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Toward a Political Economy of Indigenous Seed Systems and Climate Resilience in Ghana's Agricultural Renewal

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Abstract

Seed banks play a crucial role in sustainable agriculture, particularly in developing countries where farming is central to rural economies. Indigenous seed banks, managed by local communities, focus on preserving traditional seed varieties that are better adapted to local climatic conditions and pest challenges. However, these community-managed banks face challenges within a political and economic framework that often undermines their effectiveness. The rise of conglomerate agriculture, with its emphasis on hybrid and genetically modified seeds, has pushed many indigenous varieties into decline, threatening food security and sustainability. This paper explores the indigenous seed landscape in Ghana and the political economy surrounding biopiracy, where global corporations' appropriate local genetic resources for commercial gain. It identifies the barriers that farmers face in accessing high-quality local seeds and the market structures that favour hybrid and modified seeds. The paper advocates for decentralized, community-based seed preservation systems as a cost-effective solution to improving access to seeds, thus reducing reliance on expensive commercial alternatives. Using the Meta Seed Bank of the Nile Valley Multiversity as a case study, the paper outlines the processes for replicating indigenous seed banks in other developing countries. The study finds that well-organized, locally managed seed banks provide an effective solution to the challenges posed by the lack of quality seeds and the dominance of modified varieties. It emphasizes the role of indigenous seeds in combating environmental degradation, improving nutrition, and enhancing pest and disease resistance. This research offers valuable lessons for other developing countries, advocating for the integration of community-driven seed preservation models into national agricultural systems to promote food sovereignty and enhance resilience in the face of climate change. Such initiatives can reduce dependency on external seed markets and foster more sustainable farming practices.

KEYWORDS:
Indigenous Seeds; Seed banks; Grains; Legumes; Meta Agriculture; Ghana

1 | INTRODUCTION

Globally, agriculture underpins economic and social stability, playing a vital role in ensuring food security, creating employment, and driving national development. Smallholder farmers are particularly crucial, producing 70% of the world's food supply (Sambo, 2023). In Ghana, agriculture contributed 21.1% to GDP in 2023 and employed 39.5% of the workforce, reflecting its importance for rural livelihoods and national economic activity (OBG, 2024). Yet, the sector faces profound challenges, particularly the erosion of indigenous seed systems, which have historically sustained local production.

The practice of saving and exchanging seeds has been integral to farming communities for centuries, embedding cultural, ecological, and economic values in traditional agriculture. Indigenous seeds, carefully domesticated over generations, are prized for their adaptability, pest resistance, and nutritional benefits. However, the advent of the Green Revolution disrupted these systems. Hybrid and genetically modified (GM) seeds, combined with international intellectual property regimes, have shifted control over seed markets to multinational corporations. While offering higher yields and improved climate resilience, hybrid seeds often necessitate significant inputs—fertilizers, pesticides, and irrigation—rendering them less accessible to smallholder farmers. This shift raises concerns about farmer dependence, biodiversity loss, and the erosion of food sovereignty.

In Ghana, these trends intersect with the worsening impacts of climate change and the expansion of industrial agriculture. Hybrid seeds, though productive under optimal conditions, can exacerbate food insecurity in low-input systems, contributing to deforestation and soil degradation as farmers expand agricultural land to offset poor yields. These dynamics underscore the need for interventions that preserve indigenous seed diversity as a foundation for resilient, sustainable agriculture.

The Meta Agriculture Seed Bank, an initiative of the Nile Valley Multiversity, emerges as a vital response. Its goals—conserving genetic diversity, strengthening seed systems, and ensuring sustainable food production—align with both environmental and socio-political imperatives. By safeguarding indigenous seeds, the Seed Bank challenges the monopolization of agricultural resources, advocating for a decentralized, community-driven approach to food systems.

This initiative reflects a broader political economy struggle over control and access to agricultural resources. The dominance of corporate seed systems epitomizes the consolidation of power within global agribusiness, facilitated by intellectual property laws that marginalize traditional practices. For farmers in developing countries, this control translates into reduced autonomy, heightened vulnerability to market fluctuations, and restricted access to affordable seeds.

At the same time, state policies often prioritize industrial agricultural models through subsidies for hybrid seeds and chemical inputs, perpetuating dependency on corporate supply chains. These policies, shaped by international development paradigms, frequently undervalue indigenous knowledge and biodiversity. Establishing an indigenous seed bank like the Meta Agriculture Seed Bank counters these dynamics, advocating for agricultural sovereignty, ecological sustainability, and climate resilience.

This study explores the intersections of seed systems, climate change, and food sovereignty, advancing arguments for preserving indigenous seeds as both an ecological necessity and a political-economic strategy. It critically examines threats to seed diversity and proposes mechanisms for safeguarding the agricultural heritage that underpins global and national food security.

2 | INDIGENOUS SEED BANKS: A PILLAR FOR BIODIVERSITY, CULTURAL PRESERVATION, AND CLIMATE RESILIENCE

Indigenous seed banks are integral to agricultural biodiversity conservation, cultural heritage preservation, and the advancement of sustainable farming practices. Rooted in centuries of indigenous and local knowledge, these banks house traditional seed varieties that have been cultivated and adapted by farming communities to meet local ecological and cultural needs. Their importance extends beyond conservation, offering strategic solutions for modern agricultural challenges such as biodiversity loss, climate change, and food insecurity.

The establishment of indigenous seed banks is essential for restoring ecological systems and revitalizing native crop varieties that have been marginalized by the Green Revolution and industrial agriculture (Nevill et al., 2016). Traditional seeds, such as rice, maize, and millet, are known for their resilience, long shelf life, and adaptability to local environments. Unlike commercial or hybrid seeds, they can withstand moisture reduction and freezing, making them ideal for long-term storage and future use. By preserving these seeds, seed banks ensure access to valuable genetic resources and provide a buffer against the loss of traditional crops due to the homogenization of industrial agriculture.

Seed banks serve as hubs for community-driven conservation and agricultural development. As platforms for managing agricultural biodiversity, they empower farmers to regain control over seed resources, promoting seed sovereignty and reducing dependence on expensive patented seeds from multinational corporations (Shiva, 1997). Community seed banks and other initiatives, such as the Meta Agricultural Seed Bank, exemplify how local farmers can actively engage in seed conservation, sharing, and knowledge exchange to strengthen agricultural resilience (Sthapit, 2013).

Moreover, seed banks support sustainable farming by integrating traditional and modern seed systems. They encourage crop diversification strategies such as polycultures, crop rotation, and agroforestry, which enhance pest and disease resistance, boost yields, and buffer against climate variability (Linn, 2011). These practices not only improve food security but also preserve cultural identity and heritage, as traditional seeds are deeply intertwined with indigenous food systems, rituals, and knowledge. Indigenous maize (corn) seeds come in a wide variety of colours (see Figure 2), including yellow, white, red, blue, purple, and multi-colored variants, each with unique cultural significance and nutritional benefits, and they are often more resilient to local environmental conditions compared to commercial hybrids (Akinola et al., 2020; Shrestha et al., 2015). These diverse shades reflect the rich genetic diversity of maize, which has been carefully cultivated and adapted by indigenous communities over generations.

Indigenous seed banks play a pivotal role in safeguarding agricultural biodiversity, fostering climate resilience, and empowering local communities. By bridging the gap between formal and informal seed systems, they contribute to sustainable agricultural practices while promoting cultural preservation and food sovereignty. These banks are vital in ensuring that future generations inherit robust, diverse, and resilient agricultural ecosystems.

3 | THE META SEED BANK OF THE NILE VALLEY MULTIVERSITY: PRESERVING INDIGENOUS SEEDS FOR SUSTAINABLE AGRICULTURE

The Meta Seed Bank (MSB) represents an innovative response to the urgent need for preserving indigenous crop varieties amidst challenges posed by climate change, biodiversity loss, and industrial agriculture. By collecting seeds from wild plants, traditional agricultural fields, and community exchanges, MSB focuses on safeguarding genetic diversity and supporting smallholder farmers in Ghana and beyond. Indigenous seeds, adapted to local environments over generations, remain vital for sustainable agriculture and food sovereignty. However, their decline due to the dominance of hybrid and genetically modified (GM) seeds in commercial markets poses significant risks to agroecological resilience.

The MSB prioritizes genetically diverse and locally adapted seed varieties, ensuring their resilience to pests, diseases, and changing climatic conditions. By addressing gaps in the accessibility of native seeds in Ghana, MSB offers smallholder farmers the opportunity to utilize these resources. Indigenous seeds are stored under controlled conditions to maintain their viability, including drying to reduce moisture and cryopreservation for sensitive seeds. Partnerships with other seed banks allow MSB to duplicate collections, mitigating risks from natural disasters. This comprehensive approach enhances long-term conservation while serving as a research and resource platform for scientists and farmers.

A critical innovation of MSB is its promotion of vermicomposting, an eco-friendly practice that converts organic waste into nutrient-rich fertilizer. Research highlights its efficacy in improving soil structure, enhancing seed germination, and boosting crop yields compared to chemical fertilizers (Atiyeh et al., 2000; Ferreras et al., 2006). This sustainable method complements MSB's mission to integrate soil health with seed conservation.

MSB employs three seed conservation models—on-farm, ex-situ, and in-situ seed banks—tailored to different scales and purposes. On-farm banks are localized, facilitating community-level seed storage, while ex-situ banks offer controlled environments for long-term storage. In-situ conservation allows seeds to interact with their natural environment, fostering adaptation and maintaining genetic diversity. These strategies collectively address genetic erosion, ensuring the viability of indigenous seeds under varying conditions.

The decline of indigenous seeds, such as millet and guinea corn(see pictures in Figure 3), reflects a policy bias toward high-yielding monocultures subsidized by governments. While these policies have improved staple crop production, they have marginalized traditional crops, reduced biodiversity, and degraded soils due to intensive chemical use (Russell, 2023). With projected crop yield reductions of up to 50% by 2030 (Boko et al., 2007), initiatives like MSB are essential for mitigating food insecurity and adapting to climate change.

The Meta Seed Bank is more than a repository; it is a dynamic institution supporting biodiversity, sustainable agriculture, and farmer empowerment. Within the MSB, indigenous rice varieties (see Figure 3) have been carefully preserved in a wide range of

colors, including white, red, black, purple, and golden hues, with each variant offering unique nutritional properties and cultural significance, while contributing to biodiversity by maintaining genetic diversity and resilience to pests, diseases, and climate variability, making them more adaptable to changing environmental conditions (Akinola et al., 2020; Shrestha et al., 2015; Zhao et al., 2022). These diverse rice varieties help mitigate the impacts of climate change by providing a buffer against environmental stresses such as drought and salinity, ensuring food security for communities reliant on traditional farming practices. Through its seed conservation efforts and sustainable farming practices, MSB addresses pressing agricultural challenges while fostering resilience. Its integration of traditional knowledge with modern techniques serves as a model for ensuring food sovereignty and ecological sustainability in the face of global environmental changes.

4 | CLIMATIC CONDITIONS FOR SEED VIABILITY AND GERMINATION: IMPLICATIONS FOR AGRICULTURE

Global agriculture, a cornerstone of food security, faces growing challenges from climate change and environmental variability (Reed, Bradford, & Khauday, 2022). Shifting temperatures, erratic rainfall, and extreme weather events disrupt traditional cultivation practices, necessitating adaptations in seed management and genetic materials (Lamichane et al., 2020; Zhao et al., 2022). Central to this adaptation is understanding the role of climatic conditions in seed viability and germination—critical factors for ensuring crop productivity.

4.1 | Impact of High Temperatures on Seed Germination and Crop Yields

Heat stress, a common consequence of climate change, has detrimental effects on plant physiological, morphological, and biochemical processes. During vegetative and reproductive stages, elevated temperatures impair seed germination, reduce pollen viability, and decrease seed setting, grain quality, and overall yield (Brunel-Muguet et al., 2015; Niu & Xiang, 2018). Structural damage to seeds from high temperatures leads to ion leakage and altered biochemical composition, further compromising germination and vigour. Tropical areas like Ghana experience significant yield reductions due to these climatic pressures, exacerbating food insecurity. Additionally, heat-induced crop phenology changes and pollen sterility disrupt reproductive success, further diminishing seed productivity (Chakrabarti et al., 2011).

4.2 | Climate Change and Seed Longevity

Climate variability also affects seed storage conditions, influencing longevity and storability. Key factors include temperature, moisture content, and oxygen availability. Studies reveal that lower storage temperatures and reduced seed moisture content prolong viability. For instance, seeds with moisture content between 4-7% and stored at 4°C to 20°C retain viability for extended periods (Russell, 2023). The International Plant Genetic Resources Institute (IPGRI) recommends drying seeds below 7% moisture and storing them in airtight containers at -18°C for long-term conservation.

4.3 | Strategic Adaptations for Crop Preservation

A robust seed storage mechanism is imperative for maintaining genetic resources and mitigating climate change impacts on crops. Seed banks represent a cost-effective solution, offering controlled environments to safeguard seed viability over time. By implementing these systems in tropical regions, the persistence of native crops can be ensured, and the resilience of agricultural systems against climate variability strengthened.

Understanding the interplay between climatic conditions and seed viability is essential for optimizing seed storage and addressing the challenges of modern agriculture. This knowledge supports informed interventions to enhance crop performance and sustain global food systems in an era of climate uncertainty.

FIGURE 1 The diverse nature of indigenous rice

FIGURE 2 The different shades of indigenous maize (corn) and other seeds

FIGURE 3 Varieties of indigenous millet

5 | FACTORS AFFECTING THE SUSTAINABILITY OF INDIGENOUS SEED BANKS IN GHANA

The sustainability of indigenous seed banks in Ghana is influenced by several factors, particularly challenges related to technical, operational, and policy frameworks. One of the main issues faced by seed banks such as the MSB is variability in their performance, including adherence to phytosanitary standards, the quality of seed production, and the technical rigour involved in monitoring seed germination and viability. Proper management of information about stored seeds, their growing conditions, and the overall operational management of seed banks also play crucial roles in ensuring long-term sustainability (Shrestha et al., 2015).

5.1 | Legal and Policy Constraints

The establishment and operation of seed banks in Ghana are hindered by the lack of supportive laws and policies for the conservation of indigenous seeds. While agricultural and biodiversity policies are intended to promote conservation, they often fail to prioritize or protect the interests of local farmers and communities in preserving indigenous seed varieties. In contrast, some countries have implemented Farmer Rights Acts to support seed conservation, but Ghana has seen limited success in translating such policies into effective action. The promotion of hybrid seed varieties by research and extension agencies has further marginalized indigenous seed varieties, leading to a decline in the preservation of local crops within seed banks.

5.2 | Climatic and Environmental Challenges

Extreme weather conditions, including high temperatures, are major contributors to seed bank failures in tropical regions. These conditions negatively affect seed germination, crop yields, and the overall viability of stored seeds (Wasswa et al., 2015). Climate change, coupled with poor irrigation systems, exacerbates the problem, making it difficult for seed producers to meet the demand for indigenous seeds. As weather patterns shift and extreme weather events become more frequent, particularly in the northern regions of Ghana, the ability to produce and store seeds sustainably continues to decline (Challinor, 2016). Despite the urgency, there is a notable lack of research into the appropriate climatic conditions needed to preserve seeds in seed banks effectively.

5.3 | Over-Reliance on Imported Seeds

Another significant challenge facing seed banks in Ghana is the over-reliance on imported seeds. This dependence has stifled local seed production, discouraging investment in large-scale production of indigenous seeds. While the country continues to import large quantities of seeds to support local farmers, this practice undermines the development of a robust domestic seed industry and hinders efforts to preserve indigenous varieties.

5.4 | Financial Constraints

Seed production and the establishment of seed banks require substantial investment. However, many seed producers in Ghana struggle with inadequate capital to fund the necessary infrastructure for seed conservation. The lack of a supportive financial system for seed producers further exacerbates the challenges, limiting the capacity of seed banks to function effectively and sustainably. Without adequate financial support, the long-term viability of indigenous seed conservation initiatives remains uncertain.

The sustainability of indigenous seed banks in Ghana is contingent on overcoming a combination of legal, climatic, financial, and infrastructural challenges. Addressing these issues will require the establishment of favourable policies, better financial support for local seed producers, and climate-adaptive seed storage practices. Only through a multi-faceted approach can Ghana strengthen its seed banking systems, ensuring the conservation of indigenous seeds and securing food sovereignty in the face of climate change.

6 | THE POLITICAL ECONOMY OF THE SEED MARKET: IMPLICATIONS FOR INDIGENOUS AGRICULTURE IN GHANA

The global agricultural seed market is heavily concentrated, with a few dominant players controlling a substantial portion of seed production and sales. As of recent reports, four corporations—Bayer, Corteva Agriscience, ChemChina's Syngenta, and BASF—collectively control around 60% of the global seed market. Bayer's acquisition of Monsanto in 2018 solidified its dominance in genetically modified (GM) seeds and crop protection. Similarly, Corteva Agriscience, a spin-off from DowDuPont, and ChemChina's Syngenta, have shaped the landscape of modern agricultural biotechnology, prioritizing genetically engineered seeds that promise higher yields and enhanced resilience to environmental stress (Zhao et al., 2022). This consolidation raises concerns regarding reduced competition, limited seed diversity, and the dominance of proprietary technologies, often excluding smallholder farmers and reducing their autonomy in seed choice and production.

In Ghana, the agricultural sector faces a paradox where, despite the potential for indigenous crops to provide ecological, nutritional, and economic benefits, their commercialization is hindered by market failures and policy shortcomings. Indigenous crops, such as millet, guinea corn, and traditional rice, are not only essential for food security but are also resilient to climate change, offering sustainable alternatives to industrial monocultures (Akinola et al., 2020). However, the infiltration of hybrid seeds into local markets has made it difficult for indigenous seeds to compete. The high costs of hybrid seeds and the established distribution networks favouring these commercial varieties create significant barriers to the adoption of indigenous seeds, leading to their marginalization in favour of genetically modified crops that require costly inputs like fertilizers and pesticides.

One of the critical challenges faced by indigenous seed banks and producers in Ghana is the lack of production and marketing knowledge, which limits their ability to compete with commercial farmers or export their products. Most indigenous farmers lack access to crucial information about market prices, production techniques, and the broader commercial seed market. The absence of this knowledge hampers the commercialization potential of indigenous crops and limits their economic viability. Inadequate infrastructure—such as poor storage facilities and transportation—further exacerbates these issues, making it difficult for farmers to access markets and compete effectively with hybrid seed producers (Ali et al., 2021).

Sociodemographic factors, including low education levels, limited market access, and aging farmers, also affect the success of indigenous crop commercialization in Ghana. Many smallholder farmers in Ghana are older and lack the skills necessary to engage with modern agricultural markets. Additionally, government policies do not adequately support the production and commercialization of indigenous crops, further discouraging their cultivation and preservation. The lack of government support for indigenous farming systems and the slow adoption of farmer-based organizations (FBOs) further exacerbate the challenges.

Another crucial issue in the political economy of seed markets is the phenomenon of biopiracy, where corporations' appropriate indigenous knowledge and genetic resources for profit without compensating local communities. Biopiracy has become

increasingly prevalent, with large multinational corporations patenting indigenous crops or seeds after minor modifications, effectively privatizing genetic resources that have been carefully cultivated by local communities for generations. This practice undermines the rights of farmers to use, exchange, and improve upon their own seeds, effectively making them dependent on commercial seed suppliers for access to agricultural resources.

Notable cases of biopiracy include the patenting of basmati rice by a U.S. company, despite its long history of cultivation in India and Pakistan, and the commercialization of quinoa, a staple crop for Andean communities, often without equitable benefit-sharing (Shiva, 1997). These practices not only deprive local communities of their rights but also promote monocultures, replacing diverse indigenous varieties with a few high-yield crops. This shift reduces agricultural resilience to pests, diseases, and climate change, exacerbating the vulnerability of local food systems.

The dominance of multinational corporations in the seed market and the exploitation of indigenous agricultural knowledge have significant implications for food sovereignty and environmental sustainability. Indigenous seed banks, such as those championed by local communities and initiatives like the Meta Seed Bank in Ghana, are critical in combating these inequities. By promoting seed sovereignty—allowing farmers to control their seeds rather than relying on commercial seed suppliers—indigenous seed banks play a crucial role in maintaining biodiversity, supporting sustainable agriculture, and enhancing climate resilience. Moreover, these seed banks contribute to the preservation of indigenous knowledge, which has been developed over centuries and is crucial for adapting to environmental changes.

The political economy of the global seed market, characterized by corporate consolidation, intellectual property rights, and the dominance of hybrid and GM seeds, significantly impacts the agricultural landscape in Ghana and other developing countries. Addressing these issues requires supporting local seed systems, ensuring fair access to indigenous seeds, and promoting policies that prioritize food sovereignty and environmental sustainability. Empowering smallholder farmers with the knowledge, resources, and support to preserve and commercialize indigenous seeds is vital for securing resilient and sustainable food systems in the face of climate change.

7 | CONCLUSION AND KEY IMPLICATIONS FOR AGRICULTURE AND PUBLIC POLICY

This study highlights the critical role of indigenous seed banks in addressing agricultural challenges in Northern Ghana. It reveals that indigenous seed banks are not only essential for conserving plant genetic resources but also play a vital role in enhancing seed viability and germination. Through these initiatives, local farming systems are strengthened, which in turn promotes food security, biodiversity conservation, and the long-term sustainability of agricultural practices. The study underscores the significant contribution of these seed banks to strengthening ecosystems and ensuring that local agricultural practices remain resilient in the face of climate change.

A key factor influencing agriculture in Ghana, particularly in the northern regions, is the changing climate. The Meta Seed Bank, as a central player in conserving local seed varieties, contributes directly to the resilience of the agricultural ecosystem by preserving genetically diverse and climate-adapted seeds. With the growing demand for high-quality indigenous products, there is a clear opportunity for the promotion of indigenous farming as a pathway to economic and nutritional sustainability. However, the increasing reliance of smallholder farmers on costly patented hybrid seeds exacerbates economic inequality, as it limits access to affordable, sustainable alternatives. This issue also ties into global concerns regarding the privatization of genetic resources, which undermines local seed sovereignty.

International frameworks such as the Convention on Biological Diversity (CBD) and the Nagoya Protocol aim to regulate access to genetic resources and ensure that benefits are fairly shared. However, challenges in enforcement persist, often leaving local communities vulnerable to exploitation. National legal frameworks, like India's Protection of Plant Varieties and Farmers' Rights Act, demonstrate the importance of empowering farmers to save, exchange, and use seeds, providing a model for other nations, including Ghana.

7.1 | Implications for Public Policy and Sustainable Agriculture

The findings of this study have several key implications for both agriculture and public policy in Ghana and other developing regions. We discuss the local seed system, alternative models for seed exchange, cross cutting collaborations and indigenous agricultural systems in turn.

7.1.1 | Strengthening Local Seed Systems

Policymakers should prioritize the development and support of indigenous seed banks as vital institutions for sustainable agriculture. This includes funding for capacity-building in local communities, establishing stronger regulatory frameworks to protect indigenous seed varieties, and supporting policies that allow farmers to access, save, and exchange seeds freely.

7.1.2 | Promoting Alternative Models for Seed Exchange

Advocacy for open-source seed initiatives, where genetic resources are freely exchanged and shared, should be encouraged to reduce dependency on commercial seed suppliers and promote seed sovereignty. Encouraging community-managed seed exchanges can foster resilience and biodiversity.

7.1.3 | Public and Private Sector Collaboration

The public sector should engage more deeply in the research and development of indigenous seed varieties and facilitate the commercialization of these crops by partnering with private companies such as the Nile Valley Multiversity. This could include creating policies that incentivize private companies to invest in the production and marketing of indigenous seeds, thereby providing a sustainable source of income for local farmers and reducing reliance on imported seeds.

7.1.4 | Climate-Responsive Agricultural Policies

Governments must implement policies that address the climatic conditions affecting agriculture, particularly in vulnerable regions like the north of Ghana. This includes investing in infrastructure that supports seed storage under optimal conditions, as well as providing training to farmers on climate-smart agricultural practices rooted in indigenous lore.

7.1.5 | Capacity Building and Knowledge Exchange

The Meta Seed Bank also highlights the importance of capacity building and knowledge exchange. By creating platforms where farmers can access information about seed saving, storage techniques, and seed conservation methods, developing countries can foster more robust agricultural systems. The exchange of knowledge between indigenous farmers, researchers, and agricultural practitioners can lead to the development of more effective farming practices (Shrestha et al., 2015). Developing nations can adopt similar initiatives to improve farmer education and ensure the sustainability of local agricultural systems.

7.1.6 | Reducing Biopiracy and Protecting Indigenous Knowledge

One of the critical issues addressed by the Meta Seed Bank is the threat of biopiracy, where corporations' appropriate genetic resources from indigenous communities without compensating them. The Meta Seed Bank serves as a safeguard against the exploitation of indigenous knowledge and genetic resources, ensuring that the benefits of crop varieties remain within the local communities (Shiva, 1997). Developing countries can strengthen intellectual property frameworks to protect traditional knowledge and prevent the commercialization of indigenous seeds without benefit-sharing.

By aligning public policies with the needs of local farmers and ecosystems, Ghana has the potential to strengthen its agricultural resilience, safeguard food sovereignty, and ensure that indigenous farming remains central to the country's agricultural landscape. These insights offer valuable lessons for other developing nations that are striving to achieve national food security and sustainable agricultural practices. In similar economies, especially those vulnerable to climate change and agricultural disruption, integrating indigenous knowledge and biodiversity conservation into national agricultural strategies can promote long-term sustainability. By supporting community-based seed systems, investing in climate-resilient farming methods, and fostering collaboration between the public and private sectors, developing countries can improve food security, reduce dependency on external agricultural inputs, and enhance the resilience of rural livelihoods (Shrestha et al., 2015; Akinola et al., 2020). This approach not only empowers local farmers but also builds a more diversified and adaptable agricultural sector, capable of thriving in the face of changing environmental and economic conditions.

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