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The importance of inspection and certification in sustainable production of cassava in East Africa:
A case for Uganda and Rwanda

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Today more than 800 million people around the world suffer from chronic hunger and about 2 billion from under-nutrition.

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The AgriFoSe2030 program directly targets SDG 2 in low-income countries by translating state-of-the-art science into clear, relevant insights that can be used to inform better practices and policies for smallholders.

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Summary

In East Africa, cassava productivity has declined in the last 20 years, yet the crop has a great potential to significantly contribute to food security and incomes for the subsistence farmers. The crop is tolerant to poor soil conditions and is resilient to the vagaries of drought and climate change. Several case studies in the East African region and in Uganda and Rwanda in particular, have highlighted the key challenges to cassava production and productivity. The production challenges are associated with the increased prevalence of pests and diseases, lack of quality (pathogen-tested) planting material, ill-defined seed system structure and lack of statutory regulations to guide the cassava seed value chain. In general, available seed and plant regulations in the region is tailored for grain crops including cereals and legumes. Seed regulations for vegetatively propagated crops like cassava are however lacking in the region. Functional cassava seed systems, guided by explicit regulations, would ensure development and promotion of appropriate varieties, relevant inspection and certification regimes. In this report, we provide key intervention areas that can strengthen a sustainable cassava seed system that ensures availability of quality planting material in adequate quantities at the time of planting. Emphasis has been put on aspects that can guide policy development to support sustainable cassava seed systems and viable cassava value chains for food and income security.

Front picture: A farmer showing cassava root yield potential in Rwanda. Photo taken by Athanase Nduwumuremyi

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List of abbreviations

ACET: African Center for Economic Transformation
CARP: Cassava Community Action Research Project
CBSD: Cassava Brown Streak Disease
CIP: Crop Intensification Program in Rwanda
CMD: Cassava Mosaic Disease
DSIP: Development Strategy and Investment Plan
EAAPP: East African Agricultural Productivity Programme
EAC: East African Community
FAOSTAT: Food and Agriculture Organization Corporate Statistical Database
ICT: Information and Communications Technology
IFAD: International Fund for Agricultural Development
NaCRRI: National Crops Resources Research Institute
NARs: National Agriculture Research
NISR: National Institute of Statistics of Rwanda
OECD: Organisation for Economic Co-operation and Development
QDS: Quality Declared Seeds
RAB: Rwanda Agriculture and Animal Resources Development Board

BACKGROUND

Cassava (*Manihot esculenta*) productivity in East Africa has declined in the last 20 years, yet the crop has the potential to significantly contribute to food security and incomes for the rural poor. Cassava has the potential to contribute to the bioeconomy of the East African countries through post-harvest processing and value addition producing products such as quality flour for confectionaries, starch and ethanol for various industrial applications. Cassava productivity decline is associated with the increased prevalence of pests and diseases. Virus diseases, in particular, Cassava mosaic disease (CMD) and Cassava brown streak disease (CBSD) are by far the most important production challenges to cassava production in East Africa. These diseases are both vector and seed-borne, and cause devastating effects to yield and quality of cassava. The situation is exacerbated by the inability by the farmers to have timely access to quality (pathogen-tested) planting material in adequate quantities at the time for planting. These challenges can be overcome by development of a sustainable and efficient seed system interconnecting the key stakeholders in the seed value chain.

Development of an efficient cassava seed system also requires appropriate inspection and certification regimes that are largely lacking in Uganda and Rwanda (Mukasa, 2016; Nduwumuremyi *et al*., 2016). Farmers also need appropriate information on variety use attributes, agronomy, pest management, and opportunities for value addition and marketing products. In this report, we provide key intervention areas that can contribute to a vibrant cassava seed value chain involving seed producers, growers, traders, and government regulatory frameworks to revolutionize cassava production in East Africa. Therefore, this report draws on insights from previous initiatives in East Africa, and with references to developments in other regions that grow cassava on a commercial scale and are using formal seed systems to a large extent, to make recommendations for development of a sustainable cassava seed system.

CURRENT STATUS OF CASSAVA GROWING IN UGANDA AND RWANDA

Cassava plays a very important role in both household and national food security in Uganda and Rwanda. It is estimated that in some parts of Uganda nearly 90% of the people consume cassava in different forms and on a daily basis. Cassava is one of the eleven commodities that have been prioritized by the Government of Uganda in its Development Strategy and Investment Plan (DSIP). In Rwanda, cassava is grown mostly by smallholder farmers for subsistence; it is consumed in various forms (raw, paste or ugali, boiled for breakfast, mixed with beans, vegetables, etc.) and its preparation and consumption vary among communities (Nduwumuremyi *et al*., 2016). Demand for cassava is expected to increase at a faster pace than its supply as new alternative uses emerge and as consumer preferences change with the development of new cassava products. In Uganda (3.05 t/ha) and in Rwanda (7.2 t/ha) cassava yields are far below the global figures of 15-20 t/ha (FAOSTAT, 2016). These low yields have been attributed to lack of access to improved varieties, poor soils, inadequate planting density, inadequate weed management and water stress, as well as the effects of diseases. Use of fertilizers is also rare as cassava has always been viewed as a subsistence crop. Closing the considerable yield gap between actual and attainable cassava yields at farm level will, therefore, require integrated use of improved varieties, quality planting materials, good soil fertility management practices, and pest and disease management practices.

The cassava seed system in EAC is predominately informal where farmers use their own saved seed, acquired seed from neighbours or from unregistered seed suppliers. This system does not allow for seed quality control and provision of adequate quantities at times of planting. Recently, Rwanda Agriculture and Animal Resource Development Board (RAB) reported 104,000,000 cuttings of pathogen tested cassava varieties (NISR, 2015) produced and distributed to farmers, but the estimated need for cuttings was 1.5 – 2.0 billion cuttings. Thus, the distributed cuttings represented 5.2% of the total cuttings demand. Though the use of traditional seed sources of low quality affects the productivity of cassava negatively in the country, there is no business enterprise or seed company involved in cassava seed production. This is largely due to the vegetative nature of cassava multiplication and low returns to investment in the cassava seed business. Most of the efforts to supply cassava seed in Uganda and in Rwanda have so far been the responsibility of the governments and development partners.

Because of the low productivity, cassava has remained less competitive compared to its close substitutes with respect to provision of starch (carbohydrates) to subsistence farmers. However, emerging cassava processing factories such as Kinazi Processing Plant commissioned in 2012 by the government of Rwanda with the capacity of processing 120 tons of fresh roots per day will increase demand for cassava. Similarly, in Uganda, the industrial use of cassava roots has only recently begun, and the quantities used as industrial raw materials are very small (3%) compared to the amounts of cassava used for food consumption (97%). This followed the opening of the ethanol extraction factory, Kamtech Logistics Plant, in Lira District in northern Uganda in 2015. We therefore need to focus more on how to reduce the unit cost of producing starch and to diversify its uses e.g. in cottage industries. Such an increased demand for cassava roots will create a demand pull for quality planting material and thus sustainability, a process that has to be guided by appropriate regulations and policy environments.

VIRUS DISEASES AND INITIATIVES FOR THEIR MANAGEMENT

Cassava mosaic disease (CMD) and Cassava brown streak disease (CBSD) are by far the most important factors limiting cassava production and productivity in East Africa. Since the first reports of CMD and CBSD in East Africa in 1895 and 1931, respectively, no report of their outbreak has been recorded outside Africa. The prevalence of the more devastating CBSD is currently limited to eastern and southern Africa (Mbewe *et al.*, 2017). Both diseases are whitefly transmitted and are also seed-borne – the quickest and most important means of transmission especially for CBSD. CMD can cause more than 50% yield loss in susceptible varieties and the more devastating CBSD can cause up to 100% yield loss (Legg *et al*., 2017) through associated root necrosis and rotting (figure 1). Both diseases continue to be key biotic stresses that severely limit optimal cassava productivity; yet, they could be managed through use of pathogen tested or virus-free planting material and phytosanitation procedures through government mediated inspection and certification services.

Figure 1. Sypmtoms of cassava virus diseases: A) a popular landrace (*Bao*; with arrow) in northern Uganda severely stunted by CMD compared to the adjacent CMD resistant variety TME204, B) a farmer from Serere district (eastern Uganda) displaying roots with early stages on necrotic lesions (brownish dead tissues) due to CBSD on a recently relesead cassava variety NASE19. (Photos: Courtesy of Settumba Mukasa).

Landraces and officially-released cassava varieties are commonly grown by farmers on the same piece of land and have varying susceptibility levels to virus diseases. For sustainable control of cassava virus diseases, deployment of disease tolerant varieties in combination with community phytosanitation as practiced in Lake Victoria basin in Tanzania (Legg *et al*., 2017) provide great promise. Molecular and tissue culture techniques are now available to enhance testing and production of disease-free planting material. These interventions have been tested through the Cassava Community Action Research Project (Cassava CARP) at Makerere University, in various parts of Uganda, and Twigire Muhinzi approach and the Crop Intensification Program (CIP) in Rwanda (*Text Box 1*).

Text Box 1: Case Studies on cassava research initiatives in Uganda and Rwanda

The Cassava Community Action Research Project. The Cassava Community Action Research Project (Cassava CARP) was aimed at enhancing sustainable production, processing and marketing of cassava and cassava products among the smallholder cassava farming communities in Uganda.

The primary entry point of the Cassava CARP was to ensure access to quality (pathogen tested) cassava planting material of farmer preferred and elite varieties. Through community knowledge workers, the project engaged the communities in solving their challenges through the cassava innovation platforms in northern Uganda and in eastern Uganda. Farmers can now use mobile and web applications to access the community based extension system around the cassava value chain as farmers learn to consult each other and share experiences via the ICT platform (http://www.cassava-carp.org/). This was piloted in only 4 districts of Uganda namely Apac, Bukedea, Kole and Serere where cassava plays a vital role as the sole starch staple for the communities.

The Crop Intensification Program (CIP). The Crop Intensification Program (CIP) in Rwanda was launched September 2007, as a pilot program with the main goal of increasing agricultural productivity in high-potential food crops and ensuring food security and self-sufficiency. The program covered all districts with the main activities being land use consolidation, improved seed and fertilizers use, proximity extension service by proximity service providers, agricultural product marketing, change in farmer's behaviours, promotion of agro-inputs dealer's network, stimulate reliable, private-sector input and output markets through fertilizer electronic auctions.

Under these initiatives, protocols for molecular diagnosis of cassava virus diseases and virus elimination were developed (Mbanzibwa *et al*., 2011; Wasswa *et al*., 2010). Tissue culture and miniset multiplication protocols were optimized (figure 2; 3) for scaling up commercial production of quality planting material. Under the Cassava Seed System Project at National Crops Resources Research Institute (NaCRRI) at Namulonge in Uganda, inspection and certification were piloted in selected districts of Uganda. A study of farmers and farmer groups involved in the *Self Help Africa* project in Kenya found that 76% of farming households that had received quality cuttings had increased their yields by 30%, while cassava production cooperatives involved in processing the tuber and selling chipped cassava had increased their incomes by nearly 140% (Self Help Africa, 2018).

Figure 2. Tissue culture multiplication and hardening of cassava plantlets for production of cassava planting material: A) tissue culture laboratory production stage, B) hardened tissue derived plantlets in a screenhouse humidity chamber, C) Hardened plantlets ready for field planting as basic seed after inspection. (Photos: Courtesy of Athanase Nduwumuremyi).

Figure 3. Multiplication of cassava planting material using mini-cuttings (minisets). A) establishment of minisets in a humidity chamber, B) cassava plantlets ready to plant in the field as basic seed to provide certified seed. (Photos: Courtesy of Athanase Nduwumuremyi).

SEED CLASSES FOR VEGETATIVELY PROPAGATED CROPS

There are a number of seed classification systems that categorize seed according to genetic purity and quality standards. These classes, for purposes of seed production and marketing, are well described in the Seed Acts of the East African Community (EAC) member countries as: i) Pre-basic seed, ii) Basic seed, iii) First generation of certified seed (C1), iv) Second generation of certified seed (C2), and v) Quality declared seed (QDS). QDS was considered following harmonization between the OECD and the National Seed Policies in East Africa. The pre-basic seed class represents breeders' seed of generation preceding basic seed. Certified seed is defined as a class of seed produced under a certification programme from basic seed and can be of two generations (C1 and C2). The certified class is the allowable quality for a commercial farmer to have value for investment (The Seeds and Plant Regulations, 2017). Certified seed producers are registered with the respective national seed inspection and certification bodies in the respective EAC countries.

The current seed classification, and the seeds and plant regulations in EAC were developed for grain seeds – and not for vegetatively propagated crops. In Tanzania, a subsidiary legislation was passed as a supplement to the Seed Act in 2017 to include vegetatively propagated crops like cassava, potato and sweet potato. Standards and guidelines for production of cassava planting material in Uganda and Rwanda have been proposed to include three key seed classes of i) Pre-basic seed, ii) Basic seed and iii) Certified seed, based on some quality criteria including the production environment (Mukasa *et al.*, 2016). The certified seed crop would then be allowed to ratoon. The first ratoon crop, and probably a second ratoon crop, could also be used as source of planting material.

POLICY RECOMMENDATIONS FOR SUSTAINABLE CASSAVA SEED SYSTEMS

A good seed system ensures sustainable access to or provision of quality seed in adequate quantities as desired by farmers at the time of planting and affordable prices. All these components are interrelated although may be executed by different actors within the seed value chain including government (inspection and certification), seed growers, researchers (who develop new varieties), processors and traders. The interrelations between the key actors can be spelt out in appropriate guidelines, regulations and policies that relate to the nature of the crop and the socio-economic environment. We have identified key features of enabling policies and interventions for a sustainable cassava seed system that are hinged around various aspects of the cassava quality seed value chain as illustrated below.

Promote generation of niche cassava varieties

Significant work has been done by the National Agricultural Research Institutes in Uganda (NaCRRI) and in Rwanda (RAB) to develop high yielding, disease and drought tolerant cassava varieties, which are already being grown by farmers. Also, farmers grow land races with preferred attributes like culinary properties albeit lower root yields. The released varieties e.g. NASE 3 (TMS30752), NASE 13, NASE 14 (MM96/4271), NASE 19 and NAROCASS1 were largely selected for high root yield (up to 40 tons/ha) and tolerance to the virus diseases like CMD and/or CBSD. Unfortunately, varieties tolerant to CMD tend to be more susceptible to CBSD and vice versa. Developing a disease tolerant and a super variety that has all the attributes liked by farmers, traders, processers and final consumers may require more rigorous breeding and selection programmes and thus more research support. The varieties developed and released should strongly be linked to niche markets. Cassava varieties could be categorized according to end-use purposes such as for fresh root consumption, flour for local food dishes, high quality flour (for confectionaries), starch (for industrial purposes), animal feed, and bio-ethanol (for industrial purposes). Therefore, governments should continue to support variety development. For instance, public or private institutions need to be supported to conserve disease-free pre-basic seed, for further scaling up and dissemination to farmers by seed merchants.

Support awareness of the consequences of poor quality cassava seed

Many farmers are ignorant of the symptoms and the consequences of not controlling cassava seed quality. Thus, a combination of comprehensive and sustained aggressive publicity campaigns and phytosanitation measures will stimulate removal of infected plants to eliminate infection sources and thereby to reduce the disease spreading in non-infected plants lowering virus inoculum and disease spreading in farmers' fields. To increase motivation for farmers to buy clean planting materials, their awareness about disease symptoms and causes needs to be greatly enhanced. Local governments have a key role to play in this regard. They are closer to the cassava farmers and their engagement can reduce the cost of inspection while at the same time increase trust. They can also play a big role in publicity and awareness creation and local cassava business development. Inspection and certification schemes for cassava planting materials have been piloted in Uganda and in Rwanda and but need to be further institutionalized and supported for large-scale uptake and impact.

Support seed quality standards and laboratory testing.

Quality of seed is envisaged to greatly contribute to increased cassava productivity and eventual lowering of the unit cost of production. Issues of seed quality include physiological state, genetic purity, and freedom from pests and diseases. Under field conditions, the tissue culture derived virus-free planting material can rapidly get infected by viruses especially in the high disease pressure zones and without appropriate isolation distance (>100 m). Over 70% infection rates have been recorded for susceptible varieties in central Uganda and Rwanda within one year. To ensure production of quality planting material, government should support development of robust inspection and certification guidelines with tested standards that take into consideration the subsistence cassava cultivation. It should be noted that agronomic practices and certification requirements for vegetatively propagated crops are different from grain crops e.g. cereals and legumes. Therefore, supplementary or subsidiary legislation to the present seed and Plant Act of the respective countries are needed urgently. These guidelines should cover production of basic seed (under protected environment or net houses) and certified seed. Robust detection and diagnostic methods are essential for improving quarantine security and bringing national phytosanitary regulations into line with international trade conventions and protocols. This is another area that requires deliberate government investment and/or engagement with private sector diagnostic laboratories.

Support community based multiplication quality cassava seed

In order for farmers to realize the yield potential of cassava, they should be able to access adequate quantities of quality and disease-free seed in time for planting. They should also get the planting material at an affordable price. The cost of inspection should be kept low as well as transportation cost given the bulky nature of the cassava planting material (cuttings). Mother gardens for production of basic seed or field production of certified seed should be located in close proximity with the farming communities while at the same time allowing for the minimum isolation distance to avoid disease re-infection. Decentralized multiplication in small fields (5-20 acres) managed by farmers could serve as mother garden in communities where beneficiaries receive small amount of pre-basic seed each year as starter material. In Rwanda, a similar approach has been tried with farmer cooperatives for production of pre-basic seed (tissue culture derived plantlets or macro-propagation in net-houses through minisets) through initiative of IFAD to support farmers' access to clean cassava planting materials. This is done by promoting macro-propagation techniques in decentralized screen-houses constructed in farmers' proximity. Large (>50 acres) certified seed multiplication sites stand a very big risk of infection given the large abundance of cassava virus vectors and spreading the diseases in case of failure to ensure 100% surveillance.

Therefore, government should support a decentralised or community-based approach for production of cassava basic seed.

An appropriate cassava seed production and delivery model

Building on previous case studies in the region and innovations at Makerere University and RAB, in areas of rapid tissue culture multiplication, virus diagnostics and a 3-stage model for production and delivery of pathogen tested cassava planting material; we propose adoption of the model below (figure 4). This model would be used to track movement of planting material between actors. The three stages follow the three key seed classes of “pre-basic seed”, “basic seed” and “certified seed” seed. Pre-basic seed would first be assembled and then multiplied in the plant tissue culture laboratory ensuring genetic purity and pathogen testing (stage I) or under insect-proof net houses or protected environment. Basic seed would be produced from pre-basic seed source under well isolated (>200m) open fields for 1-2 years (stage II) and finally in the field by the selected and potential multipliers (stage III). Stage III is the production of certified seed (C1), which could be used to plant another cycle of seed (C2) subject to inspection and certification. Each seed class should be raised by an independent party or at a separate location. The recommendation is that each time cassava is planted in the field to generate certified seed, growers should use materials from basic seed class. Certified seed should be planted once in the field without allowing for ratoon crops.

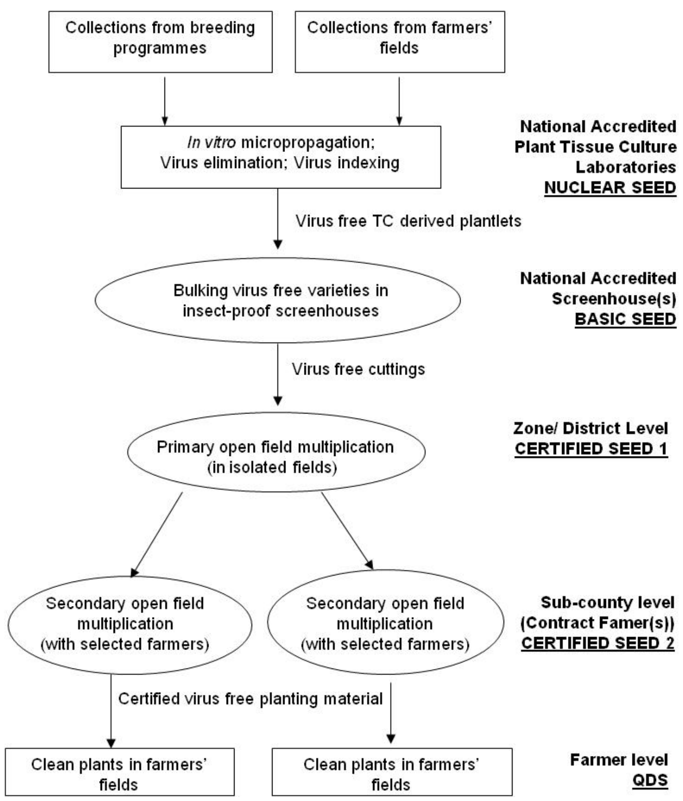

Figure 4: Proposed quality cassava planting material production schemes (adapted from Mukasa *et al.*, 2016).

ICT support for inspection and certification of quality cassava planting material

Experiences from the cassava case studies from Uganda have shown the challenges of following (tracking) cassava seed from pre-basic seed, basic seed, and certified seed. Some producers of basic seed also act as producers of certified seed. Basic seed growers ought to be different from certified seed growers, or at least the two classes should be grown in isolated areas. Similarly, government institutions are currently the ones producing pre-basic seed and basic seed with support from government and donor agencies; a situation that is neither sustainable nor produces adequate quantities to meet national demands. The use of ratoon crops as source of seed further complicates the tracking of seed and increases the possibility of re-infection since the crop stays for 2-3 years in the same garden. This period is too long and provides extended exposure of the seed crop to re-infection. Though a challenge, tracking of seed is a requirement for seed certification and quality assurance. When you provide for ratooning it becomes difficult for seed growers to terminate an otherwise well-established seed crop, when it fails to meet the minimum requirements.

Traceability of planting material across the production stages of the seed value chain is very important in monitoring quality and eliminating irresponsible actors. This can be achieved more efficiently and cost effectively through use of Information and Communications Technology (ICT). Mobile and web applications have helped farmers to identify good and bad cassava planting material suppliers under the Cassava CARP. The applications have improved cassava multiplication garden information management, including garden history and inspection profiles.

To optimally integrate ICTs in cassava seed value chain, governments should consider a policy on ICT integration in seed production, monitoring, distribution tracking and the broader extension service. The policy should enforce practices where all seed multiplication gardens are mapped using geo-coordinates and garden inspection reports aggregated on mobile and web systems. The policy should prescribe the intended services to be delivered to stakeholders in the seed distribution chain.

Promotion of cassava processing and value addition technologies

Technologies and equipment for processing cassava at small- and medium-scale have been developed and tested including use of chippers and graters with initiatives such as the Cassava Adding Value for Africa (C:AVA) project in Uganda (Posthumus, 2010). These technologies can reduce postharvest losses and thus contribute to price stabilization. Guaranteeing farmers a reasonable price for their crop will encourage them to invest in production. Therefore, the cassava industry stakeholders need assistance in initiating industry-wide associations and clusters to enhance sharing experiences, risks, and technology development costs. With appropriate technology and equipment, community-level processing could produce high quality cassava flour, grits and chips for rural and urban-based industries, allowing growers a better bargain and to retain a bigger share of the value-addition. Therefore, governments should promote private investment in cassava processing, and foster associations that link growers and processors. Developing a cluster of cassava seed producers would enable idea-sharing as well as markets and services through innovation platforms. Such platforms could be initiated by NARS or academia with support from governments and donors.

KEY REFERENCES

Legg, J., Ndalahwa, M., Yabeja, J., Ndyetabula, I., Bouwmeester, H., Shirima, R., Mtunda, K. 2017. Community phytosanitation to manage cassava brown streak disease. *Virus Research.* http://dx.doi.org/10.1016/j.virusres.2017.04.020

Mbanzibwa, D.R., Tian, Y.P., Tugume, A.K. Mukasa, S.B. et al. 2011. Simultaneous virus-specific detection of the two cassava brown streak-associated viruses by RT-PCR reveals wide distribution in East Africa, mixed infections, and infections in Manihot glaziovii. *Journal of Virological Methods* 171: 394–400.

Mbewe, W., Winter, S., Mukasa, S.B., Tairo, F., Sseruwagi, P., Ndunguru, J., Duffy, S., 2017. Deep sequencing reveals a divergent strain of Ugandan cassava brown streak virus isolated from Malawi. *ASM Genome announcement*. 5 (33).

McQuaid, C.F, van den Bosch F, Szyniszewska A, Alicai T, Pariyo A, Chikoti P.C, et al. 2017. Spatial dynamics and control of a crop pathogen with mixed-mode transmission. *PLoS Computational Biology* 13(7): e1005654.

Mukasa, S.B. *et al*., 2016. Technical guidelines for inspection and certification of sweetpotato planting material in Uganda: recommended practices. ISSN 2518-248X.

Mukasa, S. 2016. Developing a community-based cassava seed system for increased productivity and market linkages in Uganda. http://www.fao.org/family-farming/detail/

National Institute of Statistics of Rwanda (NISR), 2015. Seasonal Agriculture Survey Report, Kigali, Rwanda.

Nduwumuremyi., A, R. Melis, P. Shanahan and T. Asiimwe, 2016. Participatory appraisal of preferred traits, production constraints and postharvest challenges for cassava farmers in Rwanda, Food Security, DOI, 10.1007/s12571-016-0556-z

Posthumus, H. 2010. Linking smallholders to markets: Lessons learned from past projects and implications for C:AVA. 2018 Natural Resources Institute, University of Greenwich. https://cava.nri.org/images/documents/publications/

The Seeds and Plant Regulations, 2017. Statutory Instruments No. 14. Uganda Gazette No. 11, Vol CX 17th February 2017. UPPC, Entebbe, Government of Uganda.

Self Help Africa, 2018. Kenya farmers increase cassava yields and income. https://selfhelpafrica.org/us/kenya-aggregation-impact/

Wasswa, P., Alicai T. and Mukasa S.B. 2010. Optimisation of in vitro techniques for Cassava brown streak virus elimination. *African Crop Science Journal*, 18: 235–241.