RTB Working Paper

Exploring the regulatory space for improving availability, access and quality of vegetatively propagated crop seed: potato in Kenya

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Acronyms

ADC	Agricultural Development Corporation
BW	Bacterial Wilt
CDA	County department of agriculture
CIP	International Potato Center
COMESA	Common Market for East and Southern Africa
EGS	Early generation seed
FAO	Food and Agriculture Organisation of the United Nations
FGD	Focus group discussion
KALRO	Kenya Agriculture and Livestock Research Organisation
KEPHIS	Kenya Plant Health Inspectorate Service
KII	Key informant interview
MoALF	Ministry of Agriculture Livestock and Fisheries
NGO	Non-governmental organisation
NPCK	National Potato Council of Kenya
PCN	Potato Cyst Nematode
QDS	Quality Declared Seed
STAK	Seed Trade Association of Kenya
UPOV	The International Union for the Protection of New Varieties of Plants
VPC	Vegetatively propagated crop

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Abstract

Potato ranks second staple food crop in Kenya. The Government seeks rapid yield growth in the potato sub-sector, however with only 2% of potato seed planted currently certified there is a persistent shortage of quality seed. There is no consensus on an appropriate model for quality seed assurance which can ensure increased availability and access to quality seed by smallholder farmers, while minimizing risk of spread of plant diseases. This study addressed the question of whether the current seed regulatory framework in Kenya and its implementation meets the need for increased availability and access to quality seed potato, for who, and with what consequences? Secondary data and policy analysis were complemented by semi-structured interviews and focus group discussions involving 72 stakeholders from public, private and civil society conducted in the major potato production areas, and at national level. Our findings show a range of different actors have different and sometimes conflicting interests. Seed potato needs to be produced on a large-scale with enough land and resources to meet rotation and isolation standards and inspection costs. However, this has implications for equitable participation in the seed potato industry. Current regulatory and inspection procedures are perceived by small-scale seed producers as policing rather than facilitating quality seed production. This highlights compromises between achieving short term food security and managing risk of spread of plant diseases. The feasibility of different approaches to manage bacterial wilt and potato cyst nematode are discussed with implications for different scales of seed production. Several policy options are reviewed, with their trade-offs, emphasising the need to for inclusive stakeholder consultations to negotiate towards a common interest space.

Key words: seed potato, regulatory frameworks, integrated seed health, policy trade-offs, plural seed systems, political economy

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1. INTRODUCTION

Through a range of policy, regulation, and investment strategies, the Government of Kenya has sought to expand production volumes and the value of potato (*Solanum tuberosum*) in the country over the past decade and in its most recent national development plan of 2018 (Government of the Republic of Kenya, 2018, Muthoni et al., 2014). In 2017, the area of ware potato harvested was 192,342 ha, with a yield of 7.9 t/ha (Food and Agricultural Organization of the United Nations (FAO), 2019). While there is high variability in yields, there is potential of up to 40 t/ha (Context Network, 2016). Thus a key objective of the Government is to increase potato productivity and profitability, with a target of increasing area under production and yields by 20% for all root and tuber crops (Republic of Kenya, 2019) Most stakeholders recognise that the production and distribution of quality seed plays a critical role in this (Ministry of Agriculture Livestock and Fisheries Kenya, 2016). However, the trade in certified potato seed in Kenya is extremely small: just 6,714 tons of seed produced on 403 hectares in 2017 were certified—a figure representing less than a quarter of the estimated demand for *certified* seed potato (National Potato Council of Kenya, 2018). And when measured as a share of *all* seed potato being planted by farmers in Kenya irrespective of quality, the volume of certified seed represents less than 2% (Kenya Plant Health Inspectorate Service, 2019). Together, these figures suggest that there is an acute shortage of quality seed for farmers throughout the country. While not uncommon for many vegetatively propagated crops in Kenya and other developing countries, these shortages are nonetheless cause for concern considering the Government's prioritization for the crop and the rising demand for ware potato for table consumption and processing purposes.

Yet simple supply and demand figures belie the complexity of the market for seed potato, especially when discussing quality seed. Context and individual circumstances also influence perceptions and the use of quality seed (Almekinders et al., 2019). The term "quality seed" is defined here as planting material that meets specific thresholds set for disease, pest and physiological parameters for different seed classes. The correlation between a specific threshold (in relation to a seed class) and yield depends on genetic, agronomic, social and economic factors.

This paper investigates Kenya's seed quality assurance systems in view of the ongoing policy and regulatory changes that are being designed to expand the country's seed potato sector. The paper analyses a range of policy and institutional innovations emerging in the sector, including the drivers of these innovations, the potential winners and losers, and the implications for alternatives courses of action. At the heart of this paper is the question of whether there is an appropriate model of seed potato quality assurance—or possibly several

models—that can increase availability and access to quality seed for small-scale, resource-poor farmers, while simultaneously minimizing risk of spreading of diseases. With more than 96 percent of seed flows accounted for by ware potato producers using own-saved seed or trading through informal channels in Kenya, formal quality assurance systems seem almost irrelevant. But quality seed is critically important to production and yield growth: potato, like many other vegetatively propagated crops, is highly susceptible to seed- and soil-borne diseases that significantly reduce yields. Smallholders who rely on own-saved seed or seed acquired from neighbours or other informal sources tend to experience significant yield and quality decline over time as these diseases accumulate in their planting materials, a process known as degeneration. There are different strategies for managing this process of degeneration, including on-farm seed management, the use of resistant varieties, and the use of certified seed (Thomas-Sharma et al., 2016). The certified seed replacement paradigm has been successful in Europe and the United States of America, but less so in low and middle income countries. Commercial sources of quality seed potato are rarely an option for smallholder farmers: low seed multiplication rates, bulkiness, and perishability make seed potato production, transportation, storage, and marketing a risky investment for many prospective entrepreneurs. Added on to this are the costs of regulatory compliance: meeting stringent thresholds for pest and disease presence in seed potato can often require entire lots being destroyed and land being quarantined for several years before it can be used again for seed production. In short, certified seed potato production is a challenging business.

Moreover, because seed quality is often unobservable through visual inspection by the farmer, there are high transactions costs in the exchange of seed potato. For example, seed sellers may incur costs in building a credible reputation in the market, while farmers may incur costs in searching for a credible seller or verifying the seller's reputation. And where farmers expect that the returns to quality seed are low relative to the investment required, the demand for quality seed can be quite low. These various costs and risks have motivated many governments in lower income countries to invest directly in both the production and regulation of seed potato. This has been the case in Kenya, although the market—and participation of private sector actors in that market—is now evolving rapidly.

The paper investigates these issues through the collection and analysis of qualitative data and information from a wide range of potato sector stakeholders in Kenya. A total of 40 semi-structured interviews involving 72 individuals were conducted in 2017, with interviewees drawn from a wide range of affiliations across the public, private, and civil society sectors. These interviews were augmented by the collection and analysis of legislative documents, regulatory handbooks, technical manuals, project reports, research papers, and other documents relating to Kenya's potato seed sector.

Findings indicate the following. First, Kenya's seed potato market is a set of closely interdependent actors spanning both formal and informal sectors engaged in varietal improvement, early generation seed production, seed storage, distribution, marketing, and use. These actors have different, and sometimes, conflicting interests. This implies that it is not possible to strictly delineate informal and formal seed systems, or to strictly define quality seed as only that seed that has been inspected and certified. Seed systems and seed quality are more analogous to a continuum than to discrete, identifiable units. This has strong implications for the design and implementation of public policy and regulation.

Second, the Kenya Seed Act does not recognise quality declared seed (QDS) as a seed class or category, thus while Kenya's technical and procedural requirements for certified seed production can be met by larger seed companies, small-scale seed producers struggle to meet many of the requirements. Consequently, many seed producers who started producing certified seed have dropped out of the market, leaving the production of

certified seed to large private and parastatal companies. This reduces the supply of certified seed significantly and may limit potential growth in markets for seed.

Third, while local (county) governments, research centres, and non-governmental organizations are investing in the promotion of "clean seed" production (i.e., quality seed that is produced from a known source of certified seed, but not formally inspected) by training rural entrepreneurs and farmer organizations, a strict interpretation of the seed law infers that the sale of clean seed is illegal. Consequently, some stakeholders – with concern about short-term food security – have raised concerns that the regulatory system is policing, rather than facilitating, efforts to increase availability and access to quality seed, and thus excluding vulnerable social groups from opportunities in the seed potato market and undermining food security.

Fourth, and running counter to the previous point, many other stakeholders believe that the long-run risks posed by disease can only be addressed within the framework of a formal quality assurance system. The cases of Bacterial Wilt (BW) and Potato Cyst Nematode (PCN) management, presented later in the paper, illustrate this perspective and characterize the complexity of the underlying trade-offs.

The paper contends that in Kenya's potato sector, stakeholder alliances have two contrasting points of view. The first is framed around short-term national food security objectives and argues that increased volumes of quality seed are needed to contribute to improved smallholder livelihoods but relegates potato pest and disease management and quality assurance systems to a lower-order priority. The second narrative is framed around an underlying concern about the legitimacy and credibility of the state, arguing that compliance with public policy and regulation requires that all seed potato produced and exchanged in Kenya should be certified in order to prevent the spread of disease and emphasises long-term national food security interests. The stakeholder alliances behind these divergent viewpoints play out at multiple levels—international, national, and local—and are shaped by underlying power relationships and dynamics. The competition and contention between these alliances—as well as divergences within these alliances—continue to shape the evolution of Kenya's seed policy, regulations, and guidelines.

As these viewpoints continue to be debated, there remain serious questions about the appropriateness of the current regulatory framework for seed potato. To date, Kenya's formal seed potato certification system has had a very limited impact on the availability of quality seed for smallholders. More importantly, there is little to suggest that the scheme will contain and prevent the further spread of pests and diseases such as PCN and BW among seed and ware potato producers. The paper analyses the examples of institutional innovations which are occurring, who benefits from these, and the alternative policy options that might expand these benefits. The paper concludes with recommendations for re-shaping the policy and regulatory space to recognize different quality assurance systems, seed production systems, and ware production systems. This requires efforts to harness latent stakeholders—county governments, in particular—to innovate around the design of practical and inclusive quality assurance systems for seed potato in Kenya.

2. CONCEPTUAL FRAMEWORK

This study sought to explore the following research questions: What types of public policies, regulations or regulatory reforms are in place and what is the experience of different types of stakeholders in how these are implemented to provide access and availability of quality VPC planting material, specifically seed potato; and what types of public policies, regulations or regulatory reforms are required to provide effective quality assurance to increase access, availability, and quality of VPC planting material?[1] From a conceptual standpoint, there are several ways to analyse the stakeholder interactions, policy and regulatory space that influence the design and implementation of quality assurance systems for seed potato. The neoclassical economics viewpoint treats quality seed as an input to production that is superior to lower-quality, own-saved "farm seed" or seed exchanged among neighbours, but that also degenerates over time as diseases accumulate and negatively affect yields (Fuglie et al., 2006). Seed users therefore choose between purchasing quality seed versus own saved or seed exchanged among neighbours to maximize the present value of net returns— namely, profits. In this formulation, the price of seed is a function of its quality which can only be observed through its performance, after it is grown and harvested, that is quality seed is a credence good undetectable through visual inspection. The seed user is thus expected to purchase quality seed up to the point at which the present value of costs of using quality seed equals the present value of the benefits stream, where the discount rate reflects the rate of depreciation of seed quality overtime. Moreover, this model suggests that, in the aggregate, as more and more farmers use quality seed, they experience increased profits at a declining rate, i.e., margins fall. This model provides a framework with which to analyse the economic outcomes of alternative seed sources with quality differences.

At a very basic level, the neoclassical model provides useful guidance for thinking about seed systems but tends to overlook alternative institutional arrangements which emerge in the absence of competitive markets and perfect information. These issues are better addressed by the theory of induced "institutional innovation" or the response of social and economic institutions to relative factor scarcities (Ruttan and Hayami, 1998, North, 1990, Akerlof, 1997). For vegetatively propagated crops (VPCs), the theory suggests that seed users facing production constraints due to the high cost of quality seed in the market may organize, lobby, and petition organizations and actors to undertake reforms aimed at resolving this constraint. The costs at issue here arise from both high transaction, storage, and transportation costs, which increase the price of seed and undermine seed market coordination. The former emanates from, among others, the cost of finding and authenticating quality seed, and necessitates the provision of a quality signal, for example, a quality assurance certificate or the personal endorsement of a seed provider. In the absence of such quality signals, seed users resort to relational transactions in which repeated transactions eventually lead to trust and the reputation that each actor, especially the seller, seeks to protect.

However, the precise designs of such signalling mechanisms may be influenced by the way actors view the problem. The previously mentioned models do not consider how actors use different language to identify and define a problem and construct a shared understanding of the problem (Head and Alford, 2013) (Schneider and Ingram, 1993). Nor do they identify or account for the role played by advocacy coalitions and networks in advancing policy solutions, state functions, or institutional architectures that

[1] The paper focuses on quality assurance and does not address concerns around accessing seed of new varieties.

support of the solutions that they propose (Sabatier, 1988). The application of these concepts to seed systems is specifically illustrated by Kloppenberg (2010), Scoones and Thompson (2011), and Beko et al. (2016) (Scoones and Thompson, 2011, Kloppenburg, 2010, Beko et al., 2016), who collectively argue that policy change processes in seed systems cannot be considered strictly in technical (or technocratic) terms. Rather, they focus on the power dynamics and political economy factors that play out among seed system actors and that lead to the formation of seed system paradigms that benefit or favour one group over another. Such paradigms may relate directly to policies that shape the level of state vs. private governance of the system, or the degree of regulation and the entities mandated to regulate. Thus, we explore how configurations of actors coalesce and shift around contrasting but sometimes overlapping interests and highlight how recognising these diverse narratives can contribute to broader discussions on options and alternative pathways for seed quality assurance.

To fit the concepts of framing, narratives, and advocacy coalitions into sphere of policy change, we draw on a framework developed by Resnick et al.,(2018) to identify drivers of the policy change process, and to analyse how ideas, interests and institutions interact, and recognize potential entry points into the policy change process (Resnick et al., 2018). This framework is potentially important given how narratives in seed sector development that gain traction among policymakers tend to the extremes, for example, the existential threat posed by seed counterfeiting and the predatory behaviour of seed traders; or the threat posed by low crop yields and crop failures to national stability, law, and order; or the threat of multinational companies dominating smallholder markets. The problem perception may shift as economic and social conditions change, for example debates on globalisation may strategically pit foreign and domestic companies against each other, industry against government, or farmers against consumers. How the target groups of “ware potato farmers” and “seed potato producers” are socially constructed by national and devolved decision makers and interested stakeholders will also influence the rationale that legitimises policy choices.

3. BACKGROUND TO KENYA'S SEED POTATO SYSTEMS

3.1. Ware and seed potato value chain characteristics

In Kenya, potato is the second most important major food staple after maize (Ministry of Agriculture Livestock and Fisheries Kenya, 2016, Muthoni and Nyamongo, 2009). Potato is traditionally grown in the high-altitude highland areas. About 2-3 million tons of potatoes worth KSH 40-50 billion (approximately USD 40-50 million) are produced each year (Ministry of Agriculture Livestock and Fisheries Kenya, 2016) with 90 percent of potato farmers growing the crop for both own-consumption and income generation purposes (Muthoni et al., 2013) and an estimated 2.5 million employed in its value chain (Laibuni and Omiti, 2014). Demand for ware potato, particularly from Kenya's food processing industry, remains unmet, and Kenya imports frozen French fries (Ministry of Agriculture Livestock Fisheries and Irrigation Kenya, 2018).

The national development discourse emphasizes agriculture and food security, as demonstrated by the Agriculture Sector Transformation and Growth Strategy 2018-2030, (Boulanger et al., 2018) and the 2017 Presidential Initiative on the "Big Four Pillars of Development" (Government of Kenya, 2017) which highlights food security as a national priority. Potato figures prominently in "Big Four" initiatives aiming to bring additional land into potato production through public-private partnerships, contract farming, seed potato production, potato processing factories, and cold storage facilities (Government of Kenya, 2017).

The potato industry is characterized by a few large-scale ware- and seed-producing farms and many small-scale farmers (estimated at approximately 800,000 in 2015) located across 16 counties (Ministry of Agriculture Livestock and Fisheries Kenya, 2016). Potato is traded in unstructured marketing systems where value addition is minimal at the producer level. While most of the potato produced in Kenya is consumed as boiled or mashed, the demand for processed potato products such as French fries and crisps is increasing (Tesfaye, 2010). These various end-uses require specific varietal traits. Public sector breeding in Kenya has prioritised efforts towards increased yield and to tackle either disease problems or environmental stresses, especially drought. Some traits such as earliness, dormancy (allowing for direct planting in the subsequent season) degeneration levels and ease of cooking have had less attention. However, the demand for seed is increasingly influenced by the varietal traits required for fresh or processed potato products, rather than seed health attributes.

Yet despite potato's importance to Kenya, growth in both production and yield have been constrained by a lack of and poor quality seed. Most smallholder farmers use seed from their own sources or from neighbours to grow potato on small land units averaging 0.4-0.6 ha. Seed from neighbours can be purchased with cash, bartered (i.e., exchanged with another commodity), or acquired for free. Ware potato growers also use local open markets as sources of seed potato. By law, it is illegal to sell seed that has not been certified. However, limited enforcement capacity means that trade in uncertified potato "seed" is still active in local markets in potato growing areas. The typical practice is to select small-sized tubers (which are not preferred by consumers due their difficult and time-consuming peeling process) and sell these as seed. Often traders may purchase small quantities of certified or clean seed potato from different sources, but then mix this with small ware tubers to increase the volume. While it is possible to visually observe some seed health attributes e.g. disease symptoms; but the absence of latent infections and some symptomless viruses can only be assured through laboratory testing. Thus, it is difficult to have confidence in the quality and source of seed sold in local markets. This seed is often of unknown health and may harbour seed-borne diseases that reduce yields (Kaguongo et al., 2008). Key among these diseases are bacteria wilt (BW), late blight and, more recently detected, potato cyst nematode

(PCN). While there are efficient and effective fungicides for late blight, BW can remain in the soil for many years without a host, while PCN continuously builds up in the soil over an even longer period, and for both the management options are very restricted. It is estimated that more than 70 percent of seed planted by farmers in Kenya is infected with BW, (Muthoni et al., 2013) and 80 percent of farms producing certified seed have tested positive for PCN (Haukeland et al., 2017). And even where disease-free seeds are planted, contaminated soils can reduce yields. While any non-resistant variety can carry and transmit BW, the example of Shangi variety below (Box 1) illustrates how the implementation of regulatory processes can impact on the informal seed sector, and subsequently jeopardise the national plant health system. When Shangi was originally submitted for official release, it was rejected as it did not achieve acceptable disease thresholds. However, as a probable "escape" from trials, it was favoured by farmers, in part due to its short dormancy period. Its popularity contributed to its rapid spread by farmer to farmer dissemination. However, as it was not a released, registered variety it was not eligible for clean up, multiplication, certification and distribution as pre-basic or basic seed. Thus, as there was no flush through of clean materials, farmers continued to re-cycle it, and being susceptible to BW, probably contributed to the spread of this disease.

Box 1: the case of Shangi – a farmer selection, but not officially released

Bacterial wilt (BW) caused by *Ralstonia solanacearum* is among the quarantined pests in potato production (CABI/EPPO, 2004). Symptoms of the disease include wilting, stunting, yellowing of the foliage and bacterial ooze collecting on the tuber eyes or on the end of the stolon, causing soil to adhere to the secretions (Priou et al., 1999). In Kenya, the losses range between 50 to 100% (Ateka et al., 2001, Muthoni et al., 2014), with over 60% of farmers' fields infected with the disease (Parker et al., 2017, Were et al., 2013). Infected potato tubers are considered the major source of inoculum and contributes to the extensive spread and distribution of the pathogen both locally and internationally (Abdurahman et al., 2017, Kaguongo et al., 2014). Infected plant residues, contaminated water for irrigation or surface runoff and the use of contaminated farm tools can also spread bacterial wilt from one farm to the next (Priou et al., 1999). Latently infected tubers, which show no visible symptoms, pose a serious threat of spreading the disease to new areas. Since there is no known approved chemical for controlling bacterial wilt, management strategies aim to reduce the incidence and spread of the diseases through use of clean seed and good agricultural practices. Host-plant resistance has eluded many breeders despite some varieties showing potential to yield even in the presence of the pathogen (Parker et al., 2017). Strategies such as, integrating onion (*Allium cepa*), garlic (*Allium sativum*) and black mustard (*Brassica nigra*) into crop rotation pattern or as pre-crop have been shown to significantly reduced disease incidence compared to other non-host crops, such as cereals and legumes. However, effective crop rotations are not practical because farms are too small (Kaguongo et al., 2008) and the pathogen has wide host range which reduces options for rotational crops. Given the difficulty in its management and ease of spread, bacterial wilt has been a quarantined potato disease with zero-tolerance for field inspection and laboratory testing for latent infection. Use of certified or clean seed has been advocated for managing the disease however, limited availability and access to such seed are major constraints for farmers (Kwambai et al., 2011, Muthoni et al., 2012). Moreover, the certification process is limited to officially released varieties, which can lead to spread of diseases through the movement of 'informal varieties' for instance, variety Shangi in Kenya (Kaguongo et al., 2014) where there was no flush through of clean seed and farmers were left to save and re-use seed. The variety is widely spread and distributed among the potato farming communities with over 70% of farmers growing it (Kaguongo et al., 2014).This example shows how regulation processes can block farmers' access to quality seed of varieties they prefer, if they are not officially released and registered and hence not eligible for certification process. This meant that farmers relied on purchasing from local ware market or neighbours and using it as seed. The variety was finally officially registered in 2016 but certified seed of the variety only available in 2017. The uncontrolled distribution of this variety might have contributed to the wide spread of bacterial wilt among the potato farms in Kenya and the neighbouring countries.

Source: Atieno, E.O.

The problems of lack of, and poor quality seed are reflected in the yield gap between Kenya and other countries. Potato yields in Kenya typically range between 8-10 tons/ha as compared to an average of 40 tons/ha in developed countries (Gildemacher et al., 2011, Muthoni et al., 2013, Okello et al., 2017). Recent reports suggest that still less than 2% percent of the total seed planted in Kenya is certified seed (Kenya Plant Health Inspectorate Service, 2015, Kenya Plant Health Inspectorate Service, 2019), with the remainder either recycled or purchased from local markets.

The problem of inadequate supplies of quality seed has led to a range of efforts to increase both production and distribution of seed potato, and to improve the regulatory framework. The former includes the adoption of new techniques of early generation seed production (e.g., aeroponics[2] and rooted apical cuttings[3]) that increase multiplication rates in minituber production (pre-basic seed) and reduce production time the i.e. the number of field generations by about 1-3 for producing certified seed. Government and research organisations with donor support have promoted "clean seed" production by farmer groups or individuals, using certified seed as a source of starter material and training in seed quality maintenance practices such as positive and negative selection, and the management of major diseases such as BW. This has helped to focus attention on underlying issues such as increasing seed replacement rates, accelerating varietal turnover rates, regulating seed market actors and exchanges, and monitoring new and emergent pest and disease threats.

Partly due to these efforts, the ware potato area harvested has been increasing steadily from about 135,000 ha in 2008 to 217,315 ha in 2018 (Food and Agricultural Organization of the United Nations (FAO), 2019). In 2017, the National Potato Council of Kenya (NPCK) estimated that there were seven registered seed potato merchants in Kenya, which together with a limited number of out grower schemes, produced 6,714 tons of seed potato out of an estimated 30,000 ton requirement for certified seed potato[4]. Table 1 presents the seven registered seed merchants and estimated production data. However, caution should be noted as this demand estimate is notional, since demand is shaped by other factors such as price of the seed, price of close substitutes; price of complementary inputs like fertilizer, agrochemicals, and labour; and costs of shifting land use to more profitable crops (Spielman and Kennedy, 2016). There are other few small out growers usually serving the larger ones. The dominant players are the Agricultural Development Corporation (ADC), a parastatal, and the private seed companies, Kisima Farms Ltd. and Charvi Ltd. which accounted for more than 75 percent of certified seed potato production in 2017.

Institutional reforms have included licensing private seed inspectors, training potato farmer organizations and small entrepreneurs to produce, store, and market seed potato. Yet many of these technical and institutional changes have emerged unevenly, with results in still largely confined to the scale of small pilot projects. And, as is discussed throughout this paper, many of these changes are unlikely to succeed at any greater scale without resolution of the arguments that underlie the quality assurance system for seed potato. Thus, the current dualistic (i.e., formal and informal) system of seed potato production and marketing is likely to continue into foreseeable future.

[2] The "3G" system uses mini-tubers produced under aeroponics to reduce the multiplication time, lower the production cost of starter seed and decrease the build-up of diseases leading to degeneration; so that the number of field generations required to bulk seed can be reduced from five or seven to three.

[3] An apical cutting is a rooted transplant produced from tissue culture plants. There are normally two stages in rooted apical cuttings systems: production of cuttings in a lab and screenhouse, followed by sale to seed multipliers or potato farmers who plant the rooted cuttings to produce seed tubers.

[4] This is enough to plant around 10% of the area planted to ware potato, so certified seed is only enough to plant 2% of area.

Table 1: Production of certified seed potato in Kenya, 2017

Registered seed producers/ merchants	Seed production area (ha)	Estimated production (tons)
Agricultural Development Corporation	100	1,600
Agrico EA Ltd.	50	800
Kisima Farm Ltd.	153	2,448
Charvi Ltd.	64	1,024
Suera Ltd.	5	80
KALRO Seed Unit	18	288
Sungus Enterprises	8	128
Apical cuttings (70,000 cuttings)	-	266
Others (outgrowers)	5	80
Total seed production area/tons	403	6,714
Estimated area covered by available seed (2 ton/ha seed rate)	3,357 ha	
Deficit in tons (28,468 – 6,714)		**21,754 tons**

Source: NPCK presentation to Seed Potato Key Stakeholders' Meeting, 25th September 2018, PanAfric Hotel, Nairobi, Kenya.

3.2. Kenya seed legislation and implications for vegetative propagated crops

Table 2 presents the major seed legislation in Kenya. The principle legislation is the Seeds and Plant Varieties Act (Cap 326) (Republic of Kenya, 1972) with its subsidiary Regulations, Amendments and Revisions. The Seeds and Plant Varieties (Seeds) Regulations, were first passed in 1991, and state that a person shall not offer seed for sale seed of species set out in the Second Schedule[5], unless the seed has been certified or it has met minimum standards prescribed for the class and species. The National Seed Policy was finalised in 2010 and provided an overarching framework for all seed legislation in the country. The purpose of the seed policy was to support the development, promotion and regulation of a modern, competitive seed industry; and to guide the harmonisation of the regulations that govern seed with regional and international conventions. Subsequently, in 2012 an Amendment to the 1972 Act allowed private persons to undertake specified seed certification activities on behalf of the regulator for seed classes below basic seed, and incorporated provisions of the International Union for the Protection of New Varieties of Plants (UPOV) 1991 convention. There were further Revisions to the 1991 Regulations in 2012 and 2016. These included clauses with implications for the seed of vegetatively propagated crops. The 2012 Revision incorporated seed certification standards for potato and the Revision in 2016 included a reduction in the number of certified seed classes from C1 – C4 (2012) to C1-C2 and allowed the release of land races and farmer-selected varieties e.g. Shangi.

Prior studies (Munyi and De Jonge, 2015) have pointed out several weaknesses in the current legislative framework. The key weakness is that the framework does not recognize farmer- based seed systems or the

integration of formal and informal systems. Munyi and Jonge observed that in the preparation of the 2010 National Seed Policy, the interests of private seed companies especially multinationals, represented by the Seed Trade Association of Kenya (STAK), predominated as evidenced by an almost entire focus on the formal sector; with only one paragraph mentioning the informal seed sector, which "ironically acknowledges its importance in that it provides 80% of the national seed requirement' (Munyi and De Jonge, 2015). Munyi and De Jonge also commented that the plant breeders' rights as incorporated under the 2012 Amendment to the Seeds and Plant Varieties Act prohibits farmers from exchanging or selling farm-saved seed of protected varieties. This is a requirement for all UPOV member countries. As most planting material is accessed through these channels, this provision locks out many farmers from accessing quality seed. The legal requirement that only registered varieties can undergo the certification process restricts the sale of farmers' preferred, but non-registered varieties. However, as noted earlier in the case of Shangi which became so popular due to short dormancy, leading to its release, although it had been earlier rejected by the varietal release committee as it did not meet disease thresholds.

Table 2: Major seed legislation in Kenya and implications for seed of vegetatively propagated crops

Legislation	Purpose and implication for seed of VPCs
2012 Amendment of the Seeds and Plant Varieties Act (Cap 326) (1972)	• Allowed private persons to undertake specified seed certification activities on behalf of the regulator for seed classes below basic seed • Incorporated provisions of International Union for the Protection of New Varieties of Plants (UPOV), 1991
Review of Subsidiary Legislation of the Seeds and Plant Varieties Act (Cap 326)	• Revision of ***crops under compulsory certification (Second Schedule), seed classes and standards*** to comply with international requirements (e.g. sweetpotato) • Domestication and operationalization of International Conventions to which Kenya is a party e.g. International Treaty on Plant Genetic Resources for Food and Agriculture (IPGRFA) • Review of ***membership of the institutions*** created by the Seeds and Plant Varieties Act to include stakeholder representation
2012 Revision of the Seeds and Plant Varieties (Seeds) Regulations, 1991	• Relevant and simpler seed export and import requirements • Seed certification standards for potato
2016 Revision of Seeds and Plant Varieties (Seeds) Regulations,	• Release of land races, farmer-bred or selected varieties allowed, e.g. *Shangi* • Varieties released in two countries of the regional economic blocks of which Kenya is a member of are exempt from performance trials and DUS if country has harmonised variety release regulations and procedures with the regional economic body and shares data. Under UPOV varieties already released in a member country do not need to undergo additional DUS tests
2016 Revision of Variety Evaluation and Release; Plant Breeders Rights Regulations	• Seed certification standards included for sweetpotato • Reduction of number of certified seed classes from C1-C4 (2012) to C1-2 (2016)

Source: (Republic of Kenya, 2016a, Republic of Kenya, 1972, Republic of Kenya, 2012b, Republic of Kenya, 2012a, Republic of Kenya, 2016b) and authors

4. EMPIRICAL METHODS

The data and information analysed in this paper were collected from key informant interviews (KII), focus group discussions (FGD), and document analysis conducted between June 2017 and December 2018. Identification of participants for the key informant interviews and focus group discussions was guided by the multi-stakeholder framework for intervening in roots, tubers, and bananas seed systems (Bentley et al., 2018, Andrade-Piedra et al., 2016). Participants were interviewed using semi-structured interview guides that were developed for each category of actor as part of a larger project on seed systems and markets for vegetatively propagated crops (VPCs)[6]. (International Food Policy Research Institute (IFPRI) et al., 2019). Table 3 provides an overview: a total of 40 semi-structured interviews involving 72 individuals were conducted in June and July 2017 in Nairobi and in two major potato-producing regions of the country: Meru County and Molo area in Nakuru County. Stakeholders at the national level were interviewed in Nairobi. Interviewees were drawn from government agencies, regulatory bodies, industry associations, research centres, development partners, non-governmental organizations, private companies, farmers' organizations, and farm communities.

The interview guides covered topics that ranged from basic stakeholder details to quality assurance standards and practices, to viewpoints on the effectiveness of current policies and regulations. Where just one or two respondents were present, discussions were conducted as KIIs, and where a larger number of respondents were present, they were conducted at FGDs. The difference pertains primarily to how the discussion is managed and how information is presented, discussed, validated, refuted, and revised by participants and the interviewer, with a larger group (FGDs) often allowing for more iterative processes and a single respondent (KIIs) allowing for greater depth in the inquiry. KIIs and FGDs lasted between 1.5 and 2 hours. While almost all interviews were held in English, several interviews were also conducted in other languages.

These interviews were augmented by the collection and analysis of legislative documents, regulatory handbooks, technical manuals, project reports, research papers, and other documents relating to Kenya's potato seed sector. Field notes were compiled and, using a grounded theory approach (Silverman, 2010) (Glaser and Strauss, 1967) reviewed through different theoretical lenses to identify and analyse emerging issues and questions.

[6] The larger project was a collaboration between IFPRI, CIP, IITA, and CIAT, and was funded by the CGIAR Research Program on Policies, Institutions, and Markets (PIM), with additional support from the CGIAR Research Program on Roots, Tubers, and Bananas (RTB).

Table 3: Overview of type of interviews conducted for study

Actor category	Organizations	Nº. of Individuals
Policymakers, advisors, and regulators	5	14
Public research agencies, institutes, centres, and stations	4	11
Small-scale seed entrepreneurs, seed enterprises, and related enterprises	6	16
Medium- and large-scale seed companies	7	12
Industry associations	2	3
Seed traders	-	2
Seed users	-	16
Total	24	72

5. FINDINGS

5.1. Key agencies, actors and their functions

Table 4 summarises the key stakeholders, interests and implications. This shows that within each stakeholder type, there are different scales of operation, with implications for institutional linkages, and seed availability, access and quality for different seed market segments. The findings from interviews conducted for this study highlight topics that are hotly disputed among interest groups with different world views. This has created a series of interlinked "contested" spaces where social, political and institutional factors interact with the technical issues.

Table 4: Stakeholder interests, type of seed production model and implications

Stakeholder	Interests, roles & type of seed production model	Implications
Seed users	Quality seed free from diseases & pests. Smallholders source from saved seed, neighbours, local markets, clean seed producers. Large-scale ware producers source certified seed or manage seed as part of vertically integrated production model.	Smallholders: certified seed too expensive to use & maintain. Mixing "seed" from unknown sources. Limited land: planting on BW contaminated soils. Trust based on own experience & KEPHIS label. Aware of fake and poor quality seed, and desire more traceability. Smallholder and commercial scale seed users have different interests (e.g. varieties, volumes purchased, price point)
Seed producers	Small-scale seed producers (individual, group) consider certified seed production and inspection is expensive. Large-scale seed producers (public, parastatal, private): support from government and donors Different and overlapping interests, and concerns about quality assurance system.	Targeting different market segments Seed companies in stronger position to influence changes in seed regulations. Limited availability of EGS in-country Importation of seed mini-tubers
Regulatory body (KEPHIS)	Assure quality of agricultural inputs; Safeguard against spread of plant diseases.	Balancing strong lobby groups in horticulture export industry;
Seed Traders Association – (STAK)	Represent interests of seed industry (multi &/national). Aligning Kenya seed policies with global seed practices. Advocate for private seed inspection system & self-regulation	Balancing interests of emerging seed companies with the big players; concern that a QDS type approach and informal seed system actors do not have capability to prevent spread of disease without county/regional surveillance programme.
Ministry of Agriculture, Livestock and Fisheries (MoALF)	Coordinate formulation and implementation of policies and strategies for sub-sector	Policies & strategies developed at different times, leading to inconsistencies. Potato now a "political" crop for current government
County Department of Agriculture	Provision of extension services for small holder and commercial farmers Policy implementation Training of staff and farmers on technology transfer	Greater powers under devolved constitution; County legislation must be subsidiary to national laws; however national legislation does not yet reflect changed context at county level Development of Nyandarua county potato strategy
NGOs, Foundations	Support food & livelihood security; "graduate" farmers towards commercial sector	Support for integrated clean seed systems/alternative seed production models; disease free seed production zones. Broker large orders from seed companies to distribute to smallholder seed producers.

Stakeholder	Interests, roles & type of seed production model	Implications
KALRO Tigoni – national potato programme and Agricultural Development Corporation (ADC)	Variety testing/breeding to ensure varieties available for release; Development and dissemination of suitable technologies; Provision of basic seed potato. Research on pest and disease management; Maintenance and supply of breeder's seed; Disseminate research findings to the MoALF and other stakeholders; Capacity building on seed production and marketing.	Disciplinary perspectives may clash e.g. internal tensions around disease spread vs. seed availability. Kenya's national research system and its parastatal seed production units straddle the large companies and small-scale seed providers in the market. They are charged with serving both the smallholder and commercial farming sectors. KALRO-Tigoni, for example, hosts the national potato breeding programme, produces mini-tubers from pathogen-tested plantlets, and serves as a registered seed merchant. ADC-Molo and other parastatals similarly multiply and sell seed on their own farms under their seed merchant licenses, but do not operate out grower schemes for the same quality-control reasons noted for the large companies.
FAO	Support for normative policies for seed trade; plant health Development of QDS approach for seed of grain crops and vegetatively propagated seed, however in-country support dependent on national seed legislation.	For on-going projects imports certified seed potato from Netherlands and purchases from Kisima farms. Support for PCN risk assessment and management strategy.
Stakeholder forum (NPCK)	Represents potato ware and seed value chain stakeholders from public and private sectors. Advocates for place of small-scale seed producers in overall system.	NPCK trying to address disjointed, asymmetric information, lack of coordination – along value chain; and between counties and national government; and counties and research. Advocates for QDS with a disease testing component, and for zoning disease free areas
Policy stakeholders	Balancing needs of smallholder and commercial farming interests	Managing influence of international stakeholders and development partners.
CGIAR	Support for breeding/selection. Validation of seed production models with private sector and NGOs. Pest and disease diagnostics and management strategies.	Different disciplinary perspectives on issues

5.2. Divergent perspectives

The debate on the need for effective regulatory reform of the Kenyan seed sector, especially for VPCs, has been characterized by overt and covert resistance from or on behalf of the "would be" losers. One viewpoint argues for the need to increase the availability of quality seed through "clean seed" approaches to meet national food security objectives. However, this is countered with the argument that only certified seed can meet the quality requirements required to avoid the risk of spread of disease.

The interests and perspectives from different stakeholders on these two narratives are elaborated further below. Smallholder ware producers use different sources of seed: recycled from their own crop, obtained from neighbours, local markets, trained multipliers producing "clean seed", and seed companies or agro-dealers selling certified seed. They may use multiple sources in one season, juggling a series of trade-offs related to price, ease of access, and perceived quality. For example, the local price charged for "clean seed" may be the same as that of certified seed. But there may be higher transaction costs (e.g. transport costs) to purchase the latter. Generally, ware producers interviewed for this study expressed mistrust in the local seed system, whether sourcing from market traders or neighbours. Yet they also have concerns about certified seed. As one male ware producer explained:

> "what has passed as certified hasn't met that expectation, in some instances, even before planting it is not right – so why did I even go and buy certified seed, when I could get from the market".

Smallholder ware producers consider certified seed as too expensive to purchase and maintain, so those that do purchase certified seed do so only in small quantities and then re-multiply and/or mix them with small ware tubers purchased from local markets. The concern of respondents from research and the regulatory organisations is that this practice does little in terms of managing soil-borne diseases. One County Department of Agriculture official explained: "the size of farms means that farmers plant on bacterial wilt infected fields, so even if they plant clean seed it has no value for them".

The many actors producing and or selling seed potato include small-scale individual and group seed producers; medium-scale private seed companies; parastatal seed production units; agro-dealers; and retail market sellers. These seed producers may be closely connected in the seed production chain but serve different segments of the market and may offer rival products, e.g., certified vs. "clean seed" produced with starter seed from a known source vs. seed of unknown source and quality. Given the complex yet integrated nature of this seed system and the broad demand for quality seed in any form, a range of other actors play a complementary role to these seed providers. They include extension staff with the county departments of agriculture who source starter seed and provide technical support to "clean seed" producers while also referring customers to them. Meanwhile, non-governmental organizations, charitable foundations, and their projects provide similar types of support. This is often with the longer-term aim of transitioning small-scale seed producers into certified seed production, based on a model where farmers manage their land collectively to ensure proper crop rotations and isolation distances. As a result of these efforts, many small-scale farmers and farmer organizations have started down the path toward certified seed potato production, relying on basic seed sourced from KALRO Tigoni, ADC-Molo, or private seed companies (primarily Kisima Farms Ltd.). But many have experienced technical (i.e. meeting rotation and isolation standards) challenges in meeting KEPHIS standards, together with cost of production for certified seed production and cost of inspections and have either left certified seed potato production, or shifted to the production of "clean seed", which, in Kenya, is not a legal seed class.

However, this does not necessarily suggest that KEPHIS's role has been singularly focused on assessing and rejecting seed potato produced by small-scale farmers. Several smallholder seed producers interviewed for this study recognized the constructive role played by KEPHIS even in the informal sector. In the words of a female seed potato producer in Nakuru county, "[KEPHIS] can see and identify problems, [that] I cannot". Still, the technical requirements combined with the fixed costs of KEPHIS inspections render certified seed production a prohibitively costly investment for many seed producers operating at a small scale. The addition of variable input costs in the absence of sufficient credit availability makes seed potato production still more challenging. As one key informant, a village-based advisor in Meru noted, "these seeds come with many input and crop management requirements if one is to get a good yield—fertiliser, weeding, strict rotation".

For larger seed companies, the situation is different. Changes in the policy and regulatory framework have led to an increasing number of foreign-owned or multinational companies entering the market for seed potato. Some companies are operating their own tissue culture laboratories and screenhouse facilities for seed potato production, often built and accredited for other crops such as flowers. Some are investing in new seed production technologies (e.g., aeroponics and rooted stem cuttings) with start-up capital from a charitable foundation and the International Potato Center (CIP). None of the companies visited operate contract or out-grower schemes because production under such schemes can often be challenging for quality control and assurance in the case of seed potato. Rather, they depend on their own internal quality assurance systems alongside KEPHIS inspections. Some respondents involved in the importation of Dutch seed potato varieties felt unfairly implicated in the spread of disease and argued for more clarity around seed potato imports and improvements in sampling and diagnostic testing procedures.

But there remains a strong call from many of those interviewed for this study—including farmers who themselves use seed potato—for the Government to focus more seriously on local seed producers and sellers to address quality concerns. Solutions suggested by several respondents include a more active role for KEPHIS in monitoring and regulating the quality of the entire potato seed system through (i) active prevention of fake[7] seed in the market, and; (ii) the introduction of traceability systems for seed potato seed through labelling and other means. This underlines the need to determine an appropriate level of regulation in relation to the costs involved. Moreover, this does not necessarily suggest that market surveillance, seed certification, and labelling will replace the trust that farmers place in the reputation of seed sellers or their repeated experience with a seed seller. Rather, these strategies should be viewed as complements to trust and experience-based relationships.

Figure 1 illustrates these interactions between the "formal" and "informal" seed sectors with different and sometimes overlapping alliances coalescing around the two major narratives: food security or disease risk mitigation. Different stakeholders have varying levels of influence on the processes which guide policy and regulations (arrow thickness reflects the strength of influence). The Ministry of Agriculture, Livestock and Fisheries (MoALF) is responsible for policy guidelines and approving amendments and regulations. The figure shows the strong interactions between the MoALF and KEPHIS. However, the MoALF also has oversight for policy implementation with the devolved county departments where food security objectives have high priority, leading to emphasis and support to increase availability of seed to smallholder farmers. The County Departments of Agriculture (CDAs) provide extension services to ware producers and link them to sources of "clean seed". KEPHIS as the regulatory body emphasises disease risk mitigation objectives and certifies the seed which flows

[7] Respondents gave examples of fake seed, as for example, when in informal markets, small ware potato tubers are sold as "seed", and or, such a product is promoted as "Super Shangi"- riding on the popularity of the released Shangi variety.

from the formal seed sector EGS producer to the few large scale private seed companies. Some certified seed enters the "informal" seed system, to be further multiplied as "clean seed". KALRO as main provider for breeder and pre-basic seed, and to a lesser extent the CGIAR (providing technical support) straddle both scales of seed production. Limited capacity to meet demand has led to importation of seed mini-tubers (for further multiplication) of varieties suitable for the processing industry. There are different donor interests supporting both registered seed companies and smallholder seed producers. The main interactions by ware producers are with small holder seed producers, large-scale seed companies, and the CDAs. Small holder seed producers have limited direct influence on policy processes. However, with devolution – the counties support and represent their interests.

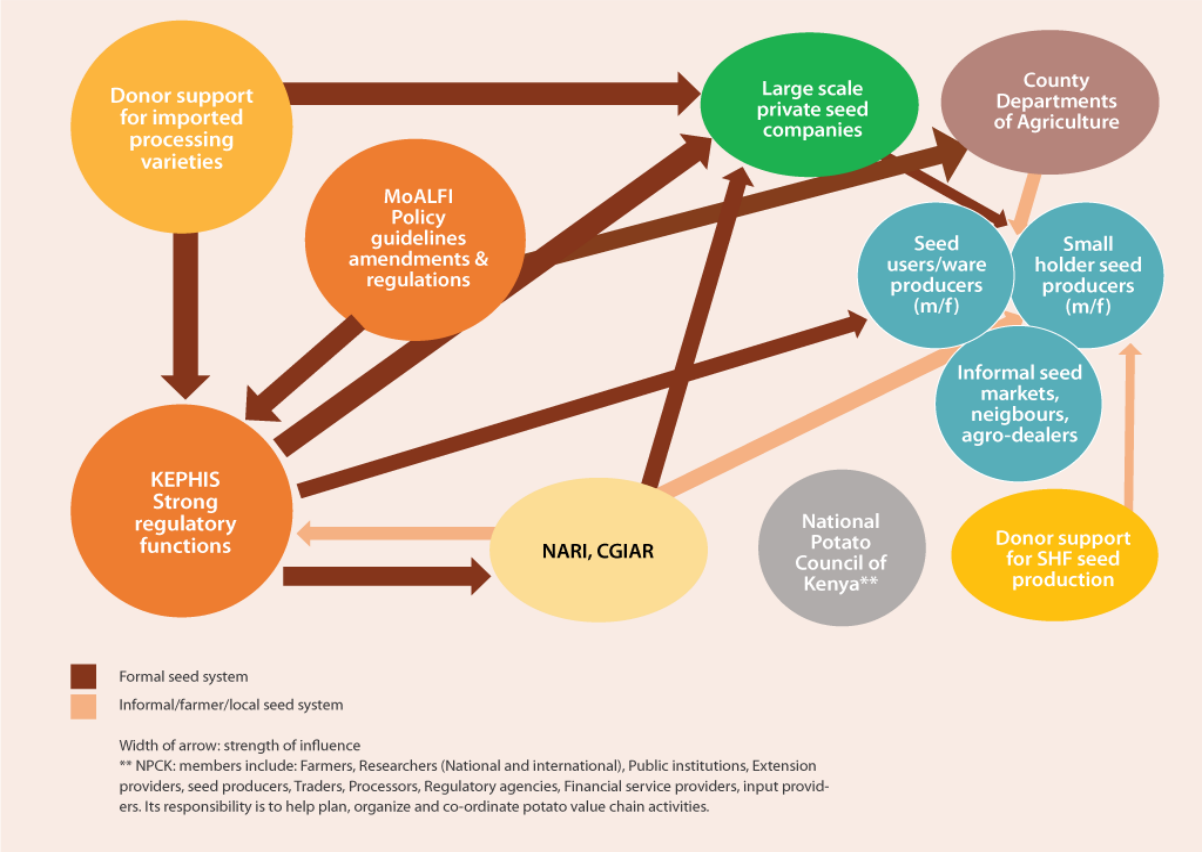

Figure 1: Who sits at the table: stakeholder interactions in seed potato arena in Kenya

The stakeholders that advocate for reforms to recognise "clean seed" production, see the benefits to their constituency—smallholder seed producers and farmers—and argue that the market and industry can self-regulate effectively. However, the regulatory body argues that the industry and nation state stand to lose as debilitating diseases spread through the distribution and marketing of infected seed, and lack of appropriate management of soil borne diseases. The former group is focused on short-term food security whereas the latter is considering a longer-term outlook. The case of PCN in Box 2 highlights these trade-offs. Moreover, once PCN is endemic in any particular area, then zero tolerance in seed potato destined for that area is irrelevant and self-defeating. This emphasises the importance of breeding for host resistance as part of an integrated seed health strategy which would benefit all seed producers.

Box 2: Potato cyst nematode: complex trade-offs for disease mitigation and food security objectives

One of the main pests threatening potato productivity is the potato cyst nematode (PCN) of the *Globodera* spp. genus;[1] With two of the most important species of PCN recently discovered in Kenya (Mwangi J.M. et al., 2015, International Centre for Insect Physiology and Ecology, 2017, Mburu et al., 2018).These are pests have regional and international impact on potato trade, as they are subject to strict quarantine regulations in more than 100 countries and high economic impact on potato production (EPPO 2013). In the UK, PCN causes yield losses ~$US70 million or 9% of national potato production (Nicol et al., 2011). The PCN produces cysts which can persist in the soil for more than 20 years, even in the absence of an appropriate host and withstanding extreme cold temperatures (-15˚C) and/or prolonged dissection (Scurrah et al., 2005). Several species of Solanaceae crops that are regularly used in the crop rotation systems in Kenya (e.g. tomato, eggplant and African nightshade) act as alternate host of PCN. The cultivation of host crops in addition to the traditional maintenance of volunteer potato plants by farmers between planting seasons (GIZ 2014) perpetuates PCN in the soil, increases the nematode populations in the field and makes it virtually impossible to eradicate.

A national survey conducted in 2016 found that 80% of farms producing certified potato seed (including private and public ones) were positive for *Globodera rostochiensis* (Haukeland et al., 2017). In the Seed Potato certification guidelines (KEPHIS 2016) there is zero tolerance for *Globodera rostochiensis* for all seed classes: i.e. breeder minitubers, pre-basic, basic and certified seeds. Thus, a stringent application of the Kenyan law for seed certified production would leave 80% of certified seed farms out of the business. The implementation of management/ eradication programs for small holders would require a colossal financial, human and technical effort by KEPHIs (KEPHIS 2018). Considering the food-security context of Kenya, where potato is the second most important crop grown by small holder farmers. The implementation of a zero-tolerance policy would also require the identification and certification of new seed potato production areas free of PCN, ideally situated in agroecological zones where potato has not been traditionally gown. This could potentially help to address the problem from a seed quality perspective but would have a limited impact on preventing further spread of PCN among ware potato growers who are responsible for the majority of seed potato flows. As observed in other countries, eradication of PCN in Kenya will not occur; but mechanisms should be put in place as soon as possible to minimize the impact of this devastating pest. A trade-off between PCN containment and mitigation systems and food security objectives Kenya, will have to be achieved within the available technical and financial resources, current research gaps, and legislation.

Source: Cortada Gonzalez, L.

5.3. Devolution of state authority

Given this persistent discord, one might see the need for greater coordination and communication aimed at solving the underlying problems. Ideally, the National Potato Council of Kenya (NPCK) plays a role in addressing these tensions through coordination and communication. NPCK is a public-private partnership working on the entire value chain, providing a forum for information sharing, networking and articulation of issues on the entire potato value. It has worked to influence policy that supports seed potato production, e.g. prescribing maximum weight of 50 kg for single package unit of ware potato. However, by its nature it is balancing the needs of different interest groups within its membership, in relation to external interest groups. Likewise, one might expect the Seed Trade Association of Kenya (STAK) to play a role in addressing these tensions. However, STAK's priority focus is on the seed of cereal crops and key informants interviewed for this study generally suggested that STAK has not been a significant actor in conversations around seed potato production, marketing, policy, or regulation.

The transition to the new Constitution in 2010 provided an opportunity for improved coordination by shifting the role of policy implementation to county governments while retaining policy formulation at the national level. This devolution of power provides counties with the mandate and resources to develop their respective comparative advantages in the agricultural sector—including seed potato production and marketing in counties such as Meru and Nyandarua—while also securing technical support and guidance from MoALF, KALRO, KEPHIS and other governmental agencies at the national level.

However, respondents in the survey noted as yet there is very little alignment within MoALF and among the agencies within its purview on an appropriate approach to ensuring the provision of quality planting materials for potato and other VPCs. The National Potato Strategy has failed to deliver on over-arching guidance. For example, it recognized that KALRO is unable to produce enough pre-basic seed, and thus proposed shifting that mandate to ADC, even though this change contravened the existing seed regulations. Naturally, KALRO refused to support this change, but support went ahead to ADC for the provision of additional screenhouse production capacity. Moreover, while the MoALF has supported smallholder seed potato production at county level, with KEPHIS conducting the training, the seed is not certified, and it is the county department of agriculture which provides the buyer of this "clean seed" the assurance of quality. The national potato strategy has never been fully resourced; and subsequently with the change in national ministry responsibilities vis a vis county department of agriculture a National Root and Tuber strategy was developed. This takes a different approach, promoting the involvement of large scale, progressive farmers to meet the seed production target so that all farmers plant certified seed, and which envisages "wiping out the informal seed potato sector" within 15-20 years.

Thus, contention is not limited to the development of competing narratives around what an "optimal" seed system is for potato in Kenya. There is also debate around where real government authority lies. The county governments have greater powers under the devolved constitution, meaning that they have considerable authority—and possibly commensurate resources—to address local food security issues through mechanisms such as the supply of seed to farmers and coordination of seed system stakeholders to increase seed production at the county level. Meanwhile, KEPHIS maintains its regulatory mandate and role of ensuring that only certified seed is produced and distributed throughout the country. This sets up the potential for both coordination or conflict between county governments and KEPHIS. As noted earlier, the decentralization of KEPHIS activities and county-level training provided by KEPHIS to county governments and seed producers suggests strong collaboration. At the same time, however, the very policies and regulations that KEPHIS is mandated to enforce militate against county government activities (including partnership-based projects with NGOs) to produce and distribute "clean seed". While pragmatism may be the operative strategy currently being used under devolution, the inherent tensions between national and county mandates may limit the scope for long-term coordination and the development of Kenya's seed potato system. This has implications for the role of the Council of Governors in harmonising bye laws for the movement of seed potato across county boundaries.

5.4. Equity and inclusion

Differences are also manifested in discussions about the scale required to be a successful seed (and ware) potato producer. We observe that the "clean seed" approach is a point of disagreement for some of the large-scale seed producers, who argue that "clean seed" production opens opportunities for moral hazard. Their primary concern is that the absence of formal quality assurance systems incentivizes profit-maximizing seed producers with short-term outlooks to take risks—producing and distributing sub-standard seed—without consequence.

Their concerns are bolstered by technical arguments that highlight the difficulty in meeting phytosanitary standards on small farms where isolation distances and disease containment cannot be effectively managed.

NGO and CDA stakeholders and some within the MoALF at national level voiced their concerns that this situation raises the question of how strict certification approaches may exclude certain groups, and privilege others to the benefits of income generation opportunities from seed potato production. Smallholders, in particular women with limited land holdings, find it more difficult to practise rotation and physical distancing (i.e., isolation) from other (ware) potato crops. Moreover, the imported Dutch varieties of seed potato are more expensive to buy as royalties are paid and these varieties require more inputs and intensive management practices.

The private seed companies with larger land holdings or capacity to rent land can meet isolation and rotation requirements and achieve economies of scale that reduce the unit cost of production. These companies also have access to a wider range of potato varieties from the Netherlands, Scotland, and CIP, in addition to the varieties developed and released in Kenya. Yet even with these resources and support, many companies require four to five years to break even on seed potato production and to achieve economies of scale, which is an unrealistic scenario for smallholder seed producers. As such, most of the seed companies prefer to sell certified seed potato in the standard units (50kg) and to customers requiring large volumes (i.e. several tons) of seed potato. This means that they tend to market their products toward large scale ware farmers, NGO projects, MoALF, and KALRO. When they do sell to farmers, it is usually to farmer groups and small-scale multipliers who then divide the bags among themselves for onward multiplication for "clean seed" or ware potato production. These companies also provide extension and advisory services to farmers—training and field days—to raise awareness and encourage farmers to use quality seed.

Several of these companies are also innovating in seed potato production (including hybrid potatoes and the use of true botanical seed[8]) to reduce costs, increase multiplication rates, or otherwise create more commercially viable operations. Often these technologies will require adaptations in cultivation technologies, distribution systems and regulatory frameworks. They may also require investment in specialized technical knowledge and skills, as well as proper facilities, which may be beyond the reach of smallholder seed producers. However, by increasing availability of quality seed at lower cost, technologies such as rooted apical cuttings have the potential to benefit smallholder ware producers (Parker, 2019). Once planted in the field, an apical cutting produces 10-25+ seed tubers, compared to 5-10 seed tubers per mini-tuber (at costs of USD 0.10 and USD 0.15-0.30, respectively). Given the high productivity of rooted apical cuttings, it is economical for multipliers to sell quality seed after two seasons of field multiplication, and after three seasons, it is highly profitable. This is compared to commercial seed produced from minitubers, which is usually sold after three to four seasons of multiplication. It takes a multiplier who starts with minitubers a minimum of 9 months to produce a commercial crop of seed tubers, whereas those who start with rooted apical cuttings produce a crop within 3-4 months. Using cuttings as starter material for seed production reduces the time it takes to produce commercial seed by one year compared to minitubers, boosting the profitability of seed multiplication and the supply of quality seed available for farmers (Parker, 2020). Moreover, this form of seed allows differentiation with ware potato, thus being able to send a clear signal to the buyer. This technology is now recognized under Kenya's seed regulations as the same as tissue culture (G0 seed) so that an increased number of generations can be multiplied before commercialisation which, in turn, increases profitability.

[8] See https://www.solynta.com/ https://knowledge4food.net/wp-content/uploads/2017/02/161130-Report-Solynta-mission-to-East-Africa.pdf

Ultimately, these findings suggest areas of both overlapping and divergent interests around the appropriate scale for seed production and marketing. The diversity of seed producers in Kenya's potato market is not without its challenges for equity considerations in policy and regulation. Frequent concerns cited by respondents to this study revolved around the insufficient quantities of mini-tubers and pre-basic seed available to commercial producers in the market. This points to underinvestment in KALRO's capacity to provide high-quality early generation materials, as well as underinvestment by the private sector in the production of commercial materials but could also point to lack of effective demand for seed. Further, several respondents recognize the underlying discord between the *de jure*--regulations that only permit market exchanges of certified seed—and the *de facto*—the widespread trade in uncertified seed. This plays out in terms of who grows which varieties for seed and ware production, and how seed quality is assured through both internal and external mechanisms. One consequence of these tensions is a persistent deficit of quality seed for small-scale farmers.

5.5. Regulatory policing vs. regulatory guidance

Left unresolved, this situation may have few short-term consequences. But as private investment in Kenya's seed market increases, pressure on the policy and regulatory framework to address this discord will likely increase. This opens the door to a deeper discussion of KEPHIS, the regulator of Kenya's entire seed system. KEPHIS's responsibilities range from the local— ensuring that seed traded in the market is compliant with the statutory provisions governing seed production and marketing—to the international—ensuring compliance with UPOV on plant variety protection and with Common Market for East and Southern Africa (COMESA) on the harmonization of seed trade. Most importantly, KEPHIS is mandated to ensure that all seed merchants formally register their business interests in seed production, and that seed that meets the certification standards according to class which, in the case of potato, is limited to pre-basic, basic, certified 1 and certified 2.

While there is consensus that KEPHIS has been effective in ensuring compliance with certification standards, there has also been long-standing criticism of the organization for presiding over an industry that is unable to meet the demand for quality seed, especially of VPCs including potato. The low volume of certified VPC seed is attributed to the stringency of KEPHIS's seed certification requirements, much of which was designed for cereal crops where production can be more readily centralised and where inter-seasonal storage is less of an issue than it is with VPCs. As a result, the language often refers to "seed lots" and "germination tests" that are appropriate to maize and other cereals but less so to potato and other VPCs (Kaguongo et al., 2014). Similarly, references to the number of allowable generations from breeder to certified seed that can be multiplied tends to reference standard practices for maize hybrids (where a small number of generations between breeder and certified seed is desirable). But this is wholly inapplicable to potato with low multiplication rates so that any restriction in the number of generations allowed within a seed class reduces the economic viability of seed production. As a result, KEPHIS has faced pressure to relax its requirements on seed potato production and marketing and to allow increased private (especially farmer) participation in seed production. But while the 2016 revision in the seed regulations introduced some changes to domesticate and operationalise international conventions to which Kenya is a party, and which is to the benefit of private large seed companies, potential small-scale seed producers still face significant hurdles. For small-scale seed producers, these hurdles are set forth in the requirements for registration as seed merchants, which include: (i) having enough land to meet the specifications on isolation and separation distances; (ii) paying for registration and inspection, and (iii) meeting the costs of pathogen testing. KEPHIS has also been criticized for the delays in getting inspections conducted in time, mainly due to shortage of staff and vehicles to transport the inspectors to the field.

Several actor coalitions have pressured KEPHIS to effect regulatory reforms in its operations, responsibilities, and mandates. In the most part, the call for reforms have been vocalized publicly. Examples include suggestions designed to benefit small-scale farmers engaged the seed production: more affordable KEPHIS charges and high standards; farm inputs subsidies and financial support; and allowing "clean seed" as a seed class in the market or a QDS type approach, so long as there is traceability back to a certified seed generation. There have also been more discrete actions taken by actor coalitions to signal discontent with the status of seed potato market in Kenya. For instance, departments of agriculture at both the state and county levels continue to actively promote the production and sale of uncertified "clean seed", in violation of the regulatory framework. Meanwhile, KALRO, NGOs, CIP, charitable foundations, and donor-funded projects train and support farmers in the production and marketing of "clean seed" under village seed enterprise schemes, and train farmers in the on-farm maintenance of seed quality, which improves the quality of recycled seed. And foreign companies and donor-funded project continue to exert their influence on the seed potato industry sector in ways designed to open the door not only to greater foreign investment, but also to the importation and licensing of planting material from abroad. Large seed companies supported by donor governments argue that additional generations of certified seed should be allowed in the seed standards. At present C1 and C2 are allowed. Allowing C3 through C7 to be sold as certified seed with some level of quality assurance, would reduce the price of certified seed and would bridge the gap in supply and demand rather than the promotion of "clean seed".

Both KEPHIS and private companies have stated that alternative seed classes are not a viable solution because they are subject to non-compliance and abuse that ultimately leads to the spread of pathogens[9]. Many of these same companies also believe that small-scale seed potato production is simply not a viable option for Kenya: neither quality nor scale economies are feasible in these production systems. The result: allegations and counter-allegations around the origins and causes of potato diseases in Kenya and very little progress is resolving the policy and regulatory discord that persists in the country.

The continuous pressure from multiple actor coalitions has led to several changes in the policy and regulatory framework governing seed potato production and marketing in Kenya. Some of these changes have been small and piecemeal while some have the potential to bring about lasting improvements. For example, in 2012 accredited third-party seed inspectors trained by KEPHIS were permissible, meaning that inspections need not depend solely on the availability of a KEPHIS inspector. However, the roll out has been limited and taken time. Relatedly, accredited private laboratories for pathogen testing are now permissible. Scratch cards have been incorporated into the labelling/packaging for the seed of high value crops to aid traceability. Further, small-scale seed producers can now be registered as outgrowers under a seed merchant's licence. Finally, KEPHIS has undergone a considerable degree of decentralisation, thereby bringing its services closer to farms and farmers.

At the heart of Kenya's policy and regulatory challenge in the seed potato market is the role of regulation and the regulator. Should regulators assume a policing function following strict interpretation of the law, or should the regulator take on a more guiding role. County governments, research centres, and NGOs have invested considerable resources in training smallholders to produce "clean seed"; however, a strict interpretation of the seed law infers that selling seed which has not been inspected and certified is illegal. Thus, some stakeholders are concerned that the regulatory system is policing rather than facilitating efforts to increase availability and access to seed, and this leads to exclusion of certain groups from opportunities in the potato seed market. But the flow of seed potato from multiple sources leads to continued and potentially increasing contamination of

[9] Currently (2020) there are on-going consultations to define "standard seed" (for which a provision was made in the 2012 revision of the seed regulations) for small grains, legumes, cassava and sweetpotato, with some relaxation of disease and pest thresholds.

soils that affect both seed and ware production and productivity. Yet there seem to be few efforts to strike a reasonable balance between the needs of smallholder seed (and ware) producers, on the one hand, and the overall health of the potato production system—including its soils—on the other hand. The risks of a lose-lose situation are non-trivial.

5.6. Trade, development, and commerce

Contestations are also observed in competing investment strategies in seed potato production systems. Kenya hosts an active coalition of private-sector interests that advance business models which rely on the importation of proprietary potato varieties and seed potato suitable for industrial processing—varieties that represent a potentially lucrative growth industry for Kenya but are currently key to a relatively small niche. However, these imported varieties and seed are more susceptible to diseases and require high inputs and more intensive management. In short, the niche they are designed for is not particularly relevant to most potato farmers in Kenya—those small-scale farmers whose credit and market participation constraints limit the relevance of processing varieties to their production systems. Nor are such varieties relevant to the taste preferences in the fresh ware market. This is not to suggest that these two seed and production systems are antithetical: they can readily operate side-by-side in Kenya. But the growth of the more industrial model requires a policy and regulatory regime that actively manages seed quality, ensures phytosanitary compliance in imported materials, and protects plant breeders' rights. These requirements may be either irrelevant or inappropriate to the smallholder model. But the policy and regulatory regime neither acknowledges nor distinguishes between these two models. This leaves Kenya's seed potato market open for continued competition between coalitions with equally compelling but very distinct narratives.

5.7. Future policy options

Our findings and analysis demonstrate that there is persistent pressure for change in Kenya's seed potato system as coalitions of actors vie for space to protect their interests and values. These coalitions have formed around several but sometimes overlapping narratives: ensuring short term household food security versus ensuring plant and soil health which contribute to long term national food security; devolution of state authority versus consistency in national regulatory mandates; market growth versus equity and inclusion; and development of industrial production models versus advancement of smallholder production systems. These coalitions pit different branches and levels of government against one another, place development actors in opposition to state regulators, and squeeze farmers from both sides. Critical and long standing concerns around disease and pest management underly these debates. That said, there are several constructive options that could assist Kenya move forward as a whole. We discuss several of these options below.

The first option—is to introduce explicit recognition in the legal and regulatory framework of the dual production models and systems that exist in Kenya, along with recognition that the systems are interlinked and may, in due course, become explicitly integrated in both purpose and form. The current situation—recognition of a formal seed potato system that serves only a small share of the market alongside general disregard for the informal system—is untenable given their relative importance to the overall seed potato system and the long-term prospects for integration.

This relates directly to a second option: creating separate regulations for seed potato systems based on the production system and relative risks in those systems. This may entail agreement on realistic seed standards under the existing "standard" seed class, as well as a greater reliance on self-regulation and truthfully labelled

seed based on trust: in other countries (e.g. India) this may work, with a higher percentage of farmers buying seed, and a strong legal system to redress complaints. Some organisations are supporting this approach through encouraging seed producers to cluster, to be able to meet isolation distance and rotation practice requirements. This requires investment in building production and business capacity of medium scale seed producers, registered as seed growers, sourcing pathogen tested starter seed every year, linked to markets and the regulator through an ICT platform. This approach would need to be complemented by zoning of uncontaminated land or only allowing land where rotation practice had been strictly adhered to. However, for Kenya, the current land tenure system, and landholding size may not be amenable to this approach; and, experience of cooperative farming approaches has a mixed history in Kenya.

This highlights a third option - the need for policies and investments to provide more space and support for integrated seed health strategies to respond to specific disease and crop contexts. An integrated seed health strategy seeks an optimal combination of the use of and appropriate inflow of certified seed (including re-focusing formal seed potato certification to the early generation levels of pre-basic and basic seed), with increased investment in farmer seed management and good agricultural practices, and in accelerated breeding efforts for host resistance; the latter being the only realistic approach for managing BW and PCN[10].

Finally, recognising that these options involve multiple actors with divergent perspectives—it is crucial to identify or negotiate towards common interest spaces through inclusive stakeholder consultations. This is already being actively pursued by the Government of Kenya through consultations with value chain actors on the design of regulatory guidelines for VPC seed systems, and through consultations on the development of action plans for potato value chain development. Systematic, structured, and documented stakeholder consultations are essential to identifying areas of common interest where competing coalitions can compromise and coordinate, and to identifying areas where such compromises or coordination cannot be readily achieved—which together create a sense of shared ownership and responsibility among stakeholders.

[10] However, creating resistant varieties will take years and major changes in the perception of the public towards GM crops.

6. CONCLUSIONS

This paper assessed the implications of the current seed regulatory framework for seed potato in Kenya. Based on the experiences of different stakeholders of the implementation of seed regulations and standards, it examined the options for quality assurance system for VPCs in Kenya to improve availability, and access to quality seed for ware producers. Efforts to pilot alternative quality seed production models – are challenged from scaling – because the current regulatory framework creates trade-offs in terms of meeting the demand for quality seed and managing the risk of spread of plant diseases and pests. This creates tensions between central agencies and the devolved county governments. The latter have the objective to improve food security through supporting farmer group seed production models, where seed is predominantly shared among members. The former adheres to the national seed regulatory framework. This puts in jeopardy the national plant health system where there are biological interactions at farm, county, regional and national levels.

In the context of market and coordination failures, due to high transaction costs, stakeholder interactions around the regulatory process are manifested as different contested spaces. The findings point to examples of how different interest groups (operating at international, regional, national and local levels) and underlying power relations have induced recent amendments to the seed legislation (e.g. liberalization of seed laws, private inspectors). However, there remains mis-trust among the different actors around the supply and quality of seed. This has led to questions about the appropriateness of the current regulatory framework for seed potato, where seed certification schemes would have limited impact on containing and preventing further spread of pests and diseases such as PCN and BW among ware potato producers with more than 96% of seed flows. Co-ordination in the sub-sector is hampered by uneven power relations, leading to short-term winners and losers in the on-going reform process.

Empirical findings highlight the critical need for national regulatory frameworks to acknowledge the role of plural seed systems and approach quality assurance (through appropriate institutional and technological changes) in a holistic and comprehensive manner to improve the overall plant health system. This approach has been advocated in other country contexts (Sperling et al., 2014, Almekinders et al., 2019, Louwaars and de Boef, 2012). However, current seed regulatory frameworks in countries such as Kenya are not supportive of such integration (Munyi and De Jonge, 2015). For VPCs such as potato where most seed moves through the informal system it is imperative to re-shape the regulatory space to recognize that the different seed systems (and related ware production systems) are linked and interdependent and that trade-offs are required so that both can be accommodated within the national development discourse. This would require harnessing latent stakeholders (e.g. Counties) to interact with specialists over different options to achieve policy objectives learning over time who could induce institutional innovation to put in place a plant health system and determine an optimal quality assurance system for seed potato in Kenya.

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