The GM potato push in Rwanda: Key Issues and Concerns

3 FEBRUARY 2020
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On 7 April 2015 the African Centre for Biosafety officially changed its name to the African Centre for Biodiversity (ACB). This name change was agreed by consultation within the ACB to reflect the expanded scope of our work over the past few years. All ACB publications prior to this date will remain under our old name of African Centre for Biosafety and should continue to be referenced as such.

We remain committed to dismantling inequalities in the food and agriculture system in Africa and our belief in peoples’ right to healthy and culturally appropriate food, produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems.

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PELUM Rwanda is a nonprofit organisation dedicated to facilitating effective learning, networking and advocacy, designed to achieve sustainable community empowerment, and improved food security and asset accumulation by the rural communities across Rwanda. There are an estimated 50,000 small-scale farmers affiliated to member organisations of PELUM Rwanda in order to improve their livelihoods and food security. PELUM ASSOCIATION is a regional network operating in 12 Eastern, Central, and Southern African countries.

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### List of Acronyms

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<th>Acronym</th>
<th>Description</th>
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<tr>
<td>ABNE</td>
<td>African Biosafety Network of Expertise</td>
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<td>ACB</td>
<td>African Centre for Biodiversity</td>
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<td>ARIPO</td>
<td>African Regional Intellectual Property Organization</td>
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<td>CIP</td>
<td>Crop Intensification Program</td>
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<td>COMESA</td>
<td>Common Market for East and Southern Africa</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organization</td>
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<tr>
<td>GDP</td>
<td>Gross domestic product</td>
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<td>GM</td>
<td>Genetically modified</td>
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<td>IFAD</td>
<td>International Fund for Agricultural Development</td>
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<td>NEPAD</td>
<td>New Partnership for Africa’s Development</td>
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<td>UPOV</td>
<td>International Union for the Protection of New Varieties of Plants</td>
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<td>USAID</td>
<td>United States Agency for International Development</td>
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Key findings

The Rwandan government is considering permitting the cultivating a GM potato variety, ‘Victoria’. This will be the first ever genetically modified (GM) crop to be grown in the country. GM Victoria, which has undergone field trials in Uganda between 2015 and 2017 and is currently undergoing multi-location trials, is slated for commercially released in Uganda in 2020 – despite the rejection of the GMO bill in Uganda by President Museveni in April 2019. Due to this regulatory backstop in Uganda, corporate interests have shifted their attention to Rwanda, where the government is fast tracking the development of a biosafety policy and legal framework that will enable the introduction of this GM potato.

The Victoria GM potato variety has been genetically modified through cisgenesis modification with three genes taken from three wild potato varieties from South America, to confer resistance to late blight. In Uganda, the Ugandan Agricultural Research and Development Institute conducted the field trials in partnership with the International Potato Centre, which supplied the genetic material. The International Potato Centre has been working for some time on producing a stack of three resistant genes from wild potato relatives combined with what is referred to as ‘farmer-preferred East African varieties’. The United States Agency for International Development (USAID) funds the project. USAID is involved in GM projects across Africa, including those focused on indigenous crops, like cassava and cowpea. The development of the GM potato was undertaken by a public research organisation, with support from the 2Blades Foundation. The 2Blades Foundation has worked with GM seed companies, such as Monsanto and the J.R. Simplot Company.

Civil society is deeply concerned with the hasty process underway in Rwanda to facilitate the entry of the GM potato. Cisgenesis modification is a relatively new technique, and it is not yet clear how the stack of three genes will interact with each other or with the genetic material of the host plant. Proponents claim that the GM potato confers resistance against late blight disease,
extremely strong intellectual property protection on varieties of plants, even those that originate and exist already in farmers’ fields. Rwandan farmers will eventually be forced into paying the high costs associated with GM seed production as well as for exorbitant technology fees. As it stands, Rwandan potato farmers currently make a small profit on potato production, but only when they use their own or farmer-exchanged seed.

It is clear that Rwanda is altering the trajectory of its agricultural sector, overlooking the significant role smallholder farmers play in seed and food supply, and pushing aside the livelihoods of smallholder farmers in the country. The introduction of this technology aims to enhance Rwanda’s potato exporting capacity, which may have a drastic impact on the already food insecure nation.

Introduction

Rwanda has been a Party to the Cartagena Protocol on Biosafety for almost 16 years, yet only during 2018 and 2019 did they put together a biosafety policy and legal framework. This was likely done in anticipation of the introduction of a GM potato variety that underwent field trials in Uganda between 2015 and 2017. The genetic modification was done via a process of cisgenesis (detailed below) in which a stack of three genes resistant to late blight disease was artificially inserted into two ‘farmer-preferred’ Ugandan potato varieties.

The Rwandan government supports the adoption of the GM potato as a way of increasing yields and therefore food production and farmer incomes (Ntirenganya 2019). According to proponents, the GM potato will contribute to reducing food insecurity and poverty in rural areas (Ntirenganya 2019), ignoring evidence that this technology will be unsustainable and inappropriate for smallholder farmers (ACB 2008). Proponents fail to take into account the reality of smallholder farming systems and the potential far-reaching negative consequences for farmers’ livelihoods and the environment.

This paper provides a socioeconomic overview of Rwanda’s agricultural industry and challenges in farming, with a focus on potatoes. It provides a sketch of the key actors working in the potato sector and describes the GM technology proposed for uptake in the country. It also highlights key areas of concern around the adoption of the GM potato in Rwanda.

Country overview

Rwanda is a landlocked country in east-central Africa. It has five provinces – Northern, Western, Southern, Eastern and Kigali, and is subdivided into 30 districts (International Fund for Agricultural Development [IFAD] 2019a). The 1994 genocide had a significant impact on the country’s economic and social development.

Rwanda’s Vision 2020, published in 2000, aimed to transform the country to a knowledge-based economy by 2020 (Ferrari et al. 2017) and to achieve middle-income country status (IFAD 2019a). Though the economy maintained a high annual growth rate of 7.9% between 2000 and 2016, it remains classified as a low-income country. The primary economic drivers are the construction sector, which grew by 10% in 2019, and wholesale and retail trade, which grew by 9%. Rwanda is highly dependent on external aid for about 16% of its national budget (IFAD 2019a).

As it stands, Rwandan potato farmers currently make a small profit on potato production, but only when they use their own or farmer-exchanged seed.

Rwanda is the most densely populated country in Africa (FAO 2016). Its current population of 12.2 million is expected to grow to 14.6 million by 2025 and to 22 million by 2050. More than 80% of the population still live in the rural areas. More than half are under 20 years of age, with 40% of rural inhabitants less than 15 years of age (IFAD 2019b).
Agriculture currently contributes 32.7% to gross domestic product (GDP) and comprises 70% of the export revenues, which are predominantly generated by cash crops of coffee, tea and pyrethrum (IFAD 2019a). The sector grew by 6% from 2018 to 2019, supported by government measures to increase production (PriceWaterhouseCoopers 2019). Domestic agriculture provides for about 90% of the country’s food supply and employs 66.5% of the population. The most common livelihood activities in Rwanda are agricultural production (72% of households), daily agricultural labour (24%), livestock raising for sale (18%), unskilled daily labour (13%) and informal sale/trade (11%) (IFAD 2019a).

According to the last official household survey conducted in 2017, there are around 2.1 million agricultural households (about 80% of total households) in the country (Republic of Rwanda & NISR 2017). Households average 4.6 people; most of them (78.6%) produce crops and the balance farm livestock. Most Rwandan farmers are smallholders working on plots of an average size of 0.5 hectares. Many have even smaller parcels of land and need to sell their labour on bigger farms for their survival (IFAD 2019a). Eighty percent of holdings are less than one hectare and 70% are on hills or hillsides. Less than 5% are irrigated and there is extremely limited mechanisation (IFC 2019). Large-scale monoculture production is not a suitable option for Rwanda. Farmers mostly practise rain-fed and intensive intercropping agriculture, producing food crops on almost 70% of their land – two thirds of food produced is consumed at the household level (IFAD 2019a).

The agriculture sector has become increasingly industrialised. For example, in partnership with USAID and the Japan International Cooperation Agency, the World Bank’s International Development Association has funded and supported the intensification of production for export markets, in marshlands and on hillsides, with a focus on the horticulture market, as well as some food crops such as rice (World Bank...
The World Bank has been instrumental in shaping agriculture policy reform regarding spending on input distribution, irrigation and water and soil management, and strongly promoted the entry of the private sector into the agricultural input chain, particularly for inorganic fertilisers (World Bank 2016).

The United Nations’ Food and Agriculture Organization (FAO) classifies 40% of land in Rwanda as being at high risk to erosion (IFAD 2019a). This is primarily due to the high demand for land – particularly for agriculture – and the abandonment of traditional practices such as fallowing, that preserve soil integrity.

Poverty affects about 43% of the rural population (IFAD 2019a). Poverty levels are highest among households with no or little access to land, where people only gain income through seasonal labour. Rural women and youth are the most affected. This has significant consequences for household-level food security. While 80% of households at the national level are considered food secure, half of them are considered only marginally so. Almost 38% of children under five years are chronically malnourished, 41% of rural children are stunted and 37% of all children have anaemia. Levels of food insecurity are highest in the western and northern parts of the country (IFAD 2019b).

**Agricultural sector overview**

Despite the significant role smallholder agriculture plays in the income, livelihoods, food and nutritional security of the population, there is a strong orientation to industrialise the country’s agricultural landscape to produce for export markets.

**Governance of the sector**

The most recent Economic Development and Poverty Reduction Strategy 2013–2018, based on Rwanda’s Vision 2020, aims to grow the GDP by a sustained 11.5% to achieve middle-income status and to reduce poverty levels to less than 30% of the population (KPMG 2017). Specific policies towards this end, include increasing productivity in the agricultural sector and growing private sector investment in priority sectors (KPMG 2017). The Strategic Plan for the Transformation of Agriculture (2018–2024) identifies sectoral priority areas and investments to transform the sector, including growing the inclusion of the private sector (IFAD 2019a). The plan sets out specific targets – to grow the sector by 8.5% a year and boost food security to 90% of households (FAO 2016). There is also a commitment to improve nutritional security through a National Multisectoral Strategy to Eliminate Malnutrition, a National Food and Nutrition Policy and Strategic Plan (2013–2018), and by participating in the international Scaling Up Nutrition initiative (FAO 2016). Some of the goals laid out in Vision 2020, such as GDP per capita and percentage of farmers using fertilisers, were exceeded in 2010 and have been revised upwards (FAO 2016). The increased uptake is supported by government subsidisation of 15%–35% of the cost of fertilisers for farmers participating in its Land Use Consolidation Program.

The policies below further support the attempt to modernise crop production in the country (IFAD 2019a):

- Irrigation Master Plan
- National Post-Harvest Staple Crop Strategy
- National Information and Communication Technology for Rwanda Agriculture Strategy

The Ministry of Agriculture is responsible for initiating and managing programmes to modernise the sector, ensure food security and contribute to growing the economy (USAID 2016). The Rwanda Agricultural Board, a ministerial organisation, has the mandate to govern the country’s seed sector and a mission of developing the sector into a ‘knowledge-based, technology driven, and market orientated industry’ (USAID 2016). Two of its departments focus on seed-related research, crop production and food security, and crop breeding. It is also responsible for the Land Use Consolidation Program (IFC 2019). The Rwanda Agriculture and Livestock Inspection and Certification Service is the department responsible for protecting crops and livestock against foreign pests and diseases. It enforces plant health law and related phytosanitary requirements for seed import and export.
The National Legislative Framework for Seed has a new organisational design, with the Ministry of Agriculture supported by a Seed Council that in turn is supported by a Plant Variety Release Committee, Plant Breeders’ Rights Committee and a Quality Assurance community. These are underpinned by a national seed certification service, plant variety rights office and plant breeders’ rights office and other bodies that incorporate research, seed breeding and multiplication, agro-dealers, and a seed processing unit (USAID 2016). The state retains control of research and development, extension services, seed and fertiliser purchase and distribution, and export support (IFC 2019).

**An industrialised approach**

The Rwandan government has pushed hard to industrialise and commercialise the agricultural sector, in a bid to increase national food production and to produce surplus for exports. This model is focused on yields, just as the country’s economic model is focused on GDP, which is increasingly recognised as a limiting approach that does not account for social and environmental health and wellbeing. The government has taken an interventionist approach to push farmers towards this model, based on three elements: formalisation of land tenure (and consolidation of land), investment in modern inputs (distributed through a subsidy system), and commercialisation.

**Land Tenure Reform Program (2004)**

Post-independence, all land, except that registered as private property during the colonial era, was transferred to the state (Rubanje 2016). In 2004, a nationwide Land Tenure Reform Program was launched to ‘demarcate, adjudicate and register’ individual land holdings, to provide security.
of tenure and to encourage investment in property and livelihoods by enabling use of land as collateral for bank loans (Focus on Land in Africa n.d.). Registration of land was mandatory. By June 2018, 8.6 million titles had been awarded, leaving only 14% of land unregistered (Nsabimana 2018). Conflicts over land are widespread, however, and there are concerns that this process will enable the government to force farmers into consolidated production (Ansoms et al. 2017), which could result in some farmers and communities losing their land. The Land Use Consolidation Policy was launched under the control of the Crop Intensification Program (CIP).

**Land Use Consolidation Policy (2007)**
In 2007, the government launched the Land Use Consolidation Policy to support voluntary collaboration between farmers in demarcated areas to collectively produce on five hectares of land (Ntihinyurwa & Masum 2017). The programme aimed to increase the use of inputs, support integrated pest and disease management, and enhance mechanisation and irrigation of consolidated parcels of land (Rubanje 2016). Farmers were incentivised to join with the promise of free seed and subsidised fertilisers distributed under the CIP (Ntihinyurwa & Masum 2017). It was meant to be a participatory endeavour, with farmers giving input at every stage, from selection of land, crops and input to post-harvest practices and sale of produce. However, in their review of the programme, researchers Ntihinyurwa and Masum noted that the principles of inclusion and participatory decision-making are seldom put into practice, as farmers have little to no control over which seed to plant and are often unfamiliar with the crop they are forced to produce.

The Land Use Consolidation Policy has expanded the area under irrigation, increased the use of cultivated terraces, and supported adoption of ‘improved’ inputs through CIP distribution of seed and subsidised fertiliser (FAO 2016). Within four years of implementation, production of Irish potatoes had tripled (Rubanje 2016). The goal is to put at least 102,000 hectares under irrigation by 2024; by late 2019 only 50,000 hectares had been covered (Ntirenganya & Major 2019). It has also resulted in the resettlement of some households into residential villages to enable access to all agricultural land within the five hectares.

**Crop Intensification Program (2007)**
The CIP focuses on improving the yields of specific crops – Irish potato, hybrid maize, wheat, rice, beans and cassava – to enhance home consumption and farmer incomes from sales (Ansoms et al. 2017). It works through consolidated production, sale of fertilisers and improved seed, provision of extension services, and improvement of post-harvesting handling and storage.

The Rwandan government’s Irish potato strategy aims to strengthen the national potato research programme, support large-scale multiplication of so-called improved potato seeds (seed potato), organise the seed market and advisory services, and develop post-harvest and value-addition activities (FAO 2015). The plan was to increase production of the Irish potato to 6 million metric tons by 2019, by expanding the area under production and increasing yields (FAO 2015). In 2017, 846,184 metric tons were produced and in 2018, 835,500 metric tons.

**Subsidisation programme**
The Rwandan government has invested significantly through the CIP and the Land Use Consolidation Program, to encourage concentrated crop production by fully subsidising seed and fertiliser, initially at 35–50% (IFAD 2019a), revised in 2013/14 to 15–35% of cost, to cut public expenditure (Mwesigye 2017) and facilitate increased private sector involvement. The subsidy may well be further reduced in the coming seasons.

Eight private companies import fertilisers into the country to supply the subsidy scheme – they trade through the state-owned Agro Processing Trust Corporate that distributes to more than 900 private agro-dealers who in turn sell onto farmers (Mudingu 2017). In 2016, about 32,000 tons of fertiliser were sold through this system (Mudingu 2017). About 55,000 tons of fertiliser would need to be sold to meet the target of 45 kilograms a hectare (Mudingu 2017). Under CIP, the use of improved seeds has risen from 3% to 40% and fertiliser use has increased from four kilograms a hectare...
in 2006 to 30 kilograms a hectare in 2013 (FAO 2016). The goal was to increase this to 45 kilograms a hectare by 2017/18 (FAO 2016).

Three seed companies are licensed to import seeds into Rwanda for maize, wheat and soya (Mudingu 2017). Private seed companies that operate in Rwanda include the Kenya Seed Company Rwanda, SeedCo Rwanda, Pannar (owned by Corteva Agriscience), local company Win and RESCO Rwanda – most focus on hybrid and open-pollinated maize varieties, soybean and the common bean (USAID 2016). The Kenya Seed Company also produces wheat, sunflower, sorghum and vegetable seed (USAID 2016). Potato seed is bred and multiplied primarily through the public sector (see below). The government continues to subsidise fertiliser and sets ceiling prices for its sale price as well as arranging for private dealers and distributors to manage the potato trade (IFDC 2014).

While Rwanda’s smallholder farmers clearly need government support to overcome the challenges they face, the support provided is geared towards imposing a very particular model of farming systems, which is being reinforced through other means such as loans, insurance and subsidies (see Ntirenganya 2018).

### Overview of potato farming in Rwanda

The potato is Rwanda’s second most important crop after plantain and the country’s most important source of calories after cassava (PotatoPro n.d.). Average consumption is about 80 kilograms a year in urban areas (Agri Knowledge Centre 2012), 150 kilograms a year in most rural areas and up to 250 kilograms a year in areas where production is very intensive. Average yields lag behind other African countries though, at 11.6 tons per hectare in 2017 (Ferrari et al. 2017) compared to South Africa’s 36 tons, Zambia’s 31.6 tons, Nigeria’s 31 tons, Senegal’s 22.3 tons and Libya’s 19.6 tons per hectare (Travella 2019). Key production challenges are access to land and quality seed, post-harvest losses, soil degradation, pests and diseases, and poor farmer organisation. Farmers are often forced to sell soon after harvest into a temporarily glutted market (Agri Knowledge Centre 2012), which serves to drive farm gate prices down.

Rwanda’s medium- and large-scale production focuses on horticulture and sugarcane (IFC 2019). Most of the country’s more than 70 000 potato farmers are small, family-owned operations, producing around 10 tons a hectare (IFAD 2019a). They are grouped in 30 cooperatives that produce more than 19 000 tons a month during harvesting season (PotatoPro n.d.). Farmers cultivate potatoes two to three times a year due its three-month growing period (Ferrari et al. 2017).

About 60% of potato production takes part in the Nyabihu, Musanze, Rubavu and Burera districts at high altitudes in the northern and western provinces (Ferrari et al. 2017). In high production areas, potato farming contributes 57% of farm income and is considered an important source of income and food source (Ferrari et al. 2017). The tendency of farmers in Africa to cultivate potatoes in close rotations is a major concern.

### Rwanda’s potato sector

Potatoes originate from Peru and Bolivia. The most common variety commercially grown in the world is commonly referred to as the Irish potato. Irish potatoes are widely distributed in Europe, and most varieties outside of South America are derived from the varieties adopted in Europe (Travella 2019). The potato is grown across 158 countries and is considered to be the fourth most important crop in the world with a traded global value of US$92 billion in 2019. It has higher average global yields (20 tons a hectare) than maize (5.7 tons a hectare) and wheat (3.5 tons a hectare) (Travella 2019).

Given that only 14% of maize is produced for food, potatoes are the third most important food crop in Rwanda, behind rice and wheat. Rwanda is currently the largest producer of potato in the East African Community (USAID 2016), the third largest potato producer in the sub-Saharan region and one of the top five potato producing countries in Africa, producing about 846 148 tons of potato a year in 2017 (PotatoPro n.d.). There is a significant variation in the tonnage reported across sources.
or even continuous cropping has resulted in declining yields and diseases accumulating in the soil.

The only certified potato varieties available on the market until 2018 were Sangema, Cruza, Mabondo, Victoria, Kirundo, Mizeri, Kigega, Ngunda, Nderera, Gikungu and Kinigi, with the most commonly grown being Kinigi, Kirundo, Mabondo, Cruza and Sangema (PotatoPro n.d.). Most farmers rely on sourcing seed from their own harvest (about 15%) or through farmer exchange (about 85%) (Ferrari et al. 2017).

In Rwanda seed is classified as breeder, basic, certified and quality declared seed, the latter being multiplied by smallholder farmers (FAO n.d.). The Rwanda Agriculture Board is responsible for producing breeder, pre-basic and basic seed for potato (USAID 2016). The Rwanda Agricultural Board has been criticised for ‘wearing too many hats’ and not supporting the farmer managed seed sector, which plays a critical role in the country, in a way that promotes resilience (Van den Broek & Byakweli 2014).

The Rwanda Agricultural Board Northern Zone produces certified potato seed in Muzanze, Burera, Nyabihu and Rubavu (Ferrari et al. 2017). The production of breeder seed is in two stages: producing in vitro plantlets and then producing mini-tubers from the plantlets (USAID 2016). The public sector produces 93% of in vitro plantlets through the tissue culture laboratories of the Board and the Ruhengeri Institute of Higher Education (Ferrari et al. 2017). The government’s in vitro laboratory produces up to 160 000 plantlets a year (USAID 2016). Root cuttings are planted in nursery beds in aphid-proof screen houses, then multiplied in the open field. The final production stages are done by cooperatives and the groupes des producteurs de semences. The private sector (about 20 private producers) has a market share of 71% in production of mini-tubers. The government’s long-term goal is to withdraw from multiplication and leave it to the private sector (Ferrari et al. 2017).

In 2018, five new varieties were released – the first in 30 years (Ferrari et al. 2017). These varieties – Twihaze, Ndeze, Kazeneza, Nkunganire and Izihirwe (PotatoPro n.d.) – were approved by the Rwanda Agricultural and Animal Resources Development Board following a collaborative evaluation with the International Potato Centre of 21 CIP-bred potatoes (Ferrari et al. 2017). They are all cloned Irish potato varieties imported from Peru and tested for their appropriateness to growing conditions in Rwanda.
Potatoes grown in monocultures are very sensitive to a range of pests and viral and bacterial diseases (Travella 2019), especially cutworms, aphids, the potato tuber moth, leaf-miners, bacterial wilt and late blight (Okonya et al. 2019). Late blight, in particular, has a devastating impact on potato farmers around the world, causing damage to more than 3 million hectares planted to potatoes and costing farmers an estimated $6.7 billion a year in lost revenue (Travella 2019). It is caused by a pathogen that can disperse easily over short distances and can live on and between crops as mycelium (2Blades n.d.). There is no definitive way of preventing infection, although choosing naturally resistant varieties and practising crop rotation and good agricultural techniques can go a long way towards reducing the risk (2Blades n.d.). Yield losses in East Africa due to this pathogen are estimated at up to 70% of the total harvest (Travella 2019). Farmers in this region are at increased risk because the small size of holdings encourages farmers to abandon traditional practices of crop rotation and fallowing (Agri Knowledge Centre 2012), leaving the crop vulnerable to the disease. It also reduces soil fertility, resulting in the need for more fertilisers.

Potato farmers in Rwanda have turned to using more and more pesticides – normally eight applications of three different chemicals each season (Agri Knowledge Centre 2012). This comes at a high financial cost – up to 25% of the value of the potato harvest. Three quarters of the pesticides imported into Rwanda are fungicides (mostly Mancozeb and Ridomil) (Okonya et al. 2019) and their excessive use has negative implications for both human and ecosystem health (Travella 2019). Late blight has developed increased resistance to fungicide applications and is able to quickly adapt into new strains (Travella 2019).

In 2017, the government signed a public-private partnership agreement with BlackPace Africa Group – a Nigerian and Swiss-owned company – to invest in the potato industry and develop it into an exporting sector over five years (Nuwagira 2017). The company will also invest in building two processing plants – one in the Kigali Special Economic Zone for frozen French fries and one in Nyabihu District to produce products for export (Nuwagira 2017), although there are no reports to date of them having done so. Instead, in 2017 the group bought Ndiyo Business Group, a large producer of salted potato chips in Rwanda, which now operates as Cros-Agro, with headquarters in Abuja, Nigeria (Potato Pro 2017).

The project receives significant government support, including for research and in resolving trade issues (Nuwagira 2017). The intention is to develop joint research on technical, economic and social aspects of the development of new varieties, improved seed systems, processing, and market development (Potato Pro 2017). The goal is to produce 10 million tons of potato by 2022 and to process up to 100 000 tons into French fries, from inception, and potato flakes and crisps for export markets in Africa and the Middle East (Nuwagira 2017). The aim is also to grow yields from 15 to 35 tons a hectare by 2022, and government has promised to give land for cultivation, including 166 000 hectares in the Northern Province (Nuwagira 2017). The signed technical and scientific agreement focuses on developing the Irish and sweet potato value chain (PotatoPro 2017). In 2018, the government started the process of privatising the potato processing plant in Nyabihu District.

It is against this backdrop that Rwanda’s plans to trial the GM Victoria potato variety should be seen. This variety has been genetically modified with three traits from wild potato varieties, through cisgenesis, to be resistant to late blight genes. It has undergone field tests in Uganda and is currently undergoing multi-locational trials, despite the rejection of the GMO bill in April 2019 by President Museveni.

GM potatoes globally

The potato was one of the first crops to be genetically modified in the early 1980s, although the first commercial release was only in 1995 – Monsanto’s NewLeaf in the United States and Canada (ACB 2008). Production stopped, however, after the 2001 growing season because leading potato processors (initially McCain’s, Proctor &

In 2001, field trials started in South Africa for the GM SpuntaG2 modified with a Bt gene Cry1A1 (formerly BtCryV) to protect plants against the potato tuber moth (ACB 2008). The project was overseen by the country’s Agricultural Research Council (ARC), supported by the International Potato Centre, Michigan University and Syngenta. USAID funded the project (ACB 2008).

Despite significant opposition from various civil society organisations including the ACB, in 2004 the trials were allowed to continue. Objections included the inappropriateness of the GM production system for smallholder farmers, the risk of contamination, and the detrimental effects the accompanying pesticides and fertilisers would have on ecological systems. In addition, ACB’s submissions noted that socioeconomic issues had not been addressed (ACB 2008). In 2006, ACB again attempted to stop field trials, querying issues around transgenic instability, horizontal gene transfer, antibiotic resistance, soil microbial diversity and toxicity to non-target insects (ACB 2008). In 2009, the South African GMO authorities refused to approve the application for commercial release, citing biosafety, health and socioeconomic concerns (Gosling 2015). The ARC took the matter on Appeal but South Africa’s Minister of Agriculture announced in 2015 that GM potatoes would not be allowed to be grown commercially in South Africa as the trials had not yielded any significant advantages in terms of pest management, and that commercial farming of GM potatoes would place an unnecessary burden on smallholder farmers, who would need to separate their conventional varieties from the GM varieties (Gosling 2015).

While GM potatoes are commercially planted in the United States and Canada and accepted as food imports in Australia, there has been significant resistance in the European Union to this technology (Travella 2019). African countries have historically also been resistant but the doors are opening fast, supported by international organisations and government institutions such as USAID.
Rwanda’s GM potato project

As discussed, the Irish potato variety Victoria (known locally as ‘Imvura’) (Potato News Today 2019) that Rwanda has chosen for the project has completed field trials in Uganda and currently its suitability to different growing conditions is being tested in three different sites (Travella 2019).

The International Potato Centre provided the propagation material and partnered with Uganda’s National Agricultural Research Organisation to grow the potatoes under field conditions to test their resistance to late blight in the absence of fungicide applications (2Blades n.d.; Potato News Today 2019). The project was funded by USAID, the Consultative Group on International Agricultural Research (CGIAR) Program on Roots, Tubers, and Bananas and the 2Blades Foundation (International Potato Centre 2017b).

The crop was field evaluated in Uganda at the Kachwekano Zonal Agricultural Research and Development Institute in Kabale (Kiggundu 2016). Field trials took place in 2015, 2016 and 2017 of ‘farmer-preferred varieties’ engineered through cisgenesis for late blight resistance (Travella 2019). The genes were taken from wild potato relatives (Rpi-blb1 and Rpi-blb2 from S. bulbocastanum; and Rpi-vnt1.1 from S. venturii) from South America and transferred by agrobacterium-mediated transformation into four susceptible but popular farmer-preferred varieties in East Africa: Désirée, Victoria, Tigoni and Shangi (Travella 2019). The potato varieties underwent three replications in a randomised complete block design of plots of 15 plants each (Kiggundu 2016).

Growing conditions for the field trials included the use of NPK17:17:17 fertiliser (300 kilograms a hectare at planting), insecticides for cutworms, aphids and leaf-miners, as well as regular weeding (Ghislain et al. 2018). While the trials demonstrated that the GM potato varieties were resistant to late blight, the results of yielding up to 45 tons per hectare were the same as if farmers used fungicides throughout the growing process rather than their current use of spraying only when infestations are already present (Ghislain et al. 2018).

Uganda will continue to test the varieties in three different zones in the country to assess its suitability for different growing zones (Travella 2019). While it will not be possible to commercialise the GM potato in Uganda until the recently revised biosafety bill is approved by the president (Ghislain et al. 2018), the intention is to have GM potatoes commercially available in the country by the end of 2020 (Travella 2019). With the regulatory backstop in Uganda, Rwanda has become a backup for the industry to commercialise GM potatoes, leading to the fast tracking of their regulatory framework.

In August 2019, the Rwandan government announced that it would begin trials of a GM potato (Potato News Today 2019). This is an abrupt turnaround from its position in 2016, when it expressed concerns that it could face ‘an influx of genetically modified crops from Kenya and Uganda’ as it had no regulatory means to check imports (Mugisha & Afadhali 2016). The government was resolute then that it would not lift the ban on GMOs in Rwanda and began to put the necessary biosafety standards in place (Mugisha & Afadhali 2016). However, in the past two years it has acted very quickly to put the necessary institutional and legislative structures in place to trial and eventually commercialise the GM potato.

In 2018, Rwanda asked the New Partnership for Africa’s Development’s (NEPAD) African Biosafety Network of Expertise (ABNE) to provide technical support for developing a regulatory framework (NEPAD 2019). In the same year, the Rwanda Environment Management Authority drafted a law to govern GMOs in Rwanda and submitted it to the Law Reform Commission for review, along with a National Biosafety Framework, policy and regulations. The government held its first National Biosafety Clearing-House capacity building workshop in March 2018 (UN Environment 2018). It then proceeded with stakeholder consultations on the review of the national draft biosafety policy, laws and regulations in 2019 (NEPAD 2019). It validated these in October 2019 (NEPAD 2019).
From transgenesis to cisgenesis

The GM potatoes that were trialled in South Africa and those commercially farmed in the United States and Canada are transgenic crops – genes from a sexually incompatible species are inserted into the DNA structure of the recipient species (Schouten et al. 2006). The latest iteration of genetic modification of the potato uses cisgenesis – genes from a sexually compatible species are inserted into the DNA of the recipient plant (Schouten et al. 2006).

Modifications are used in an attempt to make potatoes resistant to insects, nematodes and disease, particularly late blight and viruses (Travella 2019). Other modifications seek to alter the starch content and composition or cosmetic features (bruising and browning) and to biofortify the host plant with proteins or beta-carotene (Travella 2019). In the case of potatoes, the donor plants are wild potato species, including Solanum demissum and S. bulbocastanum (Schouten et al. 2006). The goal is to transfer genes found in wild species that confer resistance to late blight to the recipient potato species. This is intended to reduce the incidence of late blight and potentially radically decrease fungicide use by up to 90% if cultivated within an integrated pest management system (Travella 2019).

Traditional cross-breeding of wild with conventional varieties tends to incorporate undesirable characteristics, including bad taste and low yields, from the wild varieties into the resultant yield and it takes a very long time to produce a favourable result – a potato producer must screen up to 100,000 offspring potatoes each year to generate a new variety, which might still contain hidden and unfavourable traits (Travella 2019). Cisgenesis is positioned as a means to overcome this, drastically shortening the breeding cycle to just months instead of years, with guaranteed results. While this may be the case, cisgenesis has the same risks and variables as those associated with other forms of genetic engineering.

While the resistance genes used from the wild potatoes are known to be safe for consumption in their natural forms, there is neither proof that the transformation process and the behaviour of the transferred genes in the host’s genetic make-up is safe, nor is this completely understood (Lusser 2012). It is simply assumed that the transferred genes and resultant plant will behave the same in the host’s genetic structure as they would in their natural context under conventional breeding (ACB 2017b).

As with all GM crops, but particularly with cisgenesis, the amount and duration of research conducted on the long-term potential effects is insufficient. The gene is inserted at an unknown position in the recipient DNA and could be transferred several times into one genome, which could affect the way that gene expresses itself (Schouten et al. 2006). Essentially the genetic material is inserted at random places into the host’s genetic structure, which could result in random mutations of the host genome (ACB 2017b). The insertion process itself could knock out genes in the recipient plant, with unknown consequences (Schouten et al. 2006). It is possible that the disturbed new genetic structure may have new RNA or protein molecules or other changes (ACB 2017a). This can compromise the nutritional profile and performance of the crop (ACB 2017a). Changes can occur in the plant’s genetic structure at the site of modification as it attempts to repair itself or elsewhere in the genome (ACB 2017a).

Cisgenesis is therefore as risky as transgenic modification because it is the process as well as the resultant introduction of foreign genetic material that can cause the plant to express itself in unknown ways (ACB 2017a).

Attempts to exclude cisgenic plants from GM regulatory and biosafety frameworks on the basis that the modification is a gene transfer from sexually compatible species, and so is completely ‘natural’, are extremely concerning (Van Hove and Gillund 2017). Discussions to...
date around changes to GM regulatory frameworks to exclude cisgenesis from oversight have taken place in Argentina, Australia, Canada, the European Union, Japan and South Africa (Lusser 2012).

Opponents to relaxing biosafety rules for cisgenesis argue that the modification process is the same as transgenic modification and that, since consumers have the right to know if their food has been genetically modified in any way, labelling regulations need to remain in place (Lusser 2012). The hope held by advocates for the technology is that consumers will more easily accept these crops – this is particularly true when the modification is done on farmer-preferred varieties that are already known and liked by the public (Van Hove & Gillund 2017). But if regulations were relaxed or removed, consumers would be deprived of their right to choose to eat non-GM food (ACB 2017a).

There is a lack of coherent international regulations to cover these new forms of genetic modification, and some actors are attempting to exploit the situation. While European Union legislation defines GM products by the final product as well as process of introduction of foreign genetic material into a host organism or plant, other countries such as Canada have taken a more lenient approach (ACB 2017a). The Cartagena Protocol does note the need to cover future novel techniques, but there is a lack of risk assessment protocols in place (ACB 2017a). There is a clear need for techniques that can ascertain whether plants have been modified through cisgenesis (ACB 2017a) and, for all GM products, to be able to analyse changes in genetic, protein, metabolite and RNA expression (ACB 2017b).

There are several ongoing trials on potatoes using cisgenesis. The Irish Agricultural Research Agency and Wageningen University in the Netherlands have developed a late blight-resistant GM variety, Désirée, with multiple genes Rpi-sto1, Rpi-vnt1.1, and Rpi-blb3 from wild varieties S. stoloniferum, S. venturii, and S. bulbocastanum respectively (Travella 2019). In the United Kingdom, The Sainsbury Laboratory’s application to conduct field trials for GM potatoes was approved in 2017 (Travella 2019). This is part of a project to develop a Maris Piper potato variety that is resistant to late blight and nematodes, bruises less and produces less acrylamide when cooked at high temperatures (Travella 2019). The project is funded by the Biotechnology and Biological Sciences Research Council, with additional funding from BioPotatoes (UK) and the J.R. Simplot Company (Travella 2019). There are also projects experimenting with the use of direct genome editing to suppress the genes in the potato that are susceptible to late blight (Travella 2019). Two cultivars, Désirée and Mayan Gold, have been genetically modified to enhance levels of betacarotene by gene editing to silence the gene that converts betacarotene to a less useful form, zeaxanthin (Travella 2019).

Those opposing trials of these crops in the United Kingdom also note that not enough is yet understood on the potential impact of non-target organisms or of the interaction between multiple genes in the stack (Schouten et al. 2006). They also note that the trial does not consider the possible and unknowable interactions between the stacked traits (Leahy 2019). These crops will need to be screened to ensure there is no unintended other material (Schouten et al. 2006) and this will require sophisticated testing facilities and enough capacity (human resources and financial).

The Innovative Farmers Network in the United Kingdom has researched 11 naturally blight-resistant potato varieties and discovered a few heritage varieties and new varieties that have high yields and good resistance – they have tested for resistance, yield and taste, and processing potential (Soil Association 2016). The Network notes that it ‘seems pointless to spend so much time and money developing GM versions of the same thing. Trials like this are generally cheaper, easier to run and less exclusive’ (Soil Association 2016).
Plant variety protection in Rwanda

Rwanda’s Seeds and Plant Varieties Law (005/2016) incorporates plant variety evaluation, certification and registration; seed production and marketing; seed import and export; and the protection of new plant varieties and plant breeders’ rights. Rwanda became the first country to ratify the African Regional Intellectual Property Organization’s (ARIPO’s) Arusha Protocol for the Protection of New Varieties of Plants, when it acceded in June 2019. The law is based on International Union for the Protection of New Varieties of Plants (UPOV) 1991, although Rwanda is not a member of UPOV 1991. Despite this, and the fact that Rwanda is a member of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), the Rwanda Seed and Plant Varieties Law of 2016 is even more restrictive than UPOV 1991, and prevents the meaningful realisation of farmers’ rights.

Article 23, which describes the criteria of novelty of a plant variety (one of four criteria required to obtain a plant breeder’s right), specifically states that a plant variety will be deemed new even ‘if used by a third party in laboratory or field trials including small-scale processing’. This essentially provides permission for a breeder to obtain a plant breeder’s right on an existing seed used in farmers’ fields. Read together with Article 24, which describes the criteria for distinctness for a plant variety, where the law outlines when a variety is deemed to be of common knowledge, there is no mention or recognition of traditional or local varieties. This is not allowed for even under UPOV 1991 and ARIPO’s Arusha Protocol. With these clauses, and without any need for the disclosure of the origin of the plant material, this law essentially encourages biopiracy and prevents the equitable sharing of benefits outlined in the Nagoya Protocol on Access and Benefit Sharing, to which Rwanda is a Party. Therefore this law fails to protect traditional seed, local agricultural and food systems and livelihoods.

The exceptions to the plant breeders’ rights described in Article 41 specify that, ‘The plant breeder’s right does not apply to a smallholder farmer who uses a protected variety or the product of the harvest on their own holding for non-commercial purposes’. In fact this clause is repeated twice. This is highly restrictive and limited, and fails to take into account:

• Reliance on farmers’ seed, farmers’ varieties and farmer seed systems through local exchanges and sale.
• The historical and current role farmer seed systems play in the development and maintenance of agricultural and genetic diversity.
• Saving, reusing, exchanging and sale of seed is the main source of seed for African farmers and its role in providing nutrition and food security.

Such heterogeneous and adaptable seed, and the systems that uphold it, including local markets, will continue to be essential for adapting to climate change.

2. These criteria are: novelty, distinctiveness, uniformity and stability
Main concerns

There are widespread concerns regarding the long-term impact of GM potato adoption on smallholder farming systems, social structures and environmental health in Rwanda.

Narrow and short-sighted technology

While late blight is a major issue for potato farmers and consumers, and the continuous need to apply expensive and toxic fungicides are also causes for concern, the adoption of this GM potato variety is short-sighted. Beyond the issue of resistance of late blight, making the GM potato unable to respond to the challenge it is meant to address, this framing excludes tried and trusted solutions to mitigating late blight (Lusser 2012).

Also of concern is the lack of participatory stakeholder engagement with farmers and consumers regarding the limited information available on the long-term consequences of patenting of genetic constructs, proprietary issues concerning the GM seed and benefit-sharing agreements (Lusser 2012).

The introduction of GM crops requires a shift in agricultural production towards an industrial model, with monocropping and the use of irrigation, synthetic fertilisers and pesticides. Such a system is not the reality for smallholder farmers in Rwanda, nor is it desired, since it reduces agricultural biodiversity and therefore impacts negatively on household nutrition needs. The field trials of Victoria in Uganda used 300 kilograms per hectare of fertiliser and insecticides to control pests, suggesting that Rwandan farmers will still need to invest significantly in synthetic expensive inputs to reap any benefits resulting from the (short-term only) non-application of fungicides.

Growing potatoes under irrigation can have devastating effects on ecosystems, as seen in South Africa’s Sandveld region, which produces 15% of the total potato crop in the country (ACB 2008). Potato production can use, on average, 7 000 cubic meters of water per hectare a year and may cause water stress on wetland and other fragile ecosystems. The Sandveld region typically gets only 200 millimetres of rain a year and potato production in the region is completely reliant on the use of irrigation and fertilisers. Production of the crop expanded in the region between 1993 and 2005 drawing on already scarce underground water reserves. By 2005, the quality of the water drawn from boreholes had deteriorated significantly due to legal and illegal withdrawals for potato production and some wetland areas were categorised as irreversibly damaged (Yeld 2005).

Lack of choice

Currently the government only provides those who join its Consolidated Land Use Program with free seed and subsidised fertiliser, and farmers are given little to no choice as to what crop they plant. If government uses this channel to distribute the GM potato, farmers will therefore have little to no choice as to whether to adopt the technology, and the GM potato may easily enter local farmer-managed potato seed systems through farmer seed saving and exchange. The risks associated with this technology are not fully known, but this will have significant impacts on late blight resistance and increase overall fungicide use where contamination takes place.

In South Africa, with larger land holdings, the government decided in 2015 that GM potato cultivation would not be allowed because of the regulatory burden that would be placed on farmers to keep conventional and GM crops separate. Rwandan potato farmers, even if they are producing on consolidated five hectares of land, will not be able to meet the biosafety requirements of setting aside land as refugia. It is not yet clear how the Rwandan government aims to overcome this formidable challenge.

The unsupported claims of durable resistance

Late blight is a fast-adapting pathogen. Trials in the Netherlands and Belgium on cisgenic GM potatoes show that resistance may only be effective when a stack of several genes is used from a range of wild varieties – and this might need to be up to four or five stacked genes that are sufficiently different to provide more complex protection against late blight (Haesaert et al. 2015). The argument made is that using stacked genes will delay
the inevitable adaptation by the late blight pathogen. However, this delay period has not yet been scientifically quantified; it will only be possibly to ascertain the validity of durable resistance over time once the potatoes are produced on a large scale (Lusser 2012).

Resistance will also be dependent on careful monitoring to ensure management of resistance as it occurs (Lusser 2012). This presents a significant risk to smallholder farmers who adopt the technology but do not have the capacity to undertake sophisticated monitoring of the crops, resulting in them facing increased financial risk if the promise of durable resistance is not met. It is not clear from any cisgenic potato trials who would be responsible for monitoring and resistance management once the crop is commercialised (Lusser 2012).

Conclusion

The Rwandan government is looking to the GM potato to solve a multitude of problems – low average yields and vulnerability to late blight. It would also lower the current high levels of fungicides used on crops, a practice that has adverse impacts on human and environmental health. In the case of the Ugandan field trials, however, the GM potatoes were grown under ideal conditions, using an array of insecticides to combat other common pests and 300 kilograms of fertiliser per hectare. Rwandan’s current average fertiliser use is a tenth of that. While farmers may save on the costs of fungicide, they will face other input, financial and ecological costs. Even these savings will be short-lived, since late blight is a fast adapting pathogen and resistance will soon set in.

The involvement of the International Potato Centre and USAID in the Ugandan GM potato trials seems to be key to Rwandan’s adoption of the GM variety, given their significant presence in the country and investments in the potato value chain. Of particular concern is the fact that the channels set up to provide farmers with support (inputs and extension services) are directed through the CIP, which focuses on only six crops, and the Land Use Consolidation Program, which gives farmers little to no choice on what to plant. If these channels are used to provide farmers with free or subsidised GM potato seed, farmers who wish to receive government support will have no choice about adopting the technology. Even if they choose not to use GM potatoes, this variety will quickly enter the informal market through farmer seed saving and exchange networks, with no means of recall.

More appropriate interventions in the agricultural sector would be provision of appropriate storage facilities, investments in processing, support for agroecological production aimed at producing maximum nutritional outcomes, and heightened training and support for farmer cooperatives.
References


https://www.ifc.org/wps/wcm/connect/publications_ext_content/ifc_external_publication_site/publications_listing_page/cpsd-rwanda


AFRICAN CENTRE FOR BIODIVERSITY – The GM potato push in Rwanda: Key Issues and Concerns


Ntihinyurwa P and Masum F. 2017. Role of farmers’ participation in land consolidation in Rwanda. Presentation given at FIC Working Week, 29 May–2 June, Helsinki, Finland


Schouten H, Krens F and Jacobsen E. 2006. Cisgenic plants are similar to traditionally bred plants: International regulations for genetically modified organisms should be altered to exempt cisgenesis. EMGO Rep. 7(8):750–753


