breeding programs, nutritional profiling, and market development strategies tailored to indigenous species. Moreover, more robust documentation of cultural knowledge and participatory approaches to crop promotion are required to avoid top-down interventions that may undermine community ownership.

Table 1. Key Underutilized Indigenous Crops in Sub-Saharan Africa: Agronomic Traits, Nutritional Value, and Cultural Relevance

Crop	Agronomic Traits	Nutritional Highlights	Cultural/Economic Importance	Sources
Fonio (Digitaria spp.)	Extremely drought-tolerant; grows on poor soils	High in iron, calcium, methionine	Traditionally used in ceremonies; fast-cooking grain	Wani *et al.* (2021); De & De (2020)
African Yam Bean	Nitrogen-fixing;	High in protein,	Used in traditional soups	Adewale &

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(Sphenostylis stenocarpa)	tolerant to poor soils	lysine, and carbohydrates	and stews in West Africa	Dumet (2011); Oladejo *et al.* (2020)
Taro (Colocasia esculenta)	Flood-tolerant; grows in low-input wetland systems	Rich in fiber, potassium, and B vitamins	Staple in several communities in Central and East Africa	Onwueme (1999); Olatunji *et al.* (2022)
Bambara Groundnut (Vigna subterranea)	Drought-resistant; thrives without fertilizer	High in protein, balanced amino acid profile	Popular in local markets; known as "complete food"	Musa *et al.* (2016); Abberton *et al.* (2022)
Pearl Millet (Pennisetum glaucum)	Heat-tolerant; grows on sandy, low-fertility soils	Rich in iron, zinc, and antioxidants	Common food security crop in Sahelian regions	Choudhury *et al.* (2023); Teye *et al.* (2020)
Amaranth (Amaranthus spp.)	Fast-growing; tolerant to heat and moderate drought	High in protein, calcium, and vitamin A	Consumed as both grain and leafy vegetable	Bhatt *et al.* (2019); Wani *et al.* (2021)
Teff (Eragrostis tef)	Grows well in highlands; tolerates waterlogging	High in iron and resistant starch	Staple in Ethiopia; used for injera	Wani *et al.* (2021); De & De (2020)

This review seeks to consolidate existing evidence on the agronomic performance and economic potential of underutilized indigenous crops in Sub-Saharan Africa. The primary research questions guiding this review include:

1. What are the key agronomic traits that make indigenous crops suitable for climate-resilient agriculture in SSA?
2. What is the economic potential of these crops for smallholder farmers and rural communities?
3. How can Indigenous knowledge and cultural practices be preserved and integrated into modern agricultural systems?
4. What research and policy gaps need to be addressed to scale up the use of underutilized crops?

By addressing these questions, this review aims to contribute to the broader discourse on sustainable agriculture, food security, and cultural preservation in the region.

II. Methodology

Conceptual Framework and Methodology

This systematic review investigates the agronomic performance and economic potential of underutilized indigenous crops in Sub-Saharan Africa (SSA), grounded in a multi-dimensional framework that encompasses nutritional, economic, environmental, and socio-cultural domains. The approach integrates both qualitative and quantitative studies to synthesize emerging insights and identify critical knowledge gaps across the agri-food system.

Inclusion Criteria

To ensure relevance and scientific rigor, the review employed strict inclusion criteria focused on literature that examines neglected and underutilized crop species (NUCS) as part of climate adaptation and food system diversification strategies in SSA. Selected studies emphasized the nutritional value, economic viability, and environmental contributions of indigenous crops within sustainable food systems (Ndlovu et al., 2024; Mgwenya et al., 2025). Priority was given to articles that explored multiple benefits of indigenous and traditional food crops (ITFCs), including their role in reducing malnutrition, enhancing agrobiodiversity, and promoting local food cultures (Akinola et al., 2020). Publications that analyzed the integration of these crops into broader agricultural and nutritional policies across Southern and Sub-Saharan Africa were also included (Munoko et al., 2022).

To maintain a contemporary focus, the review considered peer-reviewed articles, policy reports, and academic reviews published between 2009 and 2024. Only literature with clear empirical or conceptual contributions to agronomic performance, socio-economic outcomes, or food policy integration of indigenous crops was retained.

Search Strategy and Databases

A comprehensive search was conducted using the following academic databases: Web of Science, Scopus, JSTOR, and Google Scholar, which are widely used for interdisciplinary agricultural and development research. Search terms were structured to capture key dimensions of the research focus and included:

- "underutilized indigenous crops",
- "neglected and underutilized species (NUS)",
- "traditional food crops Africa",
- "indigenous crops and climate resilience",
- "agronomic performance of NUCS",
- "economic potential of forgotten crops",
- "food security and traditional crops SSA".

Boolean operators (AND, OR) and wildcards were applied to refine search sensitivity. Manual screening of reference lists was used to identify additional relevant literature not captured by automated searches. Studies were screened in multiple stages: by title and abstract, followed by full-text assessment based on relevance to the review objectives.

Analytical Framework

The conceptual lens guiding this review is based on four intersecting thematic pillars: agronomic performance, economic viability, policy integration, and adoption dynamics. These elements were used to assess how underutilized indigenous crops contribute to food and nutrition security, resilience to climate stressors, and inclusive rural development.

Agronomic performance was evaluated through studies examining yield stability, adaptability to marginal conditions, pest and disease resistance, and input efficiency (Chivenge et al., 2015; Akinola et al., 2020). Economic potential was analyzed through market participation, value chain integration, and income generation for smallholder farmers (Munoko et al., 2022). Attention was also given to barriers such as unimproved genetic traits, weak extension systems, and limited commercialization (Tadele & Assefa, 2012; Ndlovu et al., 2024).

Policy and institutional dimensions were considered by identifying gaps in national and regional strategies that either hinder or support the scaling-up of NUCS. While some studies highlight growing recognition of their value, explicit policy support remains minimal, and private sector engagement is still nascent (Ndlovu et al., 2024). The framework therefore calls for multi-sectoral coordination, participatory research models, and investment in breeding, postharvest processing, and consumer awareness.

Ultimately, the analytical approach used in this review facilitates a holistic understanding of the systemic constraints and opportunities surrounding the revival of forgotten foods in SSA. By synthesizing current evidence, this review provides a foundation for future research, policy development, and on-the-ground interventions aimed at leveraging NUCS for a more sustainable and inclusive food future.

III. Agronomic Performance of Indigenous Crops

Yield Potential Under Different Conditions

Yield potential among underutilized indigenous crops in Sub-Saharan Africa (SSA) varies significantly depending on water availability, soil quality, and cropping systems. Rainfed agriculture, which dominates SSA, faces yield instability due to erratic rainfall. However, when integrated with rainwater harvesting and nutrient inputs, yields can increase up to sixfold (Biazin et al., 2012; Amede et al., 2014). Despite its potential, rainfed farming is highly vulnerable to climatic variability, underscoring the need for improved soil moisture management (Gebregziabher et al., 2012). Irrigated systems offer higher productivity but are constrained by water competition, especially in semi-arid zones (Amede et al., 2014).

Soil fertility further differentiates yield outcomes. Marginal soils, characterized by nutrient depletion, yield below 1.5 tons/ha for cereals, despite a potential exceeding 5 tons/ha (Zingore, 2014). Fertile zones, benefiting from integrated soil fertility management (ISFM), reach higher productivity through optimized nutrient application (Couëdel et al., 2024). Nevertheless, widespread degradation in marginal lands hampers sustainable productivity (Smaling & Braun, 1997; Bamutaze, 2015).

Cropping systems also influence performance. Intercropping maize with legumes such as cowpea often results in land equivalent ratios >1.0, reflecting efficient resource use and enhanced nitrogen cycling (Dimande et al., 2024; Fuchs et al., 2024). Similarly, crop rotations, particularly maize-groundnut systems, can yield gains of 1–2 t/ha and improve resilience to pests and nutrient loss (Mwila et al., 2024). However, agroecological and economic contexts shape outcomes, necessitating location-specific recommendations (see Table 2).

Table 2. The minimum and maximum yield ranges for traditional rainfed conditions, improved water harvesting systems, and optimized or irrigated environments

Crop	Traditional Rainfed (t/ha)	Rainfed + Water Harvesting (t/ha)	Irrigated/Improved Conditions (t/ha)	Sources
Sorghum	1.0–1.8	3.5–5.0	4.5–6.5	Zingore (2014); Amede *et al.* (2014); Biazin *et al.* (2012)
Pearl Millet	0.8–1.5	2.5–4.0	3.0–5.0	Wani *et al.* (2021); Amede *et al.* (2014)
Bambara Groundnut	0.6–1.2	2.0–3.0	2.5–3.5	Abberton *et al.* (2022); Musa *et al.* (2016)
African Yam Bean	0.7–1.3	2.0–3.0	2.8–3.6	Adewale & Dumet (2011); Oladejo *et al.* (2020)
Taro	2.0–4.0	4.5–6.0	6.0–8.5	Olatunji *et al.* (2022); Onwueme (1999)

Tolerance to Abiotic and Biotic Stress

Underutilized indigenous crops in SSA possess remarkable resilience to environmental stressors, positioning them as climate-smart alternatives to major staples. These crops, often adapted over centuries to harsh environments, display tolerance to abiotic stresses such as drought, heat, and flooding traits increasingly vital under projected climate scenarios (Table 3).

Drought Tolerance

Drought stress is among the most critical constraints affecting rainfed agriculture. Several indigenous crops, including sorghum, pearl millet, and Bambara groundnut, exhibit superior drought avoidance and tolerance mechanisms compared to common cereals like maize and rice (Olawuyi et al., 2021). Sorghum uses deep root systems and osmotic adjustment, while Bambara groundnut maintains yields under water deficit through early stomatal closure and water use efficiency (Oyiga et al., 2016; Ali et al., 2023). Finger millet and cowpea also show high yield stability under water-limited conditions due to rapid development and efficient transpiration regulation (Mpofu et al., 2021; Olayiwola et al., 2021). However, the genetic mechanisms behind these traits remain poorly characterized, limiting breeding advances (Ali et al., 2023).

Heat Tolerance

Indigenous cereals like foxtail and finger millet maintain reproductive success under elevated temperatures through stable chlorophyll retention and antioxidant enzyme production (Anitha et al., 2022). Taro and teff show resilience at temperatures exceeding 35°C, aided by heat shock proteins and membrane stabilization (Choudhury et al., 2023). However, temperature sensitivity is highly genotype-specific; for example, cowpea yield losses can range from 10 –60% depending on the cultivar (Ndiso et al., 2022). This emphasizes the need for broader genotype evaluations across SSA's agroecological zones.

Flood Tolerance

While drought and heat tolerance have received moderate research attention, flood resilience remains underexplored. Root and tuber crops like taro and African yam can tolerate brief waterlogging through aerenchyma formation and anaerobic metabolism (Olatunji et al., 2022). Conversely, most indigenous legumes and cereals are susceptible to flooding-induced root hypoxia and fungal infection, leading to significant yield loss (Olawuyi et al., 2021). With climate models

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predicting more frequent extreme rainfall events, research on flood-adapted indigenous crops is increasingly urgent.

Table 3. Mechanisms of Abiotic Stress Tolerance in Selected Underutilized Indigenous Crops in Sub-Saharan Africa

Crop	Drought Tolerance Mechanisms	Heat Tolerance Mechanisms	Flood Tolerance Mechanisms	Sources
Sorghum	Deep root system; osmotic adjustment; stomatal control	Maintenance of photosynthetic pigments; heat-stable enzymes	Moderate tolerance via leaf rolling	Oyiga *et al.* (2016); Choudhury *et al.* (2023); Anitha *et al.* (2022)
Pearl Millet	High water use efficiency; leaf rolling; short lifecycle	Membrane thermostability; antioxidant defense systems	Low flood tolerance	Olawuyi *et al.* (2021); Wani *et al.* (2021)
Bambara Groundnut	Early maturity; drought escape via underground pods	Heat-resistant germination and flowering stages	Poor flood tolerance	Abberton *et al.* (2022); Musa *et al.* (2016)
Finger Millet	High root-shoot ratio; stomatal regulation	Stable chlorophyll content under high temperatures	Limited data	Bhatt *et al.* (2019); Choudhury *et al.* (2023)
Cowpea	Leaf wilting resistance; canopy closure	Heat-tolerant genotypes selected via breeding	Limited tolerance; affected in waterlogged soils	Abberton *et al.* (2022); Oyiga *et al.* (2016)
Taro	Moderate drought tolerance when mulched; corm reserves	Can tolerate moderate heat when grown under shade	High flood tolerance; forms aerenchyma in petioles	Olatunji *et al.* (2022); Onwueme (1999)
Teff	Grows under moisture stress in Ethiopian highlands	Maintains grain filling under high temps	High tolerance to waterlogging due to fibrous root system	Wani *et al.* (2021); De & De (2020)

Mechanisms listed here reflect physiological or morphological traits, not just yield outcomes. This table supports arguments for resilience-based crop diversification in marginal or climate-affected zones.

Soil Health and Agroecological Benefits

Indigenous crops, especially legumes, significantly contribute to soil fertility through biological nitrogen fixation (BNF). Species like Crotalaria ochroleuca and Sesbania sesban fix between 5–581 kg N ha^{-1} annually, enhancing soil productivity and reducing dependence on synthetic fertilizers (Tauro et al., 2009; Dakora & Keya, 1997; Negi et al., 2022). Their role in intercropping and rotations strengthens agroecological systems by improving nutrient cycling and soil structure (Bloem et al., 2009; Boddey et al., 1997).

Indigenous farming practices, including organic amendments and residue retention, enhance soil organic matter and water retention (Omotayo & Chukwuka, 2009; Rajasekaran & Warren, 1995). Moreover, certain NUS contribute to the formation of African Dark Earths, boosting long-term carbon storage and fertility (Solomon et al., 2016; Unuigbe, 2024).

Despite these benefits, adoption of soil-improving crops is limited by seed access, high input costs, and knowledge gaps (Breen et al., 2024). There is also a paucity of studies on indigenous crops' influence on soil microbial

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communities an emerging frontier for agroecological research (Table 4).

Table 4. Biological Nitrogen Fixation (BNF) Potential of Selected Indigenous Leguminous Crops

Crop	Estimated Nitrogen Fixation (kg N ha^{-1}/year)	Agroecological Adaptation	Agronomic Use/Benefit	Sources
Crotalaria ochroleuca	150–200	Semi-arid to sub-humid zones	Used as green manure; soil fertility restoration	Tauro *et al.* (2009); Negi *et al.* (2022)
Sesbania sesban	150–280	Widely adapted; performs well in degraded soils	Intercropped in agroforestry systems; fodder & green manure	Dakora & Keya (1997); Giller (2001)
Bambara Groundnut	28–113	Drought-prone areas; sandy loam soils	Low-input pulse crop; good ground cover	Abberton *et al.* (2022); Musa *et al.* (2016)
African Yam Bean	45–140	Humid to sub-humid tropics	Grown for both grains and tubers; boosts soil fertility	Adewale & Dumet (2011); Oladejo *et al.* (2020)
Lablab purpureus	50–150	Adapted to drought and low-fertility soils	Dual-purpose: grain and forage; fixes nitrogen effectively	Tayo *et al.* (2004); Dakora & Keya (1997)
Cowpea	40–240	Semi-arid zones; short growing cycle	Popular intercrop; improves soil nitrogen balance	Oyiga *et al.* (2016); Giller (2001)

Values represent estimated annual nitrogen input under field conditions and vary with soil type, genotype, and management. BNF in these crops contributes to sustainable intensification, particularly in low-input systems. Some legumes (e.g., Sesbania) are multipurpose—serving as both nitrogen sources and feed or fuel.

IV. Economic Viability and Market Dynamics

Cost-Benefit Analysis Compared to Staple Crops

Indigenous crops generally exhibit lower input costs due to compatibility with low-input systems and reliance on traditional knowledge (Onuoha & Ikoku, 2008; Materechera, 2021). While labor-intensive, they generate employment and support community-based livelihoods (Modi, 2019).

However, market access constraints, including poor infrastructure and limited consumer awareness, reduce profitability (Zondi *et al.*, 2022; Shelembe *et al.*, 2024). Despite lower yields, these crops' resilience and high nutritional value offer comparative advantages under adverse conditions (Noort *et al.*, 2022; Mayes *et al.*, 2012).

Comprehensive cost-benefit analyses remain scarce, particularly those that integrate nutrition, sustainability, and cultural value. This gap limits policymaking and investment planning.

Value Chains and Market Integration

Value chains for crops like fonio, Bambara groundnut, and amaranth remain underdeveloped. Fonio faces postharvest challenges (e.g., sand contamination), while Bambara groundnut suffers from limited processing infrastructure (Mbosso et al., 2020). Amaranth, though nutritionally dense, requires better integration into commercial food systems (Aderibigbe et al., 2020).

Value chain inefficiencies stem from both horizontal (e.g., cooperative formation) and vertical (e.g., processing capacity) limitations (Tropen & MaLi, 2010). Participation in global value chains (GVCs) is nascent, despite rising demand for specialty foods (Mancini et al., 2023).

Infrastructure deficits, lack of market information, and strict export standards are key

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barriers (Afari-Owusu, 2014; Liverpool-Tasie et al., 2018). Integrated market reforms and digital platforms could address some of these constraints.

Farmer Adoption and Incentive Structures

Adoption decisions are shaped by economic, ecological, and cultural incentives. Market participation improves household food security, yet limited access to markets and subsidies can deter farmers (Zondi et al., 2022; Zhang & Dannenberg, 2022). The alignment of indigenous crops with traditional practices enhances ecological resilience and social acceptability (Unuigbe, 2024; Olawuyi et al., 2024).

Institutional support subsidies, extension services, and cooperatives is vital. Extension outreach combined with subsidies significantly improves technology uptake (Leuveld et al., 2018), while cooperatives enhance access to credit and input services (Chauvin et al., 2017; Andani, 2019).

Despite positive trends, a systemic understanding of farmer incentives economic and non-economic remains underexplored, particularly concerning female farmers and land tenure issues.

V. NUTRITIONAL AND CULTURAL SIGNIFICANCE

Nutritional Composition

Underutilized indigenous crops in SSA are rich in micronutrients, proteins, fiber, and bioactive compounds, making them ideal for addressing hidden hunger and micronutrient deficiencies. Legumes such as Bambara groundnut and cowpea provide essential minerals like iron, magnesium, and zinc (Soris & Mohan, 2011; Teye et al., 2020). African leafy vegetables also offer high levels of folate, vitamin A, and calcium nutrients often lacking in staple-based diets (Lara-Arévalo et al., 2024).

Protein-rich legumes like Vigna species are dubbed the "meat of the poor" due to their amino acid profiles, rivaling that of animal protein (Jager, 2019). Meanwhile, cereals like millet and sorghum contribute dietary fiber, supporting gut health and reducing chronic disease risks (Vila-Real, n.d.). Despite these benefits, declining consumption trends due to dietary westernization and poor market promotion threaten their nutritional impact (Namukwambi, 2023). Linking nutrition research with agronomic and economic studies remains a major gap (See Table 5).

Table 5. Nutritional Profiles of Selected Underutilized Indigenous Crops in Sub-Saharan Africa

Crop	Protein (g/100g)	Iron (mg/100g)	Zinc (mg/100g)	Calcium (mg/100g)	Vitamin A (µg RAE/100g)	Dietary Fiber (g/100g)	Sources
Bambara Groundnut	18–24	5.0–8.0	3.5–5.5	30–50	<5	6–10	Musa *et al.* (2016); Abberton *et al.* (2022); Soris & Mohan (2011)
Cowpea	20–25	4.5–7.5	3.0–4.8	50–110	<5	5–9	Oyiga *et al.* (2016); Teye *et al.* (2020)
Amaranth (leafy)	4–6	7.0–13.0	3.5–5.0	200–380	1800–2200	6–8	Bhatt *et al.* (2019); Wani *et al.* (2021); Lara-Arévalo *et al.* (2024)
Pearl Millet	10–12	6.0–10.0	2.5–4.0	20–45	<1	8–12	Wani *et al.* (2021); Choudhury *et al.* (2023)
Finger Millet	7–10	4.0–8.5	2.0–3.8	250–370	<1	10–14	Bhatt *et al.* (2019); Choudhury *et al.* (2023)
Taro (corm)	1.5–3.0	1.0–2.5	0.8–1.5	30–50	<1	2–4	Onwueme (1999); Olatunji *et al.* (2022)
Teff	10–12	7.6–12.5	4.5–6.0	150–180	<1	8–10	De & De

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					(2020); Wani *et al.* (2021)

Contribution to Dietary Diversity

Integrating indigenous crops into diets improves household dietary diversity, particularly in resource-constrained areas. Studies in Nigeria reveal that underutilized vegetables significantly elevate dietary diversity scores, especially among women and children (Tanimonure et al., 2021).

These crops also offer resilience during food shortages, filling seasonal gaps and ensuring nutritional continuity (Abberton et al., 2022). Their climate adaptability makes them reliable in uncertain growing seasons, reinforcing their food security role (Imathiu, 2021). Nevertheless, regional variability in consumption patterns and cultural preferences necessitates localized approaches to promoting dietary diversity through indigenous crops (Isbell et al., 2024).

Cultural and Indigenous Knowledge Systems

Indigenous food systems reflect centuries of cultural knowledge, encompassing not only farming but also food preparation, preservation, and spiritual significance. Traditional recipes using crops like taro, amaranth, and cowpea embody cultural heritage and dietary logic (Kuhnlein et al., 2019).

Crop selection is guided by ecological indicators and adaptive practices, such as weather forecasting based on local signs (Unuigbe, 2024; Materechera, 2021). Women play a central role in knowledge transmission, seed saving, and postharvest processing (Kamwendo & Kamwendo, 2014).

Modernization and the erosion of indigenous knowledge pose significant threats to these systems. Documentation and respectful integration of this knowledge into agricultural research is crucial for sustainability and food sovereignty (Chanza & Musakwa, 2022).

VI. Innovation and Technological Potential

Genetic Improvement and Germplasm Access

Indigenous crops offer untapped genetic diversity that can be harnessed through genomic-assisted breeding (GAB) and participatory plant breeding (PPB). Institutions like IITA maintain germplasm collections of orphan legumes, including over 2,500 accessions of Bambara groundnut and African yam bean (Abberton et al., 2022; Paliwal et al., 2021).

PPB approaches enhance local adaptation and farmer ownership of improved varieties. Successful case studies from the Andes demonstrate the viability of farmer-led improvement for crops like quinoa (Galluzzi et al., 2015; Weltzien & Christinck, 2017) (Figure 1).

However, seed system bottlenecks persist. Most smallholder farmers rely on informal systems, which lack quality assurance, access to improved varieties, and policy support (Breen et al., 2024; McEwan et al., 2021). Bridging formal-informal seed systems remains a critical research and policy gap (Table 6).

Table 6. Status of Germplasm Resources and Breeding Programs for Selected Underutilized Indigenous Crops

Crop	Germplasm Holdings (Accessions)	Major Institutions Involved	Breeding Approaches Used	Key Constraints in Breeding Programs	Sources
Bambara Groundnut	~2,500	IITA, University of Nottingham, SADC	Conventional + participatory + genomic selection	Narrow genetic base; limited molecular markers	Abberton *et al.* (2022); Mayes *et al.* (2012)
African Yam Bean	<500	IITA, University of Ibadan, national genebanks	Early-stage landrace selection	Poor flowering, seed dormancy, photoperiod sensitivity	Adewale & Dumet (2011); Oladejo *et al.* (2020)
Taro	>4,000 (global), ~500 in Africa	IITA, Bioversity International, INIBAP	Clonal selection; virus-indexed clean planting	Vegetative propagation challenges; taro leaf	Onwueme (1999); Olatunji *et al.* (2022); FAO

				blight	(2020)
Cowpea	~15,000	IITA, CSIR-Ghana, ARC-Nigeria	Marker-assisted selection; drought and pest-tolerant lines	Pest pressure; climate variability; seed coat hardness	Abberton *et al.* (2022); Oyiga *et al.* (2016)
Teff	~5,000	EIAR (Ethiopia), ILRI	Hybridization; QTL mapping; farmer-preferred traits	Lodging, grain shattering, long breeding cycle	Wani *et al.* (2021); De & De (2020)
Pearl Millet	>10,000	ICRISAT, INERA, SADC	Hybrid breeding, climate-smart trait introgression	Weak private sector seed delivery; downy mildew	Choudhury *et al.* (2023); Wani *et al.* (2021)

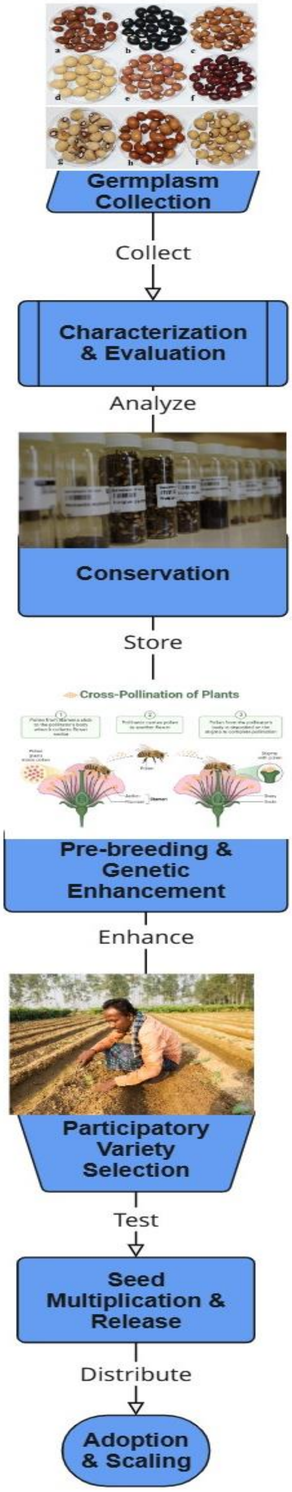

Figure 1: Germplasm Pipeline for Orphan Legumes

Digital Agriculture and Precision Tools

Digital technologies are increasingly relevant for managing indigenous crops, though few tools are tailored to them. Mobile apps like ITIKI Plus integrate indigenous knowledge and climate data for hyper-local decision-making, achieving up to 98% forecast accuracy (Masinde & Thothela, 2019). Meanwhile, AI-enabled tools like DigiFarmer and AgriBot assist with disease diagnosis, irrigation, and yield forecasting (Patra et al., 2024; Nivi et al., 2024).

Remote sensing through UAVs and satellite imagery, coupled with machine learning models

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like CNNs and Random Forests, enables accurate yield prediction and crop monitoring (Wahab et al., 2018; Kavipriya & Vadivu, 2024).

Nonetheless, indigenous crops are underrepresented in the datasets that power these technologies, limiting their usefulness in practice. Addressing this digital divide and expanding precision agriculture to include underutilized crops is an urgent research frontier.

Postharvest Innovations

Postharvest losses often exceeding 30% undermine the value of indigenous crops. Innovations such as solar dryers, flash-drying, and aseptic packaging have been piloted for crops like orange-fleshed sweet potato and cassava to retain nutrients and reduce spoilage (Akinniyi & Ejoh, 2022; Muhumuza et al., 2017).

Storage techniques using ethylene absorbers and indigenous materials (e.g., wood ash) also offer affordable solutions (Skåra et al., 2022). However, infrastructure and financing gaps hinder widespread adoption.

To date, few studies link postharvest innovations with economic outcomes for indigenous crops, signaling a need for impact assessments across the value chain.

VII. Policy, Institutional, and Research Gaps

Inclusion in National Agriculture Policies

Despite their agronomic, nutritional, and environmental benefits, underutilized indigenous crops remain largely excluded from formal agricultural policies in SSA. National development plans often prioritize major staples like maize, rice, and wheat, with limited policy recognition of NUS as strategic food security assets (Mabhaudhi et al., 2019; UN FAO, 2018).

For instance, government procurement and subsidy programs rarely include indigenous crops, undermining farmer incentives and market viability (Egbuna et al., 2020). Moreover, policy documents often lack explicit targets or budget lines dedicated to the development, research, or commercialization of these crops.

This strategic neglect perpetuates a cycle of underfunding, low adoption, and weak institutional support, despite increasing calls to mainstream NUS into national adaptation and food sovereignty frameworks (Chivenge et al., 2015).

Funding and Research Priorities

Research investment in indigenous crops remains disproportionately low compared to that for major cereals. According to data from CGIAR and national research institutions, less than 3% of agricultural R&D funds in Africa are allocated to so-called “orphan crops” (Borrell et al., 2020). This biashampers variety development, pest and disease resistance screening, and agronomic trials.

Additionally, global funding platforms such as the Green Climate Fund and bilateral aid often overlook NUS in their agriculture portfolios, favoring high-tech or export-oriented interventions (UNEP, 2021). Yet, indigenous crops align more directly with resilience, agroecology, and equity objectives.

A realignment of research priorities to incorporate these crops would enable more inclusive innovation and greater returns on investment for sustainable food systems.

Data Deficiencies

Reliable, disaggregated data on indigenous crop production, yields, area cultivated, and farmer adoption are severely lacking. National agricultural surveys and international databases like FAOSTAT do not systematically collect or report such information (Gotor et al., 2022).

This absence of data undermines policy formulation, market development, and resource allocation. For example, the lack of baseline metrics makes it difficult to assess the cost-effectiveness of investing in value chain improvements or climate-smart interventions (see Table 7).

Addressing these gaps requires national statistical systems to integrate NUS into routine data collection, and for researchers to adopt standardized protocols for yield and economic assessment across agroecological zones.

Table 7. Policy, Research, and Investment Gaps Affecting Underutilized Indigenous Crops in Sub-Saharan Africa

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Area of Gap	Description	Examples or Affected Crops	Implications	Sources
Low R&D Investment	<3% of agri-research budgets allocated to NUS	Bambara groundnut, African yam bean, amaranth	Limited breeding, no improved varieties for many crops	Borrell *et al.* (2020); Abberton *et al.* (2022)
Weak Seed Systems	Lack of certified seed production and delivery channels	Cowpea, millet, taro	Farmers rely on low-quality or recycled seed	Choudhury *et al.* (2023); Oyiga *et al.* (2016)
Policy Bias Toward Major Staples	Government subsidies, research programs prioritize rice, maize, wheat	NUS receive no support or inclusion in subsidy schemes	Market disincentives for cultivating NUS	Noort *et al.* (2022); Amede *et al.* (2014)
Limited Extension Services	Most extension officers lack training on indigenous crops	Finger millet, amaranth, Bambara groundnut	Poor adoption of improved agronomic practices	Wani *et al.* (2021); Oladejo *et al.* (2020)
Inadequate Nutrition Guidelines	Indigenous foods absent from national food-based dietary guidelines	Amaranth, teff, African leafy vegetables	Missed opportunity for nutrition-sensitive policies	Lara-Arévalo *et al.* (2024); Bhatt *et al.* (2019)
No Market Infrastructure or Incentives	Lack of price guarantees, cooperatives, or credit systems	African yam bean, taro	Producers face high marketing risks	Oladejo *et al.* (2020); Olatunji *et al.* (2022)
Neglect in Climate Policies	NUS not integrated into NDCs, CSA frameworks, or food security plans	Millet, cowpea, teff	Undermines their scaling as climate-resilient crops	Abberton *et al.* (2022); Wani *et al.* (2021)

VIII. Future Research Directions

This review highlights the urgent need for more targeted, interdisciplinary, and participatory research on underutilized indigenous crops in SSA. First, standardized field trials across diverse agroecological zones are essential to evaluate yield stability, stress tolerance, and input-use efficiency. These trials should consider genotype × environment × management interactions for context-specific recommendations.

Second, econometric modeling is needed to quantify farm-level profitability, adoption dynamics, and market responses under different policy scenarios. This would support the design of incentive structures and commercialization strategies.

Third, there is a clear gap in nutrient-yield-tradeoff studies, especially for comparing indigenous crops with conventional staples under varying agronomic and economic constraints. Understanding these tradeoffs is vital for integrating NUS into food security and nutrition policies.

Finally, future research should embed NUS within climate-smart agriculture (CSA) frameworks, evaluating their contributions to mitigation, adaptation, and resilience goals. This includes assessments of soil health, carbon sequestration, and water efficiency, as well as their potential to support inclusive and gender-responsive climate strategies.

By addressing these knowledge gaps, researchers and policymakers can unlock the full potential of forgotten foods—not only as relics of the past but as strategic resources for the future of African agriculture.

IX. Conclusion

Indigenous crops in Sub-Saharan Africa are increasingly vital as the region faces intensifying climate variability, persistent food insecurity, and the need for diversified, resilient agricultural systems. Over centuries, these crops have adapted to local agroecological conditions, conferring traits such as drought tolerance, nutrient-use efficiency, and resilience to pests and diseases, which position them as strategic assets for climate-smart agriculture (Mabhaudhi et al., 2019; Ali et al., 2023). Their cultivation supports ecological sustainability while delivering nutritionally dense foods, contributing to the fight against "hidden hunger" and micronutrient deficiencies (Tadele & Assefa, 2012; Teye et al., 2020).

Beyond ecological and nutritional value, indigenous crops present underexplored economic opportunities. Value chains for species such as fonio, amaranth, and Bambara groundnut illustrate untapped market niches that, if effectively developed, could improve rural livelihoods and stimulate local economies (Ndlovu et al., 2024; Munoko et al., 2022). However, these benefits remain constrained by systemic barriers including limited seed availability, inadequate processing infrastructure, and weak policy support (Breen et al., 2024; McEwan et al., 2021).

Unlocking the potential of these crops requires a coordinated, multi-sectoral approach. Academic institutions must prioritize interdisciplinary and participatory research that links agronomy, nutrition, economics, and socio-cultural studies (Akinola et al., 2020). Governments should integrate indigenous crops into agricultural policy frameworks, providing targeted subsidies, procurement programs, and extension services that incentivize adoption (Kamwendo & Kamwendo, 2014). The private sector, meanwhile, has a role in expanding market access, investing in value addition, and fostering consumer demand through awareness campaigns (Ndlovu et al., 2024).

In conclusion, reviving forgotten foods is not merely about preserving cultural heritage; it is a pragmatic strategy for enhancing climate resilience, ensuring nutrition security, and empowering rural economies in Sub-Saharan Africa. Their elevation from marginal crops to mainstream agricultural staples will depend on deliberate policy alignment, sustained research investment, and active market engagement.

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Author's Contributions

B.Y.K., F.P.M., M.K.A., N.K., B.A.: Conceptualization, **A.Y.P., E.A., A.M.H., K.L.L.:** Writing- Original draft preparation, **A.Y.P., G.M., M.K.A., K.L.L.:** Investigation, **B.A., A.M.H., G.M.:** Writing- Reviewing and Editing; **B.Y.K., E.A., F.P.M., N.K**.: Supervision, Visualization, and Validation.

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