CHAPTER 13

Policy and Regulatory Frameworks for Development of Seed Systems in Sub-Saharan Africa

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Introduction

The populations of countries in Sub-Saharan Africa are growing rapidly. This reality poses challenges for the environment as food and nutrition needs expand in the face of climate change. In response, both national and international research organizations are actively developing genetic innovations, agricultural technologies, and management practices to improve agricultural productivity and food production and meet the rising demand for food and nutrition security. Despite the development of numerous agricultural innovations over the years, smallholder farmers who contribute significantly to food supply in the Global South are still far behind in terms of adopting modern technologies to meet domestic demand and supply to international markets..

Institutional and policy innovations are just as important as technological advances in driving agricultural transformation and improving the livelihoods of rural farming families. Getting improved crop varieties into farmers' hands requires well-functioning seed systems, which in turn are dependent on the existence of an enabling environment. Such an environment includes proper policies and institutions that ensure smallholders get the right quality seeds at the right time and place, and at affordable prices. Having a functional seed system (whether formal, informal, or hybrid) [1] is therefore essential for overall agricultural development.

Countries in Sub-Saharan Africa are at different stages in terms of the development and functioning of their seed systems. Some countries, like Ethiopia, are highly dominated by public sector enterprises for seed production, distribution, and sale. In contrast, countries like Kenya and Zimbabwe rely more heavily on private firms for seed production, marketing, and distribution. Both public and private seed enterprises/companies play important roles, as they typically serve different market segments and groups of farmers. The private sector's fundamental objective is to make profits from the seed industry. As a result, private seed companies tend to focus on areas with concentrated markets, good infrastructure, and high population densities to minimize transportation and transaction costs. For the public sector, reducing marketing costs is a priority, but it is also mandated to serve people in need, including those who rely on access to quality seeds to improve their livelihoods.

The development of appropriate seed laws, policies, and institutions is essential for the establishment of functional seed systems. Policies create incentives, and the distribution of these incentives among the various actors involved in the seed system depends largely on the nature of markets and institutional arrangements on the ground. A single marketing system may not serve the diverse interests of farmers within a single country; therefore, governments should design multiple mechanisms to reach smallholder farmers. In countries or regions with well-functioning markets, farmers receive the information they need and have access to multiple alternatives when making their seed-related choices. Seed systems developed and led by the private sector can distribute information and various seed options in such circumstances. However, in situations where there is a need for locally produced quality seeds, particularly for crops and varieties with limited commercial interest or when the aim is to address challenges such as diseases associated with climate change using locally adapted crop species or biodiversity maintenance, public enterprises, non-governmental organizations (NGOs), and farmer cooperatives play a critical role. These entities fill gaps that the market would otherwise not meet and improve seed accessibility, especially in remote areas.

A pluralistic approach to seed systems development, as emphasized by Mulesa et al. (2021) and Thijssen et al. (2025), is important when designing strategies, policies, and legislation governing seed systems. Equally important to policy formulation is the establishment of robust regulatory frameworks. Without clear, functional regulations, it is challenging to develop a seed system that reliably delivers genetic innovations to farmers. Such frameworks must include the development and enforcement of laws on quality seed production, certification processes to ensure seed quality, and regulations governing seed movement, including guidelines to control seed-borne diseases.

In regions where formal and hybrid seed systems are limited, it is important to develop strategies that support the improvement of informal seed systems to enhance smallholders' access to improved varieties. Informal systems, especially

1 Formal seed system refers to the production and marketing of certified seeds through a registered seed company or enterprise (public or private). Informal seed system refers to non-registered seed production and marketing (or exchange). The hybrid (integrated) form is a combination of the two, where cooperatives, farmer groups or community-based organizations multiply seeds under the supervision of the regulatory body and sell these seeds to their members or neighboring farmers as a quality declared seed (QDS) to ensure seed security and seed sovereignty of their community.

farmer-to-farmer seed exchanges, are prevalent and play a vital role in many African countries where they still dominate existing seed systems. However, efforts should be made to develop formal seed systems, even as governments work to better manage informal seed systems. Capacity building in managing seed production, processing, and treatment at the farm level, along with implementing other essential measures, is key to enhancing the effectiveness of informal seed systems. This approach is particularly important for reaching marginalized communities in remote geographic locations and supporting the distribution of self-pollinated crops, which tend to slowly lose their genetic vigor.

This chapter emphasizes the significance of institutional and regulatory reforms as essential mechanisms for facilitating the inclusive transformation of seed systems. The chapter focuses on agrifood system transformation through the delivery of improved seed technologies to smallholders in Sub-Saharan African countries. It highlights policies and regulations at the country and regional level that foster the availability and accessibility of quality seeds to farmers. The remaining sections of this chapter are organized as follows. Section 2 provides a conceptual framework for the analysis. Section 3 presents various examples from different countries on the role of policy and regulatory frameworks. Section 4 discusses key findings and concludes the chapter.

Conceptual Framework

The development of seed systems passes through four distinct stages: sustenance; early commercial; rapidly commercializing and diversifying; and maturity (Jaffe and Srivastava 1992). These stages are characterized by the extent to which the seed sector serves farmers, as well as the complexity of institutional arrangements and infrastructure involved in the production, distribution, and marketing of quality seeds.

Based on an extensive literature review and analysis of supporting data, this chapter examines the role of policy and regulatory frameworks in the development of seed systems in Sub-Saharan African countries. Specifically, our analysis addresses three critical questions related to policy and regulatory frameworks: (1) What is the expected development pathway for designing and implementing policies and regulations that make seed systems responsive to smallholder farmers' demands for improved, high-quality seeds at affordable prices? (2) How long does it take for policies to influence changes in seed system development? (3) In addition to having proper policy and regulatory frameworks in place, what are the other key aspects of an enabling environment that potentially limit the development of seed systems in the developing world?

One key factor that influences the development of seed systems in a country or region is the set of policies and legal frameworks governing intellectual property (IP) rights (Kolady et al. 2012). The level of protection provided to varieties developed and registered through these intellectual rights can significantly influence the growth of private seed companies. Strong IP protection incentivizes seed companies to invest in research and development of new varieties, as they can benefit from exclusive rights and capture potential market share by introducing high-yielding and well-adapted varieties into the production system. However, thin markets and institutional constraints can limit the growth of investments made by private seed companies (Naseem et al. 2010).

Seed enterprise development has been constrained by incentive mechanisms that tend to favor parastatal entities, thereby inhibiting commercial innovation through private sector development (Tripp and Rohrbach 2001). This chapter explores why certain countries provide more support to parastatals and how such support affects the overall development of competitive seed systems.

In some regions, the seeds of certain crops are traded across borders, particularly in regions with stronger economic integration, e.g., the East African Community (EAC). Effective cross-border seed trade among neighboring countries takes place in contexts where clear and harmonized seed development and marketing policies exist. These policies help ensure seed quality and standards, guaranteeing that traded seeds are free from diseases and pests (Rohrbach et al. 2003).

Seed quality remains one of the major challenges facing many countries in Sub-Saharan Africa (Gaffney et al. 2016; Collinson et al. 2024). Quality assurance and traceability of seeds require proper supervision in the field and throughout the seed supply chain. This would typically be overseen by a dedicated regulatory authority. In principle, such supervision should be conducted by an independent government body or government-certified entity to maintain impartiality. However, in some cases, supervision is carried out internally by organizations involved in seed production, resulting in conflicts of interest. Tripp and Louwaars (1997) indicate the need to shift from direct seed supervision to developing policy and regulatory frameworks that ensure seed quality. Excessively stringent standards may limit the entry of firms into seed markets and constrain competition. At the same time, such regulations are crucial for

preventing the entry of low-quality seeds into the market. Spielman et al. (2025) point to the importance of striking a balance between regulation and market flexibility to ensure seed market expansion while also safeguarding seed quality.

The development of seed systems occurs in stages along a pathway that varies depending on a country's unique political and economic context in agricultural development. The speed at which countries move from seed systems dominated by the public sector to more competitive, private sector-driven systems largely depends on the character of the transformation of the enabling environment toward support for private sector growth. This chapter will use a historical perspective to explore why different countries follow different policies and regulatory frameworks in the development of their seed systems.

The review focuses on mapping the relationships among the different components of policy and regulatory frameworks, as well as their impacts on the success and development of seed systems in Sub-Saharan African countries. In assessing policy effectiveness, this chapter considers key indicators such as varietal turnover, compliance with seed quality standards, seed adoption rates, the presence of harmonized seed laws, and other relevant metrics to assess how the design and implementation of these policies influence outcomes.

Lessons from Selected Countries

Having robust policies and regulatory frameworks is crucial to the development of effective seed systems. Policies provide an overarching structure that defines how seed systems function, clarifying the roles of both the private and public sectors in seed production, distribution, and sales. Further, regulatory frameworks help in ensuring the development and use of high-quality seeds by establishing standards for quality control, pricing mechanisms, and market competition, among other factors. Together, these elements create an enabling environment for a sustainable and efficient seed system.

Some countries in Sub-Saharan Africa have well-developed and liberalized seed systems, supported by long-standing, effective policies. In contrast, others operate hybrid seed systems where public and private sectors, as well as cooperatives, play key roles. Additionally, in some countries, formal seed systems remain limited, and farmers primarily depend on informal seed sources. The latter should be encouraged to invest more in the seed sector in order to develop their formal seed systems.

The literature shows that countries with strong and supportive regulatory frameworks tend to have more competitive seed markets. This underscores the importance of establishing effective policy and regulatory frameworks to promote competition in seed markets and support overall growth in agricultural production and productivity by improving farmers' access to quality seeds. In this context, countries in Sub-Saharan Africa can gain valuable insights from their peers in other parts of the world. The development of seed systems is a gradual process that mirrors the overall development of the economy, including the establishment of the infrastructure and institutions that would induce private sector actors to steadily replace the public sector.

Responding effectively to climate variability requires climate-smart seed systems to produce and market seeds of climate-resilient crop varieties, making them available and accessible to smallholder farmers (Westengen et al. 2023). This is only possible when local institutions and national policies are sensitive enough to promote both highly and less commercialized climate-resilient varieties that are channeled through a broader seed supply system (Westengen et al. 2023). The following sub-section assesses the key successes and failures in seed policy, including harmonization efforts, across selected African countries.

East Africa

Ethiopia

Ethiopia's seed policy and regulatory frameworks have evolved with regime changes and national development plans. The first National Seed Policy and Strategy, introduced in 1992, included several key measures, including the establishment of the National Seed Industry Agency in 1993 and the definition of farmers' roles in genetic resource conservation and the informal seed sector. Recognizing the need to enhance the seed sector to address existing gaps, a national plant seed policy was approved by the Ministry of Agriculture (MoA), which played a crucial role in approving a revised Seed System Development Strategy in 2017. This was followed by the new seed proclamation No. 1288/2023, enacted in 2023, which replaced the Seed Law 782/2013. [2]

2 Over the past three decades, Ethiopia's seed consumption has shown a substantial growth from 138,218 tons in 2008/09 to 196,300 tons in the 2024/25 production season (MoA (2025), seed production data). This reflects the improved contributions of private and cooperative seed producers.

The 2023 Seed Law outlines rules and procedures for variety release, registration, seed production, processing, marketing, and quality certification. While some directives exist – covering import and multiplication of unregistered varieties for export, competency certification in the seed business, quality-declared seed, seed production in contracts, and seed marketing – several areas still lack directives (ESA 2024). These include the release and registration of farmers' and pastoralists' varieties, the establishment of national and regional seed advisory coordination bodies, and the regulation of emergency seed supplies. Such gaps highlight the need to further develop Ethiopia's seed regulatory framework.

Although the Seed Law allows various actors to participate in seed production and marketing, public enterprises still dominate the seed system. Recently introduced policies encourage private sector growth, but its share remains minimal and is mainly limited to hybrid maize. To move away from public seed marketing, Ethiopia introduced Direct Seed Marketing (DSM) in 2011, enabling producers to sell directly to farmers. DSM increased maize variety adoption by 15 percent, boosted farmer purchases of maize seeds by 45 percent, and raised maize seed purchases by 18 percent, contributing to an 18 percent increase in maize yields (Mekonnen et al. 2025).

Seed quality certification in Ethiopia covers standards, inspection, certification, and labeling, all of which are supported by directives and regulations. However, three key areas still need regulations: laboratory testing and administration; self- and third-party certification; and seed counterfeiting control. Despite stringent frameworks, varietal mismatch and counterfeit seeds remain serious challenges, especially for hybrid maize and vegetable seeds. Counterfeiting involves grain dressing with artificial colors, adulteration, label imitation, package reuse, and mislabeling. This is mainly conducted by opportunistic local grain traders and agro-dealers (Tsegaye et al. 2025).

Challenges in the implementation of Ethiopia's seed policies include conflicts over variety release and registration, as national research still controls testing despite this being the responsibility of the Ethiopian Agriculture Authority. Obsolete varieties are not deregistered, and formal production systems for farmers' varieties are missing. Other issues include limited investment incentives due to land access constraints, irregularities in early generation seed production, unfair competition between public and private seed companies, and problematic processes for determining seed prices. Ethiopia's seed system remains focused on distribution over marketing, resulting in low access to appropriate crop seeds in sufficient quantities, unavailability in some locations, and uncompetitive prices (Ethiopia, Ministry of Agriculture 2019).

Kenya

The Kenya seed policy framework, anchored by the Seeds and Plant Varieties Act (Cap 326), aims to regulate the development, production, certification, and distribution of high-quality seeds among farmers. The government, through institutions such as the Kenya Plant Health Inspectorate Service (KEPHIS) and the National Seed Policy (2010), emphasizes the need for innovation, access to improved seed varieties, and private sector participation. Recent policy efforts have focused on strengthening IP rights for breeders, streamlining variety release procedures, and encouraging the uptake of climate-resilient and nutrient-rich seed varieties among smallholder farmers.

Kenya's seed sector is underpinned by a clear national policy and legal framework, starting with the establishment of the National Seed Policy of 2010 and strengthened by updates to the Seeds and Plant Varieties Act. Together, these instruments set out a coherent national strategy for seed quality assurance, certification, and variety development. Central to the implementation of these policies is the Kenya Plant Health Inspectorate Service (KEPHIS), which is the regulator for testing, certification, phytosanitary controls, and anti-counterfeit initiatives that reduce the circulation of low-quality seeds. Reforms to the Plant Variety Protection (PVP) of 2012 further aligned Kenya with international standards, spurring private investments, the entry of new seed companies, and the broader adoption of hybrid and improved seed varieties in commercial markets. These factors, supported by the Ministry of Agriculture, Kenya Agricultural and Livestock Research Organization (KALRO), Seed Traders Association of Kenya (STAK), and other industry actors, form a strong statutory and institutional foundation for Kenya's seed system.

Regionally, Kenya has played an active role in advancing harmonization initiatives within the East African Community (EAC) and the Common Market for Eastern and Southern Africa (COMESA), participating in the design of frameworks such as the Harmonized Seed Trade Regulations and the EAC Seed & Plant Varieties Bill. These efforts are intended to simplify variety release, streamline certification, and ease cross-border seed trade – an area where Kenya has made meaningful policy-level progress. However, operational implementation remains uneven, with domestic legal alignment, mutual

recognition of testing, and administrative readiness lagging behind existing regional commitments. Overall, Kenya demonstrates strength in its statutory architecture, the effectiveness of its regulatory agency, and the dynamism of its private seed sector. However, further reforms are needed to translate regional harmonization agreements into practical systems that deliver efficient, reliable cross-border seed movements.

Tanzania

Tanzania's Seed Act, coupled with the country's policy and legal frameworks, aims to regulate the production, quality, and distribution of seeds to ensure agricultural productivity and food security. The Seed Act (2003, revised 2014) aims to regulate the seed industry, ensure the availability of quality seeds, and protect farmers and breeders. The act provides for the registration and certification of seeds, as well as the establishment of the Tanzania Official Seed Certification Institute (TOSCI) to oversee seed quality, licensing of seed producers, processors, and sellers, and protection of plant breeders' rights (PBRs). Tanzania's National Seed Policy (2002) aims to promote a competitive seed industry involving both public and private sectors, ensure the availability of improved and certified seeds, support the research and development of locally adapted seed varieties, and foster public-private partnerships and farmer participation.

In Tanzania, PBRs are governed by the Plant Breeders' Rights Act, 2012 (No. 29 of 2012), which replaced the earlier 2002 Act. This legislation provides legal protections for new plant varieties to encourage innovation and investment in the agricultural sector. The act grants IP rights to breeders of new plant varieties, which encourages innovation. Eligibility for protection stems from the novelty of a variety, that is, whether it is new and has not been traded for more than one year in Tanzania, or more than four years (six years for trees and vines) in other countries before the application for protection. Evaluations of eligibility also consider whether the variety is distinct, uniform, and stable. PBRs are granted for 20 years in the case of crops and 25 years for trees and vines.

Tanzania is also part of regional agreements like the Southern African Development Community's (SADC) seed harmonization protocols to facilitate cross-border trade. The country was initially a member of COMESA but then withdrew in 2000 to focus more on the EAC and SADC due to overlapping obligations.

The next sub-section briefly presents the experiences of selected countries in Southern Africa.

Southern Africa

Zimbabwe

Zimbabwe's Seed Act [Chapter 19:13], in tandem with the country's policy and regulatory framework, governs the production, certification, marketing, and use of seeds to ensure quality and promote agricultural productivity. The main legal framework that regulates the seed industry provides oversight on the registration of seed varieties, licensing of seed producers and sellers, seed certification and quality control, and the powers of inspectors to enforce standards. The seed policy promotes access to quality seeds, supports private sector participation, the use of improved and climate-resilient seed varieties, and harmonization with regional seed policies (e.g., SADC and COMESA). The Seed Services Institute (SSI) under the Ministry of Lands, Agriculture, Fisheries, Water, and Rural Development is responsible for seed testing, certification, and quality assurance, while the National Variety Release Committee (NVRC) approves new seed varieties for release and commercialization. Zimbabwe is part of the SADC and COMESA regional seed harmonization initiatives, which aim to standardize seed certification and facilitate cross-border trade. Together, these systems aim to ensure farmers' access to high-quality and certified seeds, while enabling innovation and compliance with international standards.

Zimbabwe's seed policy plays a critical role in shaping the country's agricultural landscape. This policy has a clear governance structure that facilitates stakeholder coordination, promotes investment in research and development, and supports the availability of improved seed varieties to farmers. These policies are complemented by Zimbabwe's regulatory frameworks, which ensure that only high-quality seeds are developed and made accessible to farmers. The country's regulations enforce standards in seed testing, certification, and packaging, thereby protecting farmers from counterfeit or substandard products. Moreover, the frameworks provide mechanisms for fair pricing, encourage healthy competition in the seed market, and support innovation through the protection of breeders' rights. Plant Breeders' Rights (PBRs) are governed by the Plant Breeders' Rights Act [Chapter 18:16] of 1973, along with the Plant Breeders' Rights Regulations of 1998 (Statutory Instrument 113/1998).

These laws provide legal protection for new plant varieties, granting breeders' exclusive rights to control the propagation and commercialization of their varieties. Taken together, Zimbabwe's seed policies and regulatory frameworks create an enabling environment for a robust seed sector capable of supporting sustainable agricultural growth and rural development.

Zambia

Zambia's seed regulatory framework is primarily governed by the Plant Variety and Seeds Act (Cap. 236), originally enacted in 1968 and subsequently amended. This Act provides the legal foundation for the regulation and control of seed production, sale, import, and export, ensuring the maintenance of minimum standards for seed quality, including germination and purity. Zambia's seed policy, regulatory framework, and Seed Act work together to govern the production, certification, and trading of seeds within the country to ensure quality, promote food security, and support agricultural development. The Seed Act, which is primarily enforced by the Seed Control and Certification Institute (SCCI) under the Ministry of Agriculture, outlines the legal foundation for regulating seed production, importation, exportation, and sale. It provides for the registration of seed varieties, seed growers, and dealers, as well as the inspection and certification of seeds to maintain quality standards.

The country's seed policy complements the Seed Act by providing strategic direction for seed sector development. It emphasizes the promotion of private sector participation, research and development, as well as regional harmonization with the SADC and COMESA seed trade frameworks. Regulatory instruments such as variety release systems, seed certification schemes, and phytosanitary controls are implemented to ensure that only high-quality seeds enter the market. Collectively, Zambia's seed policy and regulatory framework aim to create an enabling environment for innovation, investment, and access to diverse, high-performing seed varieties for both commercial and smallholder farmers.

Zambia's PBRs are legal protections granted to plant breeders for new varieties that they develop. These rights are governed under the Plant Breeders' Rights Act No. 18 of 2007. The Act gives breeders exclusive control over the propagation, sale, and distribution of their plant varieties for a specific period, typically 20 years for most crops and 25 years for trees and vines. To be protected, a plant variety must be new (not previously sold or distributed), distinct (clearly different from existing varieties), uniform (consistent in characteristics), and stable (retains traits through successive generations).

The system encourages agricultural innovation by allowing breeders to benefit commercially from their work while also enabling access to improved plant varieties for farmers under regulated conditions. Zambia is also a member of international frameworks like UPOV (the International Union for the Protection of New Varieties of Plants), which aligns its laws with global standards.

Zambia has harmonized its seed regulatory framework with regional standards more recently. Notably, in 2018, Zambia became the first SADC country to fully domesticate the SADC Harmonized Seed Regulatory System (HSRS). This harmonization includes components such as seed variety release, seed certification, and quality assurance, facilitating the movement of high-quality seeds across national borders. The harmonization of seed policies and regulations in Southern Africa supports multilateral seed companies in producing and marketing quality seeds across countries.

The next sub-section presents the experiences of selected West African countries (Benin, Burkina Faso, Ghana, Mali, and Nigeria) with a focus on national policies and regulations, in addition to efforts made under the Economic Community of West African States (ECOWAS) to harmonize seed policies and regulations in the region.

West Africa

Benin

Benin has aligned its seed policies with regional frameworks, particularly those of the Economic Community of West African States (ECOWAS) and the West African Economic and Monetary Union (WAEMU/UEMOA), to promote harmonization across borders. The country's seed policy focuses on promoting private sector involvement, encouraging research and development, improving seed certification systems, and facilitating access to improved varieties for smallholder farmers.

The national Seed Law, supported by regulatory decrees and guidelines, outlines standards for seed production, quality control, certification, and marketing. The National Seed Committee (Comité National des Semences) oversees implementation of seed regulations, including the registration of crop

varieties and licensing of seed producers. Benin also emphasizes the integration of both formal and informal seed systems. The country recognizes the role of traditional seed practices while also encouraging the adoption of certified seeds (Bloukounon et al. 2024). Ongoing efforts seek to strengthen institutional capacity, improve seed inspection services, and ensure that farmers benefit from improved genetics and resilient crop varieties.

Certified seeds in Benin are mainly produced by farmers' organizations and the private sector, while foundation seeds used for certified seed production are mainly sourced from the National Institute of Agricultural Research of Benin (INRAB). Prior to 1984, the government used to sponsor seed production under the guidance of the Regional Action Centers for Rural Development. However, after the 1989 sectoral review, the seed industry was restructured through the implementation of the National Seed Plan for 1990-1995. This reduced the state's role in seed production and initiated efforts to liberalize the seed market by encouraging private sector participation. The second phase of reforms (National Seed Plan 1995-2000) saw the emergence of cooperatives, many of which are now led by large federal and national umbrella organizations (Vernooy et al. 2023). The collapse of the National Society for Agricultural Promotion in 2008 – an entity that had previously coordinated 90 percent of the commercial seed trade – further accelerated the rise of cooperatives and marked a turning point in the sector's development.

Nevertheless, Benin's seed sector remains underdeveloped and in need of significant improvement. While a seed policy exists, it heavily favors the formal seed system, offering little to no support for farmer-led quality seed production initiatives, such as Quality Declared Seed (QDS) (Vernooy et al. 2023). Certified seed production is strictly overseen by the Seed Quality Control and Certification Department, under the National Seed Services. The current seed market in Benin is fully liberalized, and the regulatory and institutional environment encourages the entry or growth of private seed companies.

Burkina Faso

Burkina Faso is one of the West African countries with a relatively well-developed seed sector. The country has established seed policies and regulations, a functional seed committee, a certification agency (Service National Semenciers), an updated national seed catalogue, and an active private sector association (Union Nationale des Sociétés Coopératives des Producteurs Semenciers du Burkina – UNPSB). Burkina Faso launched a seed specialization program in 2002 that led to the adoption of the Seed Law (Law No. 010-2006/AN) in 2006 with support from non-governmental organizations (NGOs) and donor agencies (Vernooy et al. 2023). The law sought to liberalize the seed system, promote seed quality, and enhance agricultural productivity and food security. After the severe famine of 2008, government investments in the seed sector increased, leading to greater use of certified seeds and the introduction of key regulations and institutions to strengthen the seed system, including the establishment of the National Seed Committee and the Seed Sector Support Fund.

The formal seed sector in Burkina Faso was further institutionalized with the establishment of the National Seed Committee (CNS) in 2012, which published the country's first official National Variety Catalogue in 2014. This marked the beginning of a standardized variety release process, aligned with the Executive Regulation Organizing the Regional Catalogue of Plant Species and Varieties in West Africa and the Sahel (CREVAOS), which is common to 17 Member States of the three regional intergovernmental organizations (ECOWAS, UEMOA, and the Permanent Interstate Committee for Drought Control in the Sahel (CILSS)). In this regard, a cooperation agreement on the seed sector was signed in Ouagadougou, Burkina Faso, on June 4, 2018. The national agricultural research institute (Institut de l'Environnement et de Recherches Agricoles (INERA)), created in 1996, became instrumental in promoting the use of quality seeds in 2006. In 2016, INERA established three research and development programs on seed production, distribution, and marketing, with the aim of improving seed quality and supporting producers. The program also sought to integrate stakeholders in the seed sector, build their capacities, and develop high-quality seeds adapted to local conditions.

Ghana

Ghana's seed industry was established in 1958 under public control and transitioned to a privatized model in 1989, following the dissolution of the state-owned Ghana Seed Company (Vernooy et al. 2023). The private sector assumed commercial responsibilities, while the public sector retained regulatory and support functions. Initially governed by the Seeds (Certification and Standards) Regulations Decree of 1972, the sector underwent significant reforms, leading to the passage of the Plants and Fertilizer Act in 2010. Studies in 2008 highlighted the need for a national seed policy, resulting in the adoption of Ghana's National

Seed Policy in 2013 and the implementation of the National Seed Plan in 2015 to guide sectoral growth. Further regulatory advancements included the 2011 Biosafety Act, the 2016 ratification of ECOWAS seed regulations, and the 2020 passage of the Plant Variety Protection Bill, which collectively aim to foster a balanced, modern, and competitive seed industry. Ghana's seed industry can be described as still being in a growth phase, supported by various policies that aim to guide its development.

Mali

Mali's seed sector policy promotes the involvement of both formal and informal seed systems. The sector has undergone significant transformations since the country's independence, evolving from a state-controlled system to one increasingly dominated by private sector actors. Initially, seed production and certification were handled by the Institute of Rural Economy (IER) from 1960 and then by the Selected Seed Production Operation from 1977. This structure continued until 1991, when the National Seed Service (NSS) took over as the coordinating body for government seed activities. A major shift occurred in 1996, when seed production responsibilities were transferred to private companies and producer groups through Law No. 96-055. The 2003 Seed Sector Support Project (PAFISEM) further strengthened private sector involvement and promoted participatory research and informal seed systems, diversifying distribution methods and empowering small-scale producers.

Legal reforms, such as the Agricultural Orientation Law of 2006, encouraged private investment in certified seed production. The 2010 law on plant seeds formally acknowledged informal seed production and protected traditional varieties. The Agricultural Development Policy (2011-2020) and the National Investment Plan for the Agriculture Sector 2015 further guided strategic investments in priority agricultural value chains, reflecting strong political commitment to reform of the seed sector and agricultural development.

Nigeria

The seed sector in Nigeria has evolved since the 1960s. Initially run by the Federal Ministry of Agriculture, management of the sector later shifted to the National Seed Service (NSS), which managed seed programs and supplied foundation seeds to entities that produced certified seeds. In 2007, the National Agricultural Seed Council (NASC) was established as an Agency of the Federal Ministry of Agriculture and Rural Development under a new law, replacing the NSS and the 2004 Seeds Act. NASC currently oversees seed sector operations, ensuring collaboration between research institutes and public bodies to provide farmers with access to certified seeds. NASC oversees crop variety registration and seed standards through various committees, including the Crop Variety Registration and Release Committee, Seeds Standard Committee, Seed Industry and Skills Development Committee, and the Department of Training, Information, and Seed Extension. Under Decree No. 33 (1987), the National Crop Varieties and Livestock Breeds Registration and Release Committee and a registrar's office were established. NASC implements the National Agricultural Seed Decree, supporting variety development, registration, multiplication, seed quality promotion, and private sector engagement.

Under the National Seed Policy 2014, NASC is the key body responsible for implementing Nigeria's seed policy. It regulates the seed market to ensure competitiveness and quality, providing protections for both farmers and the environment. NASC supports public infrastructure and the services needed for an efficient seed supply system, encourages farmer adoption of improved crop varieties, and fosters investment in the seed sector. Additionally, it oversees the production and distribution of high-quality seeds for improved crop varieties, contributing to meeting the country's needs for food, feed, and fiber, as well as enhancing national agricultural productivity and boosting food and nutrition security.

Nigeria's seed sector has strong structures and policies to support growth, attract private investment, and foster the development of improved crop varieties. However, despite frameworks like the 1992 Agricultural Seed Decree and the National Seed Policy, implementation has been weak due to limited funding, institutional challenges, and insufficient human resources (Vernooy et al. 2023). Although NASC is central to the execution of seed policy, the organization lacks sufficient financial support to fully perform its regulatory duties, including preventing the sale of fake seeds.

Central Africa

Seed systems in Central African countries are generally less developed in comparison to those in other regions. Persistent political instability has also undermined their development. National agricultural research agencies like Institut Centrafricain de Recherches Agronomiques (ICRA) are working to

rebuild capacity within the region with the support of international organizations. The region's seed system is currently dominated by NGOs and government institutions, while importation is the key source of seeds. The Regional Cooperation of the Economic Monetary Community of Central Africa (CEMAC) has developed a regional seed catalogue to facilitate information sharing and improve access to quality seeds among member countries.

Overall, countries in the different regions of Sub-Saharan Africa have their own unique features in terms of the level of development of their seed systems. These are shaped by existing country-specific policies and regulations. Harmonizing seed-related policies and regulations at the regional level can help countries benefit from seed technologies developed in neighboring countries, thereby preventing redundant investments in varietal development and seed multiplication. Technological advancements in the digital era also support the harmonization process and movement of seeds across countries in common markets.

Conclusions

Focusing on the context of countries in Sub-Saharan Africa, this chapter has assessed seed policies and regulatory frameworks, exploring the potential (dis) incentives these policies create. It analyzes the mechanisms through which these incentives operate and their possible impacts on smallholder farmers, seed enterprises, agricultural development, as well as the broader economy. Additionally, the chapter highlighted the necessary and sufficient coordination mechanisms required to establish functional seed systems that effectively serve diverse farming systems and different groups of farmers (Westengen et al. 2023).

The effects of development policies related to seed systems are not always straightforward. Policies that favor market liberalization and private sector development could impose various trade-offs, as marginalized farmers may be locked out of the system. Further, existing seed supply channels serving these communities may be unable to compete with national or multinational private seed companies targeting more commercialized, highly networked, and concentrated seed markets.

Seed development and deployment by the private sector often targets markets where higher profit margins are achievable. However, this approach tends to overlook marginalized social groups who have limited market access and live in remote geographic areas. In this context, the role of public research and seed marketing systems is crucial in creating an inclusive system capable of serving areas that the private sector may neglect. Another option is a hybrid seed system where the public sector uses lead farmers and/or community-based seed production and management to enhance access to improved and quality seeds among marginalized social groups.

Another promising area for the improvement of seed systems in Sub-Saharan African countries is the use of emerging technologies like digital platforms and blockchains for seed traceability. Digital platforms can significantly improve information dissemination about the supply of and demand for improved varieties and quality seeds, thereby facilitating more efficient seed marketing systems and reducing the incidence of seed carryover (Nayak et al. 2021). A blockchain approach would help in the monitoring of seed quality along the supply chain, ensure seed traceability during transactions, and reduce the circulation of counterfeit seeds (Shao and Marwa 2024; Ahuja et al. 2024).

Instituting innovative policy and regulatory frameworks is a key first step for the development of seed systems that would support the transformation of agrifood systems in Sub-Saharan Africa through improved seed technologies. Effective implementation of policies and regulations targeting improved seed production, quality, and marketing, as well as enhancing farmers' access to quality seeds at affordable prices, is also critical. This can be accomplished by strengthening public, private, and producer partnerships at both local and regional levels. In some cases, inter-country seed enterprises would need harmonized policy and regulatory frameworks to ensure the protection of intellectual property and boost inter-country trade in quality seeds.

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