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Laws and regulations enabling and restricting Africa's vegetable seed sector

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ABSTRACT

Farmers in sub-Saharan Africa do not have much choice of quality seed of vegetable cultivars adapted to local growing conditions and consumer demand. Only a handful of vegetable seed companies invest in local breeding research, while nearly all rely on seed imports. Our objective was to analyse to what extent existing seed laws and regulations enable or restrict the development of a research-based vegetable seed sector in Africa. Using a regulatory value chain approach, we analysed written laws and regulations for 13 countries and interviewed private and public sector stakeholders. We generally find that countries have taken a government-centred approach to seed quality control without recognizing that government agencies have little capacity to do this properly for vegetable crops. Mandatory Value for Cultivation and Use (VCU) trials and state-controlled seed certification are the two examples of regulatory approaches that may work for cereals but are not well suited for vegetables. No country has vegetable breeding as a goal in their national seed policy, and only four set out specific objectives for the vegetable seed sector. Tailoring seed policies, laws and regulations more specifically to vegetables could stimulate local variety development and seed production and benefit smallholder farmers and consumers at large.

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Seed system; seed policy; seed regulation; seed certification; regional harmonization; plant variety; private sector; plant variety protection; plant breeding

1. Introduction

Sub-Saharan Africa accounts for the lowest per capita production and consumption of vegetables in the world (Frank et al., 2019; Kalmpourtzidou et al., 2020; Willett et al., 2019). Increased vegetable production can create job opportunities and income for smallholder farmers and other actors along the value chain, while increased vegetable consumption can contribute to preventing micronutrient deficiencies and overweight/obesity (Schreinemachers et al., 2018). Quality seed is an important input to successful vegetable production, alongside access to irrigation, the use of good agricultural and postharvest practices, and access to well-functioning markets. Quality seed refers to seed with high germination and vigour of

crop varieties with good performance under local agroecological conditions and farming practices. Unfortunately, smallholder farmers in sub-Saharan Africa have limited access to affordable sources of quality vegetable seed and restricted choice in terms of species and varieties (Afari-Sefa et al., 2012; Ayana et al., 2014; Pincus et al., 2018; Schreinemachers et al., 2021).

Farmers in Africa tend to purchase much of their vegetable seed, especially of exotic vegetables such as tomato, pepper, carrot, cabbage, and onion produced for the market (e.g. Daniel & Adetumbi, 2004 for Nigeria). Seed of traditional African vegetables, on the other hand, is more likely to be saved on-farm (Ayenan et al., 2021; Pincus et al., 2018), unless

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there is a reliable seed source such as for amaranth and African eggplant seed in Kenya and Tanzania (Ochieng et al., 2019; Schreinemachers et al., 2017). Vegetable seed of exotic vegetables is either imported from outside the continent or comes from a narrow range of open-pollinated varieties imported long ago or sourced from the public sector. Imported vegetable seed of F1 hybrids is nowadays widely available, but expensive and does not always perform well under local farm conditions (Croft et al., 2018; Dembélé et al., 2021).

As a result, Africa's vegetable seed sector is not well developed. There are many vegetable seed companies and seed producing cooperatives, but nearly all of these have developed their business around seed imports and seed trade or the multiplication of publicly available varieties (Afari-Sefa et al., 2012; Schreinemachers et al., 2021). Even multinational seed companies active in the African market rely on seed imports of varieties they have developed for other locations. Yet, smallholder farmers in Africa would be better served if seed companies offered a diversity of vegetable varieties that performed well under local farm conditions, including resistance to prevailing plant diseases, and matched local consumer preferences. For instance, bacterial wilt (*Ralstonia solanacearum*) is of the main plant diseases of tomato, pepper, and other solanaceous crop species, but strains found in Africa are different from those found in Asia, Europe, and North America, and resistance sources, therefore, do not hold up (Prior & Fegan,

2005; Sikirou et al., 2017). Accomplishing this requires more vegetable breeding research by private seed companies in Africa, supported by public sector national and international research organizations.

A key constraint to developing a research-based vegetable seed sector in Africa relates to the enabling environment of laws and regulations that govern breeding research and the production and marketing of seed (Kuhlmann et al., 2021). It has been observed that seed laws and regulations in Africa and elsewhere were written with cereal crops in mind and introduced a regulatory system that gave government authorities much control over variety release and seed production to ensure seed quality and protect farmers (FAO, 2020; Kuhlmann, 2017; Schreinemachers et al., 2021; Sperling et al., 2020). The same regulatory system was applied to all crops without considering that there was little to no capacity in the public system to properly implement this for crops other than cereals. Whereas high-income countries generally made regulatory exemptions for vegetables, many lower-income countries did not do this.

Against this background, the objective of this study is to gain an understanding of how the development of locally adapted vegetable varieties in sub-Saharan Africa is enabled or constrained by existing seed laws and regulations. This is done through a systematic comparison of seed laws and regulations across sub-Saharan Africa. The study also looks at implementation and enforcement as these may be quite different from the written laws and regulations. The comparison aims to identify good practices, but it also sheds light on problematic practices. The findings of the study could help governments in sub-Saharan Africa devise regulatory systems at the national and regional levels that will enable and stimulate research in vegetable varieties adapted to local growing conditions and local consumer demand, as such varieties help farmers earn better and more stable incomes and lead consumers to healthier eating habits.



Figure 1. Focus countries of the study.

2. Materials and methods

2.1. Scope of the study

We selected countries with an existing or emerging vegetable seed sector that also play a leading role in regional seed trade harmonization. We included four countries from East Africa: Ethiopia, Kenya, Tanzania, and Uganda; three from Southern Africa: Malawi,

Zambia, and Zimbabwe; and six from West Africa: Benin, Ghana, Mali, Nigeria, Senegal, and Burkina Faso (Figure 1). These 13 focus countries import substantial quantities of vegetable seed. UN Comtrade data for 2018 show vegetable seed imports of 2.4 million tons with a traded value of US\$ 63.8 million (UN Comtrade, 2021). The main exporters to our focus countries include France, China, United States, the Netherlands, and South Africa.

The study focuses primarily on the formal seed sector and particularly on the role of private seed companies in supplying vegetable seed to farmers. This focus is justified, because for vegetable crops, public institutions have little to no capacity in seed production and marketing, even in Asia, Europe, and North America (FAO, 2020), and the informal sector is not heavily involved in vegetable seed systems. However, it needs to be recognized that seed companies may not produce seed of all types of vegetables and there will always be a role for the informal seed sector, or farmer-managed seed systems, to supply seed of particular species and varieties (Almekinders & Louwaars, 2002). The informal sector, which is largely made up of farmers saving and exchanging their own seed, also plays an important role in the conservation of vegetable genetic resources, as very little of Africa's rich vegetable biodiversity is stored ex-situ in gene banks (van Zonneveld et al., 2021).

2.2. Conceptual framework

Figure 2 shows the conceptual framework used by the study, which is based on earlier work (Kuhlmann & Dey, 2021). The central element is the seed regulatory value chain from research and development, to seed production, to seed trade and sales to farmers. Our review focuses on the design and implementation of legal and regulatory systems at each stage of the vegetable seed value chain. The analysis tried to understand whether 'regulatory flexibility' exists across policy, legal, and regulatory instruments with regard to vegetable seed (Kuhlmann & Dey, 2021); that is, whether a country's system recognizes the unique properties of vegetable crops and has tailored the legal and regulatory system accordingly (Kuhlmann et al., 2021). For example, some of the testing common for grain crops, particularly VCU, is not well suited to vegetable crops, due to their unique properties. In addition, if a legal requirement related to the importation of vegetable seed was more relaxed than the variety registration and release process

imposed on locally produced seed, it was important to understand whether this discouraged companies from investing in the local vegetable seed production and encouraged imports instead.

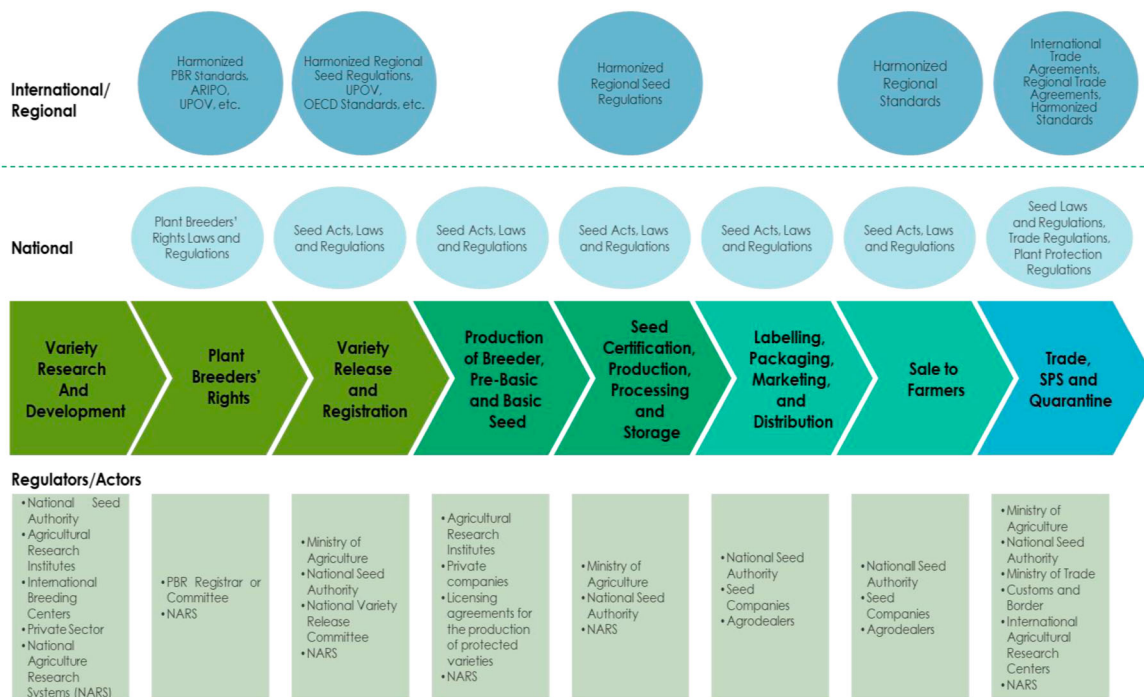
2.3. Data collection and analysis

Data for this study come from a structured document review of primary and secondary sources relating to the key issue areas, assessed using comparative methods. It was also informed by semi-structured interviews with stakeholders in the private and public sectors across 13 countries (Table 1).¹

Primary data sources included texts of policies, laws, and regulations applicable to the vegetable seed sector in the focus countries, as well as relevant regional and international legal texts. Secondary data sources included a wide assortment of documentary sources on seed systems, the enabling environment, and related issues, which helped to contextualize the primary sources within the vegetable seed system in the focus countries.

Stakeholder consultations were conducted using questionnaires tailored to the type of stakeholder (private companies, seed associations, and public sector actors) to capture their experiences working in the vegetable seed sector. Interviews were held virtually. Participants were informed about the purpose of the study, that their answers would be kept confidential, and that they could stop the interview at any time. All participants were asked for their explicit consent to participate.

Consultations were held with 12 private companies (4 local and 8 global) engaged in various activities in the vegetable seed system across the focus countries that have firsthand experience with elements of the enabling environment related to different value chain activities. Key stakeholders from the public sector included regulatory bodies, including three national seed authorities, five national agricultural research organizations, one parastatal seed company, three vegetable seed breeders, and technical and legal experts. Consultations were also conducted with key personnel from various seed trade associations such as the African Seed Trade Association, the Seed Trade Association of Kenya, the Seed Trade Association of Malawi, and others; these associations are comprised of representatives from both the public and private sectors. In Ethiopia, Kenya, Malawi, and Nigeria, legal and regulatory reforms are underway that will likely have relevance to vegetable seed, and these were



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Figure 2. Conceptual framework guiding the study (seed regulatory value chain). Source: Kuhlmann and Dey (2021), adapted from NML 2019 and NML and SAGCOT 2016.

assessed alongside existing policy, legal, and regulatory systems. Data were analysed for key elements of the seed regulatory value chain as guided by the conceptual framework. The analysis is largely descriptive, in that it compares elements across the 13 focus countries. Qualitative data were used to illustrate certain aspects by means of examples.

Table 1. Stakeholders consulted for the study.

Country	Private companies	Public actors	Seed associations	Research institutions
Benin	1	–	–	1
Burkina Faso	–	–	–	–
Ethiopia	–	–	1	1
Ghana	–	–	1	–
Kenya	1	1	1	–
Malawi	–	1	–	1
Mali	1	–	1	1
Nigeria	2	1	–	1
Senegal	–	–	–	1
Tanzania	1	–	–	–
Uganda	–	–	–	–
Zambia	2	–	–	–
Regional	–	–	1	–
Global	4	–	–	–

3. Results

3.1. Status of vegetable breeding in the focus countries

Public agricultural research organizations from all focus countries except Uganda and Malawi are engaged in the breeding of vegetable varieties. The public sector breeding programmes target both traditional and exotic vegetables but usually include only a few selected crops. Respondents from the public sector generally expressed that their vegetable programmes lacked funding support.

There are some public-private partnerships with a significant presence in the vegetable sector. For example, Zamseed is a joint venture between the Government of Zambia and several private entities and has a relatively advanced breeding programme producing hybrids and open-pollinated varieties of okra, pumpkin, and squash, among others. Kenya Seed Company (trading under the brand name Simlaw Seeds) is a parastatal seed company in Kenya with eight vegetable breeding programmes and sells varieties coming from their own programme

or developed in partnership with international research organizations like World Vegetable Center. The state-owned Ethiopian Agricultural Business Corporation does green pea and pepper breeding.

Local private companies are also engaged in vegetable breeding in sub-Saharan Africa, including Agri-Commercial Services Limited in Ghana, Premier Seed Nigeria Limited, Farm Inputs Care Centre Limited (FICA Seed) in Uganda, Société de Production de Semences Améliorées in Mali, and Nankosem in Burkina Faso. Among the multinational companies, East-West Seed and Rijk Zwaan have research stations in Benin and Tanzania and do selection trials to introduce new varieties. They also have a joint venture, Afrisem, that breeds a few crops such as African eggplant and amaranth. Nova Genetic (part of the Novaliance group that also includes Technisem) has various research stations mainly in West and Central Africa and does research – mostly variety selection in Africa – on exotic vegetables and African vegetables such as African eggplant, okra, and amaranth. Syngenta AF also has a presence in vegetable breeding in the focus countries; however, most of the company's breeding locations in these countries are used for trials, and varieties have not yet been released into the market.

Table 2. High-level findings from legal and regulatory review showing 'regulatory flexibility' in policy instruments.

Country	National seed policy has specific objectives for vegetable seed	National seed laws have specific rules/ flexibilities for vegetable seed	Regulations have specific guidelines for vegetable seed
Benin	N/A	✓	X
Burkina Faso	X	X	X
Ethiopia	X	✓*	X
Ghana	X	X	X
Kenya	X	✓•	N/A
Malawi	✓	X	✓•*
Mali	X	✓•	N/A
Nigeria	✓	✓• [†]	✓•
Senegal	X	X	N/A
Tanzania	X	✓• [†]	✓•
Uganda	✓	X	✓•
Zambia	✓	✓	N/A
Zimbabwe	X	✓• [†]	N/A

Notes: •Rule or flexibilities exist in the testing procedures for variety release and registration. [†]Flexibilities exist in field and lab testing standards for specific vegetable species. *Laws are currently under consideration and have not been implemented. N/A: Information not available. X No specific rules or guidelines for vegetable seed.

3.2. Specific treatment of vegetables in policies, laws, and regulations

Of the 13 countries studied, only Malawi, Nigeria, Uganda, and Zambia have set out specific objectives for the vegetable seed sector in their national seed policies, yet none has incorporated vegetable breeding in its policy goals (Table 2). This indicates a general lack of strategy for developing the vegetable seed sector.

The national seed laws of seven countries contain specific provisions regarding vegetable seed, with Ethiopia potentially added as an eight country once its draft seed proclamation is enacted. Furthermore, seed regulations of four countries specified different treatment of vegetable seed, while four countries did not. Based on our review, it is not apparent that the remaining focus countries have differentiated treatment of vegetable seed in legal and regulatory instruments.

3.3. Regional regulatory frameworks

Regional integration has been a major focus of Africa's development agenda for a number of years. Among the focus countries, Ghana, Benin, Senegal, Nigeria, Burkina Faso, and Mali are members of the Economic Community of West African States (ECOWAS); Zimbabwe, Malawi, Zambia, Kenya, Uganda and Ethiopia are members of the Common Market for Eastern and Southern Africa (COMESA); Zimbabwe, Malawi, Zambia, and Tanzania are members of the Southern African Development Community (SADC); and Kenya, Uganda, and Tanzania are part of the East African Community (EAC). ECOWAS, COMESA and SADC have harmonized seed regulations, while the EAC has developed a Seed and Plant Varieties Bill in 2019 that is currently in draft form awaiting approval by the EAC Council of Ministers.

Harmonization of seed regulation within these regional economic communities can help streamline seed trade while reducing time and cost associated with repeated testing and regulatory checks (Keyser, 2013). While regional trade in vegetable seed is currently not significant, as most seed is imported from outside of Africa, it may become more important as the seed sector develops.

The COMESA Plant Variety Catalogue contained 51 varieties of four crop species as of April 2023 but did not contain any vegetables (COMESA, 2023). Similarly, the SADC Variety Catalogue contained 96 crop

varieties of 8 species as of April 2023, but it also does not contain vegetables (SADC Seed Centre, 2023). Neither COMESA nor SADC has developed standards for vegetables. There is, therefore, no harmonization of vegetable seed trade in these regional economic communities.

The notable exception is the ECOWAS seed system, which included 20 crops as of December 2021, including few vegetables: onion, tomato, okra, and local eggplant. The ECOWAS Procedure Manual prescribes that a crop variety may only be released regionally after successful release in one ECOWAS country and submission of test results for Distinctness, Uniformity, and Stability (DUS), which may then result in its registration in the West African Catalogue of Plant Species and Varieties. Although VCU testing is also required at the national level, onion and tomato (the two vegetables in the ECOWAS Procedure Manual) are exempt from VCU trials and only subject to DUS testing, which should be done in one location over two growing cycles (ECOWAS, 2007).

Table 3. Status of PVP laws in the focus countries and membership in international organizations protecting plant breeder's rights.

Country	National Law	ARIPO	OAPI	UPOV
Benin	None (PVP law being developed)	No	Yes	No*
Burkina Faso	Law No. 010-2006	No	Yes	No*
Ethiopia	PBR Proclamation No.1068 of 2017 and PBR Directive No. 769 of 2021 (regulations being developed)	No	No	No
Ghana	Plant Breeders Bill, 2013 (PVP law at an advanced stage in legislative process)	Yes	No	Yes
Kenya	Seed and Plant Varieties Act, 2012	Yes	No	Yes
Malawi	Plant Breeder's Right Act, 2018 (regulations being developed)	Yes	No	No
Mali	Law No. 10-032-12 July 2010	No	Yes	No*
Nigeria	Plant Variety Protection Bill, 2021 (regulations being developed)	No	No	No
Senegal	None	No	Yes	No*
Tanzania	Plant Breeder's Rights Act, 2012	Yes	No	Yes
Uganda	PVP Act, 2014 (regulations being developed)	Yes	No	No
Zambia	Plant Breeder Right Act No 18 of 2007	Yes	No	No
Zimbabwe	Plant Breeders' Rights Act of 1976 (revised in 2001)	Yes	No	No

Notes: ARIPO = African Regional Intellectual Property Organization; OAPI = African Intellectual Property Organization; UPOV = International Union for the Protection of New Varieties of Plants. *Benin, Burkina Faso, Mali and Senegal are indirectly part of the UPOV through OAPI.

Another noteworthy aspect of the ECOWAS Procedure Manual is that, while it is based on the seed classes of the Organisation for Economic Co-operation and Development (OECD) Seed Schemes – parental material, pre-basic seed, basic seed, and certified seed (OECD, 2020) – it did not adopt the OECD class of 'standard seed' for vegetables, where the producer has primary responsibility for quality control. Hence, the ECOWAS Procedure Manual does not exempt vegetables from mandatory seed certification and makes no provision for alternatives to certification such as truth-in-labelling and group quality assurance schemes (ECOWAS, 2008), which are more flexible quality assurance schemes, effectively making the ECOWAS standard stricter than international standards. We will revisit these alternatives in Section 3.7.

3.4. Plant variety protection

Intellectual property rights (IPR) for seed are often an important consideration for breeders and are commonly established through plant breeder's rights (PBR) and granted through plant variety protection (PVP) laws that allow the breeder to claim protection over developed varieties. To do so, a breeder must usually establish novelty of a plant variety along with DUS. Once conferred, PBR cover rights and obligations in relation to breeding, registration, commercialization, and marketing of plant varieties, usually for a period of 15–20 years (FAO, 2018). A breeder can license a protected variety, but a variety can be licensed regardless of it is protected under PBR (although PBR does provide the licensor with additional protection).

The framework for PVP relies heavily upon international and regional agreements. At the international level this includes the World Trade Organization (WTO) Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS Agreement), which calls for patent protection or *sui generis*² protection of plant varieties, or both. The International Union for the Protection of New Varieties of Plants (UPOV) has two Acts (1978 and 1991) that establish a *sui generis* system of PBR protection adapted to the needs of plant breeders. UPOV membership signals adherence to this system, even though national legislation and regulations are needed. Members of UPOV can adhere to either act, which differ in terms of the scope of PBR conferred and the right of farmers to use farm saved seed, or farmers' privilege.³

In West Africa, PVP is the mandate of the African Intellectual Property Organization (OAPI), and in Eastern and Southern Africa a number of countries are party to the African Regional Intellectual Property Organization (ARIPO). The PVP frameworks of both OAPI and ARIPO are based on the *sui generis* framework called for under the TRIPS Agreement, although OAPI and ARIPO operate somewhat differently. OAPI also joined UPOV in 2014, so by default its 17 member states (including focus countries Benin, Burkina Faso, Mali, and Senegal) are also part of UPOV. The Arusha Protocol for the Protection of New Varieties of Plants under ARIPO that was adopted in 2015 confers PBR on a breeder for the production, multiplication, sale, export, and licensing of the protected variety for a minimum of twenty years. Table 3 summarizes the focus countries' membership in these international organizations, along with the status of PVP Laws in the focus countries.

In East Africa, Tanzania has a relatively well established legal and institutional structure for PBR, as does Kenya, although in the latter the system is reportedly not strictly enforced for vegetables. In both countries, once a vegetable variety has been released it effectively becomes public domain material, which discourages the development of vegetable varieties; although, generally, the breeder can file an application for PBR within a year of release of variety. Ethiopia has also adopted a comprehensive domestic PVP law (based on UPOV 1991), but regulations are not yet in place, and regulations are also needed to implement the PVP act in Uganda. Ethiopia's system is also notable in its flexible approach to balance PBR and farmer's rights, and it provides exemptions on enforcement of PBR, including an exemption for communities to grow and use farm-saved seed while they cannot sell seed of the protected variety. In Uganda, the PVP Act preserves the protection of farmer's privilege to use farm-saved seed, but does not include protection of indigenous varieties.

3.5. Variety registration and testing requirements

All countries in the study require that locally developed crop varieties be registered and released in the national variety catalogue prior to commercialization. At the time of this study, national seed catalogues showed 95 vegetable varieties released in Ethiopia, 23 in Mali, 34 in Nigeria, and 24 in Senegal.

Most other focus countries have released fewer than 20 vegetable varieties, with only 2 in Ghana and none in Malawi and Uganda. Most registered varieties are exotic vegetables such as tomato, pepper, onion while there are much fewer varieties of traditional vegetables. Consistent and reliable access to a country's national seed catalogue is an ongoing challenge as stressed by respondents in Kenya, Zambia, and Zimbabwe. Many catalogs are also not updated regularly, and online publication is rare. This raises important questions about how existing laws can be enforced. A few focus countries, however, such as Kenya, Ethiopia, Ghana and Uganda, have recently released updated national seed catalogs, which can be accessed online.

In Ghana, respondents explained that only public organizations such as the Crop Research Institute of the Council for Scientific and Industrial Research (CSIR) can register a new crop variety in the national variety catalogue. This restriction is applied in practice and is not formally included in a legal or regulatory instrument (Kuhlmann & Zhou, 2015). The condition to register crop varieties only through public organizations could deter the private sector from engaging in breeding research, as they may not be able to receive all the benefits from their investment. In Ethiopia, public research institutions are also heavily involved in the variety registration process; however, no similar requirement was observed in any other focus country.

Registering a new crop variety requires testing to determine whether it is distinct from any other variety whose existence is of common knowledge and that it performs in a way that is sufficiently uniform and stable, which is assessed under a DUS test (UPOV, 2002). Variety registration also often hinges upon VCU tests or national performance trials through a trial system with standard protocols for assessment of key agronomic and quality attributes. Hence, a new variety must be shown to be superior in some way when compared to those already in use.

Field crops are usually subject to both DUS and VCU testing in sub-Saharan Africa. However, whereas high yields and wide adaptation are key criteria for variety evaluation of field crops, quality attributes for vegetables are completely different, highly subjective (e.g. taste, shape, colour, texture, shelf-life), and not easily measured in a conventional field trial. Further, vegetable varieties may require specific climatic conditions that are very different from those

found in trial sites (FAO, 2018, 2020; Schreinemachers et al., 2021). For these reasons, vegetable crops are not normally subject to VCU testing, at least not when following international good practices.

Table 4 compares DUS and VCU testing requirements for vegetables in the focus countries. Overall, the countries display a fair amount of heterogeneity and unpredictability in testing requirements. While all countries legally require DUS testing, 9 of the 13 countries additionally require VCU trials for vegetables, the exceptions being Kenya and Tanzania in East Africa and Mali and Senegal in West Africa, the latter two reportedly follow the ECOWAS Procedure Manual which, as noted before, exempts vegetables from VCU trials.

It is noteworthy that Benin, Burkina Faso, Ghana, and Nigeria, which are also ECOWAS members, nevertheless mandate VCU testing for vegetables. Respondents in Benin explained that regulatory changes are underway that would exempt tomato and onion from VCU testing in their country. It is also notable that stakeholders interviewed in Senegal were not aware that vegetables are legally exempt from VCU testing in their country and confirmed that VCU testing is applied for all vegetable varieties in practice. This shows that national guidelines in most West African countries are not aligned with the ECOWAS regulations. Similar issues were observed in East Africa. In Kenya and Tanzania, while the rules carve out vegetable crops from VCU testing requirements, stakeholders stated that, in practice, the national seed authorities do not provide differential treatment to vegetable varieties and subject them to VCU testing. In Tanzania, the rules were recently changed to incorporate this flexibility,⁴ but respondents were unaware of this change.

Regulatory changes are underway that could change some of this in the future. For instance, Kenya is developing a new regulation on vegetable crops, which would provide differential treatment for vegetable varieties based on nutrition, storage, shelf life, and ability to perform under low rainfall, as these are factors that are more specific to vegetable seed. Ethiopia is also overhauling its legal and regulatory system for seed, and stakeholder consultations indicated that it is possible that the new seed rules may require only DUS testing for vegetables, but language to this effect does not appear in the most recent Draft Seed Proclamation.

The process of release and registration of vegetable varieties takes an average of 2–3 years (or

longer) in the focus countries. Here, institutional and regulatory structures play a central role. The composition of the national variety release committees (NVRCs) and technical sub-committees, their financial and institutional capacity, and the representation of private and public stakeholders in these committees are key factors in how well variety registration and release processes work in practice. In Ethiopia, for example, the 2020 Seed Policy also calls for greater representation of women on the NVRC, which, when implemented, could have implications for vegetables, given the prevalence of women in the sector (Kuhlmann, 2017; Kuhlmann et al., 2022).

Budgetary and capacity issues are also paramount. For example, in Ethiopia and Nigeria, it is reported that, due to capacity constraints and limited funding, the NVRCs have not been able to meet the number of times mandated under law. In such cases, the NVRCs may cancel meetings or ask donors, research organizations, or seed companies to cover the costs of testing procedures. In Kenya, applicants can request ad hoc NVRC committee meetings if they cover the meeting expenses. This is also practiced in Tanzania and is under discussion in Nigeria. In some of the focus countries, one or more technical sub-committees advise the NVRC on technical aspects of the variety testing procedures. It was observed that these sub-committees do often not include experts in vegetable crops, which could hinder the release of vegetable varieties.

3.6. Early generation seed production

Burkina Faso, Mali, and Tanzania mandate that foundation (or basic)⁵ seed (that is, seed used for multiplication to produce commercial seed) of varieties coming from the public sector is to be exclusively supplied by national seed agencies or other public sector organizations. Such requirements are unusual in light of international best practices, as seed companies would normally produce foundation seed of all vegetable varieties in their portfolio, while governments would hold them accountable for the quality of the commercial seed.

3.7. Seed quality assurance

Ensuring the quality of seed supplied in the market is an important aspect of mature seed systems. There are several options available to governments to promote seed quality, ranging from government-

Table 4. Testing requirements for vegetable varieties under seed laws in the focus countries.

Country	DUS legally required?	Minimum requirement of DUS testing	VCU legally required?	Minimum requirement for VCU testing	VCU required in practice?
Benin	Yes	2 seasons in 1 site	Yes	2 seasons in 3 sites	Yes
Burkina Faso	Yes	2 seasons in 1 site	Yes	2 seasons in 2 sites	Yes
Ethiopia	Yes	2 seasons in 3 sites	Yes	2 seasons in 3 sites	Yes
Ghana	Yes	2 seasons on-station 2 seasons on-farm	Yes	2 seasons on-station 2 seasons on-farm	Yes
Kenya	Yes	2 seasons or cropping cycles	No	–	Yes
Malawi	Yes	3 seasons or cropping cycles	Yes	3 seasons or cropping cycles	Yes
Mali	Yes	Varies per crop	No	–	No
Nigeria	Yes	2 years on-station	Yes	2 years in 10 sites on-station; 1 year in 10 sites on-farm	Yes
Senegal	Yes	Varies per crop	No	–	Yes
Tanzania	Yes	2 seasons in 3 sites	No	–	Yes
Uganda	Yes	2 seasons	Yes	2 seasons	Yes
Zambia	Yes	2 seasons	Yes	2 seasons in 2 sites	Yes
Zimbabwe	Yes	1 season in 1 site	Yes	2 seasons in 5 sites	Yes

Notes: In Ethiopia, only 1 season is required for DUS and VCU testing if the variety has been released in another country. In Kenya, DUS testing is required for 2 seasons if rainfed and 2 cropping cycles if irrigated. Sources: Review of legal documents; interviews with public and private sector stakeholders; SFA and NML (2019a); SFA and NML (2019b); SFA and NML (2019c); Kuhlmann and Zhou (2015); and Kuhlmann et al. (2019).

driven mandatory seed certification to more market-driven mechanisms. The latter category encompasses quality assurance schemes including truth-in-labelling, self-certification, group quality assurance, quality-declared seed, and other approaches (Kuhlmann & Dey, 2021).

Formal seed certification is the default in sub-Saharan Africa and is carried out under the aegis of a centralized government body that acts as the certifying authority responsible for ensuring seed quality. Table 5 shows that 4 of the 13 focus countries mandate certification of vegetable seed while Benin plans to introduce this – probably to harmonize their system with the ECOWAS Procedure Manual. In Nigeria, seed certification is mandatory for the formal seed sector, but not for registered vegetable varieties produced in the informal sector, which are only subject to minimum standards that have yet to be defined. Ethiopia is in the process of reforming its seed laws based on its new 2020 Seed Policy, and the government is proposing to introduce alternate seed quality assurance mechanisms such as self-quality assurance schemes, as well as greater private sector involvement in other quality assurance schemes (Kuhlmann et al., 2022). This will also introduce flexibilities for certification of vegetable seed. Zimbabwe and Kenya are examples of countries that exempt vegetable seed from mandatory certification, although stakeholders in Kenya reported that seed

authorities continue to insist on certification in practice.

Among the main bottlenecks to the certification of vegetable seed are considerable capacity constraints in the certification process. Inadequate public inspectors, lack of transport and logistical support, limited laboratory facilities, and knowledge gaps among personnel are all major constraints. A study for Mali described that vegetable seed production is subjected to mandatory seed certification and formally requires 4–5 field visits by government inspectors at different stages of seed production, but in practice inspectors are only able to make a single visit (Dembélé et al., 2021). Inadequate laboratory facilities also contribute to the fact that vegetable seed is usually given a low priority. The certification process is generally costly in the focus countries and is often subject to considerable delays, especially in the case of vegetable seed. In Kenya and Tanzania, it was noted that the cost of seed certification is much higher for vegetables than for other crops.

As mentioned above, the OECD Seed Schemes recognize a ‘standard seed’ class for vegetable seed. This can be an important regulatory flexibility, as such seed is declared by the supplier as true to a particular variety and of sufficient purity (Kuhlmann & Dey, 2021). Benin, Ethiopia, Kenya, Malawi, Mali, Uganda and Zimbabwe do provide for ‘standard seed’ in their legal frameworks. This allows for

Table 5. Legal requirement and regulatory flexibilities in the certification of vegetable seed in the focus countries.

Country	Mandatory certification for vegetable seed	Specific guidelines/regulation for vegetable seed certification	Quality declared seed (QDS) mechanism	Other alternatives to formal certification ¹	Private sector involvement in seed testing and inspection	ISTA accredited seed laboratories	Standard seed class
Benin	(√)	(√)					√
Burkina Faso		√*					
Ethiopia			(√)	(√)			√
Ghana			√*		√*		
Kenya					√	√	√
Malawi	√	√				√	√
Mali	√	√*					√
Nigeria	√ [†]				√		
Senegal	√					√	
Tanzania		√	√			√	
Uganda			√		√	√	√
Zambia			√		√	√	
Zimbabwe					√	√	√

Notes: = Yes; (√) = not yet in place but set out in proposed amendment. * = Provided for in the relevant legislation/policy although its working in practice is unclear. [†]Qualified by exceptions. ¹Includes self-certification and group quality assurance schemes. Source: based on an analysis of country regulations.

alternatives to centralized certification, such as setting minimum standards for vegetable seed in terms of purity and quality and then subjecting seed producers to random inspections by governmental authorities (FAO, 2015), which is, for instance, the case in Zimbabwe (Mujaju, 2010).

Another regulatory flexibility is the use of quality declared seed (QDS). Ethiopia, Ghana, Tanzania, Uganda, and Zambia have legal provisions for QDS. QDS was neither intended to supplant formal certification nor act as a substitute, but it provides an accessible option for quality assurance to seed producers who are unable to competitively use formal certification. Under QDS, producers have primary responsibility for ensuring the quality of their stock, with the government maintaining limited monitoring (FAO, 2015). It could be suitable for the focus countries where the informal sector (or farmer-managed seed system) is prevalent, where the certifying agency has low capacity, and where there is a lack of vegetable seed-specific regulations in the formal certification system. While QDS standards have been developed for vegetable seed (FAO, 2006), the approach has been mainly intended for staple crop seed, and respondents observed only limited use of QDS by smallholder vegetable farmers.

To our knowledge, more flexible arrangements such as truth-in-labelling – used, for instance, in South Africa, the United States, and India – are not currently used in the focus countries. Under a truth-in-labelling regime, producers are not subject to

government-mandated certification and are required only to ensure that standards are followed and that the label accurately lists quality and ingredient information of the contents of the package (FAO, 2015). Farmers can then choose the right products for their needs based on the descriptions provided by the producers, with government involvement mainly in oversight and enforcement. If the quality differs from what is specified on the label, legal redress is available, and the government can take action. This envisages governmental involvement in seed quality monitoring, drawing upon legal frameworks for enforcement, dispute settlement, and other mechanisms. The effectiveness of the approach depends, however, upon a high degree of sophistication on the part of regulators, seed producers, and farmers. Regulatory changes underway in Ethiopia will also provide for self-certification and authorized private or cooperative seed quality assurance.

Many of the focus countries aim for a high level of government control in seed quality assurance, but, at the same time, lack the institutional capacity to carry out such functions effectively. In some countries, such as Burkina Faso, Benin, Malawi, Mali, and Senegal, only the designated national certification authority can offer inspection and testing services. This becomes a major challenge for timely certification, given the inadequate institutional capacity of these certifying authorities. There is scope for involvement of the private sector in the certification process, in particular through private laboratory testing and inspection

services, which can strengthen systems and supplement government capacity. Kenya, Nigeria, Zimbabwe, Zambia, Uganda, and Ghana do permit the private sector to provide these services under the supervision of the central certifying body, and this change is included in Ethiopia's Draft Seed Proclamation. This is a notable good practice, allowing for faster and more efficient seed certification, and, in some cases, like Zimbabwe, there are more private inspectors than government inspectors (Zhou & Kuhlmann, 2015). In other cases such as Ghana, however, while the private sector is allowed to provide testing and inspection services, in practice the public sector continues to be the only (or dominant) source of testing and inspections (Kuhlmann & Zhou, 2015).

3.8. Regulations regarding seed import and export

It is important to keep in mind that variety testing, registration and seed certification are applied to locally produced seed and not usually to seed imports. Ethiopia and Nigeria are the only countries that require registration, including DUS and VCU testing, of varieties of which the seed is imported, although Nigeria only requires this for seed coming from outside of ECOWAS. For all other countries, an import permit and phytosanitary certificate are usually the only requirements for imported seed.

Most of the focus countries are members of the International Plant Protection Convention (IPPC), resulting in some similarity in the requirements for border phytosanitary control and common formats for the issue of certificates and permits. IPPC rules require a phytosanitary certificate from the exporting country, issued after the requisite inspections and testing (Keyser, 2013). There may be further phytosanitary checks at the border of the importing country.

Harmonized cross-border seed trade has also been a priority at the regional level, which has led to the adoption of standards and procedures set by international bodies such as OECD and the International Seed Testing Association (ISTA). In addition to permits and phytosanitary certificates, many of the focus countries require that consignments be accompanied by the Orange International Seed Lot Certificate (OIC) or the Blue International Seed Sample Certificate (BIC) issued by an ISTA accredited laboratory.⁶ Among the focus countries, Uganda, Malawi, and Zimbabwe require that all seed batches be accompanied by the OIC. In Malawi, however,

seed from other COMESA or SADC countries is exempt from OIC. The interview data showed that the requirement for ISTA certificates can be a significant hurdle, due to added costs and fact that not all focus countries have ISTA-accredited laboratories that could issue the certificates (Table 5).

Import permits are generally issued by the National Plant Protection Organization (NPPO) in a country. The NPPOs usually have some discretion in granting import permits. For instance, obtaining an import permit in Ghana is reportedly much simpler for vegetable seed than for field crops. However, in Zimbabwe, which has a well-developed local vegetable industry, respondents cited lengthy timelines to obtain import permits, causing significant delays.

Respondents also explained that sanitary and phytosanitary (SPS) measures and plant risk assessments are among the most significant hurdles to the importation of vegetable seed. This is especially so when there is no formal regulatory distinction between field crops and vegetables. Several stakeholders stressed that SPS measures act as a barrier to importation, with inspection and testing undertaken for diseases that do not pose a threat in a country.

3.9. Counterfeit and adulterated seed

Counterfeit, fake, or adulterated seed refers to a deliberate effort to misrepresent the identity of the seed and is a significant problem in each of the focus countries. Seed may have been mislabelled (e.g. seed of an open-pollinated variety sold as a F1 hybrid) or repackaged in a fraudulent way or dyed/coloured to deceive farmers. In Uganda and Tanzania, stakeholders interviewed for this study estimated that 25–30% of all seed found in the market is counterfeit. However, there is a lack of good data documenting the problem for vegetables. In most of the focus countries, imported vegetable seed is not well traced as it moves through the market, which can make it susceptible to adulteration. A number of other factors also contribute to the prevalence of adulterated and counterfeit vegetable seed in the focus countries, including lack of awareness amongst farmers on how to spot fake or adulterated seed; difficulty tracing the actual source of the seed (for example, in East Africa it is reported that seed may be sold 3–4 times before it reaches the farmer) (de Boef et al., 2019); lack of institutional capacity and funding constraints; low priority given by authorities to addressing the problem in vegetable seed;

and weak enforcement of laws and regulations, amongst others.

One of the most common ways to deal with counterfeit seed has been to incorporate a catch-all provision in a country's seed law for infringement of obligations; in some cases, more specific provisions have been incorporated. Penalties may take the form of fines and possibly imprisonment. For instance, Nigeria imposes penalties for misleading or fraudulent packaging and labelling of seed amounting to USD 2500 or imprisonment for a first-time offender and approximately USD 5000 or imprisonment for two years for repeat offenders. In Ethiopia, any person who commits fraud could be punished with a fine of about USD 1350 and imprisonment of 5–10 years. These are hefty penalties compared to fines imposed by other focus countries; however, it is reported that fake seed can still be found in the Ethiopian seed market.

The African Seed Access Index (TASAI) reported an abundance of fake seed in the Zimbabwean market (Mabaya et al., 2017). Incidence of fake seed is to be reported to the national seed authority; according to Section 24 of Zimbabwe's Seed Act, 1965 (reprinted in 2001), tampering with a sample with fraudulent intent, using a certificate issued in connection with other seed, and selling/supplying any seed that does not possess the properties attributed to it, are punishable. The prescribed penalty is a fine not exceeding USD 400, or imprisonment for a period not exceeding 12 months, or both.

Focus countries also face issues of law enforcement due to delays in court proceedings and absence of a regulatory authority that can effectuate the laws. In Ghana, there are hefty penalties imposed under law, but stakeholders report that these are ineffective, as the Ghana Seed Inspectorate Division (GSID) lacks the resources to adequately monitor formal seed distribution. No formalized mechanism has been established in Ghana to deal with complaints of counterfeiting. In Malawi, stakeholders stated that although penalties are established for counterfeit seed, they are very low and therefore ineffective.

Kenya has been a trailblazer in taking on counterfeit seed under multiple approaches. In 2008, parliament passed the Anti-Counterfeiting Act (2008 Act), which established the Anti-Counterfeit Agency. The 2008 Act prohibits indulging in production, packaging, re-packaging, labelling and making any goods that would result in an imitation of the original

product. However, in the case of seed, an action will only amount to 'counterfeiting' if PBR exists and has been infringed (based on the Seeds and Plant Varieties Act, Kenya). The process for registering a complaint is quite straightforward and efficient, with a public complaints committee at the Anti-Counterfeit Agency required to respond with their findings within four weeks of a complaint. The penalties are also quite harsh. However, respondents mentioned that its enforcement has not been effective for vegetable seed.

In addition, the Kenya Plant Health Inspectorate Service (KEPHIS), in collaboration with the Ministry of Agriculture, Livestock, and Fisheries, has developed a system whereby all seed packages under 10 kilograms are accompanied by scratch-off labels. The labels reveal a code which farmers can use to ascertain the legitimacy of the seed by sending a phone message through an initiative known as *Mulika Mbegu Mbovu* ('stop bad seed'). The Seed Trade Association of Kenya accepts complaints from private companies and registers them with KEPHIS, which can impose a significant fine. Stakeholders stated that this approach has been quite effective, although not all farmers are aware of it.

In Nigeria, reforms are underway to address seed counterfeiting from the point of production throughout the value chain through an electronic scratch label (similar to the one in Kenya). The National Agricultural Seed Council (NASC) has established a Seed Inspectorate under the NASC Act to lead the effort to combat fake seed. NASC has developed two IT-based solutions, one is a seed tracker for traceability, and the other is an electronic authentication system called SEEDCODEX, which allows farmers to authenticate seed through SMS. Some private company stakeholders stated that the system has been effective, but they also noted that it is costly, which may deter small local companies from adopting it.

In Malawi, a barcoding system is used to trace seed in the market. However, respondents expressed that this is not done on a large scale, and companies mostly use in-house mechanisms. In Tanzania, the Tanzania Official Seed Certification Institute (TOSCI) has also introduced serialized labels for seed packages weighing two kilograms or more, with information about the crop such as type, variety, and test date, that can be traced. In Zambia, the Seed Control and Certification Institute has worked with private companies and local stakeholders to address fake seed through various approaches, such as regular

inspections and information sessions to raise awareness. Zambia has an online certification system for the registration of seed growers and the issuance of licenses, which allows for cost-effective verifiable information that can help to reduce the incidence of fake seed.

4. Discussion

While our study focused on the development of the regulated formal seed sector, including private seed companies and public sector organizations, it is important to also stress the importance of the informal seed sector to maintain varieties of many vegetable crops (Croft et al., 2018; Meldrum et al., 2018; Pincus et al., 2018). There are hundreds of cultivated vegetable species in Africa, while only a handful are of interest to the formal seed sector. Although seed laws and regulations govern the formal sector, it is important to consider implications of the legal and regulatory system for the informal sector as well, because the formal and informal sectors interact (Kuhlmann & Dey, 2021).

Next, we discuss the main findings of our analysis per stage of the seed regulatory value chain, starting with enabling environment at the regional level.

4.1. Regional regulatory frameworks

Regional harmonization can have a positive impact on trade of vegetable seed within the region, but development of new rules should carefully take implementation aspects into consideration, as harmonization can increase regulatory burden for countries and intensify existing capacity constraints of government agencies. Despite efforts to harmonize regional seed trade in Africa through regional economic blocks (COMESA, EAC, ECOWAS, SADC), our analysis showed that only ECOWAS has made specific provisions for vegetable seed. It is promising that ECOWAS has recently expanded its focus crops to include more vegetables than onions and tomatoes, and greater recognition of vegetables would be beneficial. A notable good practice in ECOWAS is the exemption of vegetable seed from VCU trials; however, ECOWAS rules do not exempt vegetables from mandatory seed certification and make no provisions for alternative seed quality assurance schemes and the 'standard seed' class for vegetables of the OECD Seed Schemes. This sets the ECOWAS

requirements for vegetable seed above international requirements, which is highly unrealistic.

4.2. Plant breeders' rights

Plant breeders' rights is a priority of many breeders but can be a highly contentious issue, as it appears to pit the interests of the private seed sector against the interests of smallholder farmers. However, flexibility does exist in preserving farmers' rights, with some notable good practices among the focus countries (e.g. Ethiopia) and more broadly (e.g. India and Malaysia) (Kuhlmann & Dey, 2021). Plant breeders' rights can be an important incentive for the private sector to develop vegetable varieties, although weak enforcement in many of the countries limits its usefulness. It is also important to keep in mind that variety turnover can be fast in vegetables, and hybrids offer a natural protection against variety infringement for seed companies. Joining UPOV can signal to investors that a country is serious about plant variety protection, but it may not be the most important factor to enable local vegetable variety development.

4.3. Variety registration and testing requirements

All countries except Mali, Kenya, and Tanzania legally require VCU testing to register a vegetable variety in their national seed catalogues. National seed laws are not aligned with regional agreements, for example in West Africa, where ECOWAS exempts vegetables from VCU testing. National seed authorities in some African countries appear to have an interest in maintaining VCU trials, as it is a source of revenue, and continue to mandate them for vegetables despite rules and good practices to the contrary. The VCU trial system works for cereals, where there are only few new crop varieties per year that can easily be compared in terms of yield and wide adaptability. The system does not work for vegetables, where subjective criteria such as taste, colour, texture, and size are additionally important and where many new varieties enter the market every year. Countries in North America, Europe, and many countries in Asia, therefore, exempt vegetables from VCU testing (FAO, 2020). Countries in Africa would benefit from building out continental adoption of this international good practice and exempting vegetables from VCU testing.

Another observation is that national variety catalogues for vegetables are not regularly updated and are not accessible online. This severely restricts the function and usefulness of variety catalogues. The time it takes to register a new variety is also long, as variety commissions do not meet regularly and often lack expertise in vegetable crops. Further, the system of variety testing and registration is prone to conflicts of interest. In Ghana, we found that public organizations have an effective monopoly over variety release and registration, although there is no legal basis for this in the country's seed laws. This is also the case under the currently applied system in Ethiopia. This is a strong deterrent for any private seed company to invest in local vegetable variety development. In addition to addressing these challenges, one notable good practice may be adopting specialized seed catalogues for vegetable varieties (Kuhlmann & Dey, 2021), which could be updated more frequently.

4.4. Early generation seed production

Governments in Burkina Faso, Mali, and Tanzania maintain a monopoly over early generation vegetable seed production, at least for varieties coming from the public sector. This jeopardizes the quality of the seed produced, because public organizations have very limited technical and financial capacity to do this work properly. Challenges to early generation seed have been mentioned by several other studies for non-vegetable crops (e.g. Cramer, 2019; Dey et al., 2022). It creates risk and uncertainty for private seed companies, which cannot control the quality or quantity of foundation seed – the key input for commercial seed production. This could deter seed companies from using public sector varieties and potentially limit variety development alongside other financial, technical and regulatory constraints.

4.5. Seed quality assurance

Government-managed seed certification aims to be an effective mechanism to ensure seed quality but rests heavily on the capacity to effectively monitor seed production at every stage of the seed production process. This is a serious issue in practice, and resource limitations then force agencies to prioritize seed production of staple grains over vegetables. However, government systems do not even have enough capacity to certify seed of staple grains (Christinck et al., 2018). Even if inspectors visit vegetable

fields, they often lack the technical expertise to conduct inspections properly, as seed production is highly crop-specific and seed production protocols may not even exist for many vegetable crops. Many countries outside of Africa, therefore, not mandate seed certification for vegetables, but rely on alternative mechanisms such as minimum quality standards, truth-in-labeling, or voluntary certification. These practices are also becoming more common in Africa and are examples of more flexible alternatives that can lead to positive developments within seed systems, particularly for vegetable crops.

4.6. Regulations regarding seed import and export

Across Africa, the requirements to import vegetable seed appear much less stringent than requirements to breed and produce seed locally. This may reflect the reality that most countries depend upon the importation of vegetable seed. These dynamics have repercussions for seed sector development and production of vegetable varieties, however, and further attention should be paid to simplifying the process for domestic breeding and production. Sanitary and phytosanitary regulations in sub-Saharan Africa largely follow international practices. Two issues require attention, however. First, a few countries require ISTA certificates for seed imports, which restricts regional seed trade, as only 7 of the 13 focus countries have ISTA-certified laboratories. Second, none of the regional economic communities (ECOWAS, EAC, COMESA, SAADC) has prepared regional pest lists for vegetable crops, which prevents an accurate assessment of risk. For instance, countries were observed to inspect and test for diseases that do not pose a threat within a country.

4.7. Counterfeit and adulterated seed

The popularity of F1 hybrids among farmers and the high price of vegetable seed in the market have created incentives for seed counterfeiting and adulteration. However, published evidence for such practices in vegetables are limited, which is an important area that requires investigation. Problems are likely to increase as the vegetable seed sector expands. The focus countries have legal frameworks in place to punish offenders, but the challenge lies with their enforcement, with vegetables receiving low priority. Countries without an effective

mechanism in place to deter seed counterfeiting and adulteration are unlikely to see their vegetable seed sector develop, as farmers won't develop loyalty to brands and investors won't see good returns on their investments. However, countries such as Kenya, Malawi, Nigeria, Tanzania, and Zambia have introduced methods to trace seed along the value chain so that farmers can verify the authenticity of the seed they buy. These traceability systems are not working perfectly yet, and there is a need for more farmer training, but they are a good start and practice for countries without such systems in place to consider.

5. Conclusion

Seed laws and regulations in sub-Saharan Africa were developed with staple food grains in mind and are not generally conducive for development of the vegetable seed sector. The quality of vegetable seed can be assured using a range of legal and regulatory options, ranging from government-driven quality control to more market-driven mechanisms, but most countries have opted for the former without recognizing that government agencies have little capacity to administer these systems for vegetables and more broadly. Countries outside of Africa with a successful vegetable seed sector have also moved away from these practices.

Five areas require urgent attention. First, government monopolies over early generation seed production of vegetable seed, as found in Burkina Faso, Mali, and Tanzania, should be disbanded, with governments focused instead on simply setting minimum seed quality standards and monitoring compliance with these requirements. Second, vegetables should be exempted from mandatory VCU trials, as these are not suitable for vegetables. A few African countries and many other countries worldwide do also not require this form of testing for vegetables, based on their unique properties. Third, there is a need for an efficient and transparent online systems of variety registration, with national catalogues regularly updated and available online or specialized variety catalogues made available for vegetables. Fourth, mandatory certification of vegetable seed production does not work in practice, because the public system does not have the skills and capacity to maintain a compulsory certification system for vegetables. Setting minimum quality requirements and instituting truth-in-labelling or

quality self-assurance may be more effective, with established seed companies and upcoming enterprises opting for voluntary certification. Fifth, countries need to introduce traceability systems for vegetable seed so that farmers can check the authenticity of the seed they buy, which would address problems of counterfeiting and seed adulteration. Across all of these aspects, prioritizing flexibility and inclusion will ensure that seed systems develop in a way that recognizes the particular qualities of vegetable crops and the needs of all involved in seed systems, including smallholder farmers, women, and traditional farming communities.

Making these changes would create better incentives to spur more vegetable breeding and seed production in Africa and increase the competitiveness of seed produced in Africa over seed imported from outside the continent. To make these changes, it will be important that national seed policies, laws, and regulations recognize the unique nature of the vegetable seed sector, which is not currently the case. The potential benefits of doing so would include increased incomes for smallholder farmers and other value chain actors and more available and affordable vegetables for populations at large.

Notes

1. Interviews were conducted over a period of three months in 2020.
2. A *sui generis* framework is a unique legal framework tailored to a particular legal classification, in this case a unique IPR framework for plant variety protection. Many countries have based PVP legislation on UPOV.
3. UPOV rules allow countries to permit farmers to use protected varieties for propagation and exchange (also known as 'farmer's privilege'). Under UPOV, farmer's privilege is subject to countries national laws and regulations, and domestic approaches vary but must follow international obligations such as UPOV and the Arusha Protocol. UPOV 1978 and UPOV 1991 do differ in their coverage of farmers' rights.
4. The Seed (Amendment) Regulations, 2017, Amendment of Regulation 4 (Tanzania).
5. The term 'basic seed' is used in the OECD system while US system uses 'foundation seed' for the same generation.
6. The OIC is issued when the seed sample or consignment has officially been drawn from a seed lot that has been tested by an ISTA accredited laboratory. The BIC is issued when the sample is drawn from a lot that has been tested by an ISTA accredited laboratory, where the laboratory accredits only the sample and not the full seed lot (Keyser, 2013).

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