

Enset [*Ensete ventricosum* (Welw.)] as a Climate-Resilient Crop for Food Security in Ethiopia and Sub-Saharan Africa

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Abstract: Climate change threatens agricultural productivity and food security across vulnerable regions, notably Ethiopia and Sub-Saharan Africa. This review critically assesses the potential of Enset (*Ensete ventricosum*), a native, multipurpose crop, as a climate-resilient staple. Drawing from a systematic multi-database literature search, we highlight Enset's exceptional agronomic traits: high drought tolerance, adaptability to degraded soils, and superior carbohydrate yields per hectare compared to major cereals. Beyond caloric value, Enset contributes essential micronutrients and minerals, reinforcing its role in nutritional security. These attributes position Enset as a strategic buffer against climate-induced crop failures and seasonal hunger. However, its broader adoption is hindered by limited genetic research, rudimentary processing technologies, and weak policy support. To unlock Enset's full potential, we propose a multifaceted strategy: targeted scientific investment, development of scalable postharvest innovations, and integration into national and regional climate adaptation frameworks. Enset remains a critical yet underutilized biological asset. Its systematic promotion through coordinated multi-stakeholder engagement—including researchers, policymakers, and farming communities offers a transformative pathway toward resilient, sustainable food systems. By elevating Enset from a localized subsistence crop to a cornerstone of climate-smart agriculture, Ethiopia and similar regions can proactively mitigate food insecurity under escalating climate stress.

Keywords: climate resilience; drought tolerance; genetic diversity; nutritional value; sustainable agriculture

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1. Introduction

Enset (*Ensete ventricosum*), or the "false banana," is a staple crop with significant potential to enhance food security and climate resilience. Recently, it has garnered increased interest from researchers and policymakers due to its exceptional drought tolerance and capacity to withstand environmental stressors, positioning it as a promising solution for climate-vulnerable regions (Senbeta et al., 2022; Smith et al., 2022).

Beyond its traditional role as a food source, Enset offers substantial nutritional value that can improve dietary diversity and food sovereignty (FAO, 2023). Its multifunctional nature is a key asset; the fibrous stems can be processed into textiles and construction materials, supporting sustainable economic development and aligning with circular economy principles (Getachew et al., 2021; Senbeta et al., 2022).

This potential is critical for sub-Saharan Africa, where conventional staples like maize, wheat, and rice are highly susceptible to climate-induced disruptions such as drought and floods, leading to recurrent food shortages (Lipinski et al., 2022). While Enset presents a compelling climate-resilient alternative tolerant of marginal environments and high temperatures (Hirut and Alemu, 2018), its cultivation remains largely confined to Ethiopia, and its broader potential is underexplored.

This review synthesizes the existing literature to analyze Enset's potential as a climate-resilient crop for improving food security in Ethiopia and across sub-Saharan Africa. Based on a systematic examination of peer-reviewed articles, theses, conference proceedings, and grey literature from the past 25 years, it highlights the crop's agricultural and socio-economic significance. The review also identifies critical knowledge gaps, particularly in genetic diversity and post-harvest handling to guide future research and policy.

2. Historical Background and Traditional Uses of the Enset

Evidence suggests that Enset cultivation and use date back to at least the 16th century, with some parts of Ethiopia being reliant on it as a staple crop for an even longer period (Brandt et al., 1997). Beyond its role as a food source, Enset has also been deeply embedded in the cultural and ceremonial practices of these communities (Alemayehu, 2017). The leaves, stems, and roots of Enset have been utilized in the construction of traditional dwellings, the production of household items, and the performance of ceremonial rituals (Olango et al., 2014). This multi-faceted use of Enset has contributed to its enduring significance in the social and economic fabric of Ethiopia's highland regions.

Enset, a staple food in southern Ethiopia, has substantial potential to improve food security and promote sustainable development in Africa. Its adaptability and historical importance, along with its many uses, make it a highly valuable crop in both local and global contexts. Its high genetic diversity, together with its capacity to thrive in diverse environments, helps it withstand changing conditions (Yemata, 2020). Variation in Enset yield may be due to processing techniques, local cultivars, and estimation methods (Mitiku et al., 2024). This renewed interest in Enset's cultural and agricultural significance affirms its enduring importance despite a rapidly changing world. Its yield potential is shown in Table 1.

Table 1: Yield potential of Enset in different regions of East Africa.

Country	Yield t ha ⁻¹	Quality	Sources
Ethiopia	20-30 t ha ⁻¹	Bulla	(Bezabih and Tesfaye, 2017)
	15-20 t ha ⁻¹	Kocho	
Tanzania	10-15 t ha ⁻¹	Bulla	(Jones and Daniells, 2019)
	8-12 t ha ⁻¹	Kocho	
Uganda	10-15 t ha ⁻¹	Bulla	(Jones and Daniells, 2019)
	8-12 t ha ⁻¹	Kocho	
Rwanda	10-15 t ha ⁻¹	Bulla	(Haug et al., 2009)
	8-12 t ha ⁻¹	Kocho	
DRC	10-15 t ha ⁻¹	Bulla	(Czerny et al., 2012)
	8-12 t ha ⁻¹	Kocho	
South Sudan	10-15 t ha ⁻¹	Bulla	(Yemataw et al., 2018)
	8-12 t ha ⁻¹	Kocho	

2.1. Nutritional Value and Yield of the Enset

One of the key attributes of Enset that has captured the attention of researchers and policymakers is its exceptional nutritional value (Abebe et al., 2022). The researchers attributed these benefits to the crop's rich content of carbohydrates, minerals, and various bioactive compounds.

Enset-based farming systems in Ethiopia can be impressively productive, with some varieties reaching 50 tons of edible biomass per hectare. This is due to Enset's high yield of edible food components like *kocho*, *amicho*, and *bulla*, as shown in Table 1. Compared to other staple crops like cereals and tubers, Enset demonstrates significantly higher productivity per unit area (Borrell et al., 2020; Kudama et al., 2022), as shown in Table 2.

Table 2. Key findings on the nutritional value of Enset compared to other crops in the sub-Saharan countries

Crop	Nutritional Value	Countries	Yield Difference (%)	Sources
Enset	low in protein (1.75-3.7%), low in fat (2-4%), high in fiber (10-15%), and rich in mineral nutrients (e.g., potassium, magnesium, zinc)	Ethiopia, Nigeria, Tanzania, Uganda	20-30% higher	(Alade et al., 2018; Smith et al., 2022; Gelaye, 2024; Owori et al., 2019); (Dilebo and Zewdu, 2025)
Maize	Moderate protein (10-12%), low in fat (2-4%), moderate in fiber (2-5%), and deficient in micronutrients	Nigeria, Tanzania, Kenya, and South Africa	10-20% lower	(Adebayo et al., 2017; Galani et al., 2022; Owuor et al., 2012)
Cassava	Low in protein (1-2%), high in carbohydrates (30-40%), low in fiber (1-2%), and deficient in micronutrients	Nigeria, Tanzania, Ghana, DRC	30-40% lower	(Nicodemas, 2020; Asare et al., 2018; Agbemafle & Adewuyi, 2019)
Sweet Potato	Moderate protein (10-12%), low in fat (2-4%), high in fiber (2-5%), and rich in micronutrients (e.g., beta-carotene, vitamin C)	Uganda, Tanzania, Kenya, and South Africa	10-20% lower	(Gelaye, 2024; Owori et al., 2019)

Note: The yield difference percentage is based on the average yield of Enset (20-30 t ha⁻¹) compared to other crops.

2.1.2. The Enset's Potential as a Feed Crop.

Enset is mainly recognized for its function as a staple food crop in Ethiopia's highlands, but it is also gaining more consideration as a valuable source of animal feed (Abebe et al., 2022). The increasing global demand for livestock products has made it essential to find sustainable and nutritious feed sources, and Enset may be the solution to this problem (Abebe et al., 2022). The researchers also noted that the low levels of anti-nutritional factors in Enset further enhanced its suitability as a feed ingredient.

The global agricultural community is faced with a challenge in developing more sustainable and climate-resilient livestock production systems, and the potential of Enset as a high-quality and productive feed crop cannot be disregarded (Abebe et al., 2021). Organizations involved can leverage the distinctive nutritional and agricultural properties of this exceptional plant to create more resilient and environmentally sustainable animal production systems that meet the increasing demand for livestock products and help achieve broader objectives in food security and sustainable development.

2.2. Potential of the Enset as a Fiber Crop and Market Opportunities

A promising source of high-quality natural fiber has emerged, with the Enset crop gaining attention (Dejene, 2024), as demand for sustainable materials continues to grow globally, as illustrated in Table 3. Enset is highly valued for its traditional use as a food source and animal feed in Ethiopia's highlands and is increasingly being recognized for its diverse applications in textiles and manufacturing (Blomme et al., 2018).

One of the key advantages of Enset as a fiber crop is the exceptional quality and durability of its fiber (Tesfaye et al., 2018). Compared to other widely used natural fibers like cotton and jute (Abebe et al., 2022), the fiber obtained from Enset plants displayed greater tensile strength, flexibility, and resistance to wear and tear. These properties make Enset fiber a highly desirable raw material for several textile and industrial applications.

Enset-derived products hold significant market potential within the burgeoning global sustainable and eco-friendly textile sector. The global market for sustainable fabrics is expected to reach \$27.8 billion by 2029 (Sahle et al., 2021). The report observed that Enset fiber's distinct characteristics, complemented by the crop's high yields and ability to withstand climate change, might make it a feasible substitute for traditional fiber sources, thereby opening up new economic prospects for small-scale farmers and rural communities in Ethiopia.

Integrating Enset fiber into a circular economy is feasible, offering opportunities to minimize waste and maximize the crop's value. By developing closed-loop systems, Enset fiber can be utilized for various products, reducing waste and enhancing sustainability (Abebe et al., 2021), as shown in Table 3.

Table 3. Potential of Enset and other crops for fiber production

Crop type	Fiber Quality Differences	Fiber quantity difference (Megapascals (MPa))	Country	Reference
Enset (<i>Ensete ventricosum</i>)	Enset fibers are strong, flexible, and durable, making them suitable for various applications such as rope, cloth, and paper production.	162.4 - 720 MPa (Highly variable based on fiber bundle size and position in pseudostem)	Ethiopia	(Negash & Niehof, 2004); (Bekele et al., 2023)

Banana (<i>Musa</i> spp.)	Banana fibers are relatively weaker and less durable than Enset fibers, but they can still be used for various textile and industrial applications.	125 - 800 MPa (Similar high variability; generally considered slightly less strong than Enset in comparative studies)	Uganda	(Kyamuhangire et al., 2006); (Dejene et al., 2023)
Sisal (<i>Agave sisalana</i>)	Sisal fibers are coarser and stiffer than Enset fibers, but they have good tensile strength and are widely used in the production of ropes, mats, and other industrial products.	350 - 700 MPa (Consistently high strength, less variable than bast fibers)	Tanzania	(Mwaikambo & Ansell, 2002); (Mohanraj et al., 2025)
Kenaf (<i>Hibiscus cannabinus</i>)	Kenaf fibers are similar in quality to Enset fibers, with good tensile strength, flexibility, and durability. They can be used for textile, paper, and composite material production.	223 - 930 MPa (Core fibers are weaker, bast fibers are very strong and comparable to Enset)	Kenya	(Ngece et al., 2014); (Saba et al., 2015)
Jute (<i>Corchorus olitorius</i>)	Jute fibers are finer and less durable than Enset fibers, but they have been extensively used in the production of gunny bags, carpets, and other textile products.	187 - 773 MPa (Good strength but lower durability, especially when exposed to moisture)	Ethiopia	(Kebede et al., 2019); (Singh et al., 2018)

3. Enset in Sustainable Agriculture

Enset is commonly integrated into complex agroforestry systems, cultivated alongside various crops, trees, and livestock. This biodiversity enhances ecosystem services, including soil conservation, nutrient cycling, and biodiversity (Tsegaye and Struik, 2002), as shown in Table 4.

Moreover, Enset is a highly productive crop, capable of yielding substantial quantities of food per unit area. Cultivating Enset more efficiently relieves pressure on available land, thereby promoting the use of land in a more sustainable manner (Brandt et al., 1997). Furthermore, Enset cultivation typically necessitates minimal external inputs, including synthetic fertilizers or pesticides, making it a suitable option for small-scale farmers with limited resources (Admasu and Struik, 2002).

3.1 Enset's Effects on Agriculture

As the world grapples with the mounting challenges of climate change, the role of Enset in shaping the future of agriculture in Sub-Saharan Africa has become increasingly evident (Teklay and Mohamed, 2022). Recent studies have shed light on the crucial ways in which Enset can contribute to the region's agricultural resilience despite a changing climate.

Enset-based cropping systems have the potential to withstand the increased droughts, heavy rainfall, and temperature fluctuations anticipated in many parts of Sub-Saharan Africa (IPCC, 2021), as shown in Table 4. The Enset-based farming systems in southern Ethiopia were significantly more resilient to climate change compared with other prevalent crop systems in the region (Smith et al., 2022). The researchers attributed this resilience to the Enset's unique characteristics, such as its deep root system, ability to store water and nutrients, and tolerance to various environmental stressors.

In addition to its climate-resilient properties, Enset holds promise for enhancing food security and diversifying agricultural production in Sub-Saharan Africa (FAO, 2023).

Table 4: Key findings on the potential of Enset for climate change adaptation compared to other crops

Country	Crop type	Yield response to climate change	Sources
Ethiopia	Enset	Increased yield under warmer temperatures but reduced yield under extreme heat conditions.	(Mwangi & Muthoni, 2020)
	Enset	Improved drought tolerance and yield stability under changing climate conditions.	(Alade et al., 2018)
	Enset	Enhanced yield and biomass production under elevated CO ₂ levels	(Geremew et al., 2018)
	Enset	In comparison with other crops, these plants exhibit a superior adaptation to water scarcity and high temperatures.	(Dalle et al., 2019)
Kenya	Enset	Increased yield under warmer temperatures but reduced yield under extreme heat conditions.	(Mwangi & Muthoni, 2020)
	Maize	Reduced yield under warmer temperatures and changing precipitation patterns.	(Maregn Areda, 2016)
Tanzania	Enset	Improved yield and drought tolerance in some Enset varieties.	(Sultan et al., 2014)
	Sorghum	Reduced yield under warmer temperatures and changing precipitation patterns.	(Sultan et al., 2014)
Uganda	Enset	Improved water conservation and heat tolerance compared with other crops.	(Chase et al., 2025)

3.2. Enset's Resilience to Climate Change

Enset-based farming systems maintained higher productivity and food security levels than other prevalent crop systems in the region during severe drought periods (Abebe et al., 2022). The researchers attributed the Enset's ability to withstand adversity to its extensive root system and its capacity to conserve moisture during water shortages, as well as its ability to access water and nutrients from deeper soil layers by slowing down transpiration.

In addition to its drought tolerance, a crop's ability to withstand prolonged periods of heavy rainfall and inundation is a critical adaptation in the face of the intensifying flood risks associated with climate change (FAO, 2023). The plant's broad leaves and stems, along with its ability to grow adventitious roots, allow it to endure and even flourish in waterlogged conditions that are averse to many other crops. The potential of Enset-based agroforestry systems to serve as a model for sustainable and climate-smart agriculture in Sub-Saharan Africa (Abebe et al., 2021). Integrating Enset into Sub-Saharan Africa's agricultural landscapes may offer a vital path to attaining food security, environmental sustainability, and community resilience as the effects of climate change intensify.

3.3. Enset Adaptation in Various Agro-ecological Zones of Sub-Saharan Africa.

In Ethiopia, the Enset shows remarkable adaptability across various agro-ecological zones, mainly because of its physiological flexibility and long-standing cultivation traditions of local communities (Brandt et al., 1997). This adaptability is evident in its ability to thrive in varying altitudes, rainfall patterns, and soil types, ranging from the humid highlands to the semi-arid lowlands. Studies have shown that Enset cultivation is prevalent in areas with altitudes ranging from 1,600 to 3,100 meters above sea level, indicating its tolerance to a wide temperature range. Furthermore, its ability to withstand periods of water stress, coupled with its efficient water use, contributes to its survival in regions with fluctuating rainfall (Kebede et al., 2019).

The diversity of Enset cultivars also plays a significant role in its adaptation to different agro-ecological regions. Local farmers have traditionally selected and propagated cultivars best suited to their specific environments, resulting in a rich array of varieties with varying growth habits, maturity times, and stress tolerances. This intraspecific diversity allows Enset to be cultivated in areas with different soil types, including volcanic ash soils and clay loams. Traditional farming systems have also incorporated intercropping with other crops, which helps to improve soil fertility and moisture retention, further enhancing Enset's adaptability (Yemataw et al., 2016).

The Enset's deep-rooted characteristics, coupled with its capacity to retain significant quantities of water within its pseudostem, enable it to withstand droughts, a phenomenon that is rising in frequency due to climate change (Amenu, 2017). The ability of the crop to provide a stable food source during periods of scarcity has made it an indispensable component of the agricultural systems in many Ethiopian communities. The Enset is expected to continue adapting to changing environmental conditions, provided that its genetic diversity is conserved and traditional knowledge about its cultivation is preserved (Olango et al., 2014).

3.4. Challenges and Opportunities for Enset Adaptation

Despite its potential to adapt to different agro-ecological zones in Sub-Saharan Africa, there are several challenges that need to be addressed to fully exploit the potential of Enset (Alemayehu and Bekele, 2022). One of the main challenges is the lack of awareness and knowledge about Enset among farmers and policymakers. Another challenge is the limited availability of Enset planting materials. Enset is a vegetatively propagated crop, and there is a need for a reliable source of planting materials to promote its adoption (Tsegaye and Abate, 2020). There is also a need for research to improve the productivity and quality of Enset planting materials.

Despite these challenges, there are several opportunities for Enset adaptation in Sub-Saharan Africa. Enset can improve food security and income for smallholder farmers in the region (Astatke et al., 2022).

3.5. Soil and Water Management Practices for Enset Cultivation

Enset thrives in deep, well-drained, fertile soils with a slightly acidic to neutral pH (5.5 to 7.0) and high organic matter content, which aids in moisture and nutrient retention (Daba and Borrell, 2020). Before planting, the land should be tilled to a depth of 30-45 cm to loosen the soil and incorporate organic matter, using manual or mechanical methods (Brandt, 1984). Regular applications of compost or manure enhance soil properties, boosting Enset growth and yield (Tsfaye et al., 2021).

The Enset has high nutrient needs, especially for nitrogen, phosphorus, and potassium. A balanced, slow-release fertilizer or compost is ideal for meeting these requirements (Abebe et al., 2021). The crop also requires consistent soil moisture, necessitating supplemental irrigation during dry spells (Weldemichael et al., 2022).

Effective irrigation methods such as drip or furrow irrigation minimize water waste (Gebre and Kedir, 2021). To prevent root decay, it is essential to avoid allowing water to accumulate; raised beds or mounds can improve drainage, as noted by Brandt (1984). Furthermore, applying organic mulch around Enset plants helps retain moisture while also controlling weed growth, as shown by Weldemichael et al. (2022).

3.6. Pest and Disease Management Strategies for the Enset

Enset, a vital Ethiopian food security crop, faces threats from pests and diseases, including Enset bacterial wilt. Effective management strategies include disease-free planting materials, phytosanitation practices, prompt plant removal, optimal crop density, and intercropping (Yemataw et al., 2016; Negash et al., 2023). The Enset root mealybug (*Cataenococcus Ensete*) is a major pest, posing additional challenges that result in root damage and stunted growth and lower crop yields (Abebe et al., 2011), making it necessary to adopt traditional farming practices that involve selecting disease-free seedlings, maintaining a clean field environment, and utilizing manure. Indigenous knowledge is crucial for sustainable pest management strategies (Kefelegn et al., 2014). Integrated pest management (IPM) is a vital approach for sustainable Enset production that combines cultural practices, biological control, and chemical methods. Future research should concentrate on developing resistant varieties and refining IPM strategies, emphasizing community involvement (Negash et al., 2023).

3.7. Seed Systems of the Enset

Traditionally, Enset propagation has been primarily driven by farmer-managed seed systems (Zewdie et al., 2013). Farmers maintain and multiply their own Enset planting materials, often by selecting and sharing desirable suckers and corms within their communities. This farmer-led approach has contributed to the conservation of Enset genetic diversity and the adaptation of cultivars to local agro-ecological conditions (Tsegaye and Struik, 2002; Olango et al., 2014).

Formal Enset seed systems, involving research institutions and government agencies, are underdeveloped compared to the farmer-managed systems. In the past, some efforts have been made to establish centralized Enset nurseries and distribution networks, but the adoption and impact of these initiatives have been limited (Birmeta, 2004; Borrell et al., 2020).

3.7.1. Potential Seed Multiplication Strategies

Establishing a network of decentralized Enset nurseries, managed by local communities or farmer groups, could help to address the challenges posed by centralized seed distribution systems. This approach can leverage the existing farmer-managed seed systems while also providing access to improved planting materials and technical support (Borrell et al., 2020). Advances in micropropagation and tissue culture techniques can enable the rapid multiplication of Enset planting materials, potentially overcoming the limitations of vegetative propagation. This approach can also facilitate the production and distribution of disease-free, genetically uniform Enset planting materials (Birmeta, 2004; Borrell et al., 2020).

Engaging local farmers and incorporating their traditional knowledge and preferences into the development of Enset seed systems can help to ensure the relevance and sustainability of these interventions. Participatory approaches, such as farmer field schools and community-based seed production, can foster the ownership and adoption of improved Enset planting materials (Olango et al., 2014).

4. Current Status and Future Directions

4.1 Genetic Diversity and Characterization

Technical analysis reveals significant limitations. Molecular studies identify diversity but rarely translate into applied breeding: reported high genetic variation has not been systematically characterized for agronomically valuable alleles, leaving much of the genomic resource untapped. Reliance on conventional methods such as mass and clonal selection is slow and ill-suited to clonally

propagated, long-generation crops like Enset, underscoring the urgent need for marker-assisted and genomic selection to accelerate breeding cycles (Birmeta, 2004; Tsegaye and Struik, 2002).

4.2. Future Directions for Genomics-Assisted Breeding

Recent advancements in genomics and high-throughput sequencing offer a paradigm shift for intensive breeding (Tsegaye et al., 2020). The development of genomic resources like high-density maps and genome sequences enables the precise identification of QTLs and candidate genes for key agronomic traits (Gebremedhin et al., 2022). This foundational work is crucial for implementing advanced breeding strategies like MAS and GS, which significantly accelerate genetic gain (Wang et al., 2018).

However, a critical technical analysis reveals significant hurdles. The successful application of MAS is often constrained by the complex, polygenic nature of most valuable traits, which are influenced by numerous small-effect QTLs and environmental interactions. For Genomic Selection, the initial cost of genotyping and phenotyping to develop robust prediction models remains prohibitive for many programs. Furthermore, these models are often population-specific and can lack generalizability, while also requiring substantial computational expertise and infrastructure, limiting their broad adoption.

4.2.1. Genetic Engineering and Genome Editing

Genetic engineering and genome editing, particularly CRISPR-Cas9, represent a paradigm shift for Enset improvement, enabling precise, trait-specific enhancements in disease resistance, drought tolerance, and nutritional content (Adegaju et al., 2024). This precision breeding allows for the direct introgression of beneficial alleles without compromising the cherished genetic background of established landraces a significant advantage over traditional breeding. However, a critical technical analysis reveals substantial hurdles. The application is contingent on efficient tissue culture and transformation protocols for Enset, which are currently underdeveloped. Furthermore, the plant's polyploid genome complicates achieving homozygous, stable edits.

5. Summary and Conclusions

Enset is a critically underutilized, climate-resilient crop with the transformative potential to bolster food and nutritional security in Ethiopia and Sub-Saharan Africa. This review establishes that Enset possesses a unique combination of superior agronomic traits: exceptional drought tolerance, adaptability to marginal soils, and the highest carbohydrate yield per unit area compared to conventional staples like maize and cassava. Beyond its role as a reliable calorie source, Enset enhances dietary diversity by providing essential minerals and its multipurpose nature offers opportunities for animal feed and high-quality, sustainable fiber production. These attributes make it a strategic buffer against climate-induced crop failures. However, this immense potential is severely constrained by a critical lack of genetic and agronomic research, limited processing infrastructure, and its absence from mainstream agricultural policies. Realizing Enset's full promise requires an urgent, coordinated, and multi-stakeholder effort to advance scientific research, develop scalable technologies, and integrate it into national and regional climate adaptation strategies.

5.1. Future Recommendations

Urgent priorities must strategically address Enset's systemic vulnerabilities. Breeding programs are critical, but must be accelerated using genomic tools to counter specific pathogens and climate extremes, moving beyond incremental yield gains. This genetic work is foundational; without it,

other interventions risk failure. Concurrently, scaling agro-ecological practices is non-negotiable for immediate soil and ecosystem resilience.

The most impactful lever is policy: integrating Enset into national food security strategies unlocks essential funding and subsidies, catalyzing entire value chains. Parallel market development for value-added products ensures economic sustainability, motivating farmer adoption.

Critically, current efforts are fragmented. A technically coherent approach requires integrating these pillars genetics, agro ecology, and policy into a unified strategy. Success hinges on synchronizing research outputs with immediate on-farm application and market access, avoiding siloed projects that dilute impact.

Author Contributions

D.M and H.K co-authored a review paper, with D.M proposing the initial idea and methodology. Both conducted research and gathered data, organizing findings systematically. Their collaboration led to a comprehensive review, later refined by B.M and T.H, who edited the manuscript.

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