



Tropentag 2017, Bonn, Germany  
September 20-22, 2017

Future Agriculture: Social-ecological transitions and bio-cultural shifts  
organised by the University of Bonn and the Centre for Development  
Research, Bonn, Germany

## Formal and informal seed potato supply systems analysis in Rwanda

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### Abstract

Potato production in Rwanda is constantly increasing and represents an important food and cash source for farmers. The potato crop together with maize, wheat, rice, beans and cassava is one of the six priorities crops on which the Crop intensification Program (CIP) is focusing since 2007. Its production is mainly located at high altitudes in the Northern and Western provinces. The Nyabihu, Musanze, Rubavu and Burera districts, due to their favorable climatic conditions, are the 4 most productive districts, accounting for about 60% of the national potato production. However, because of the low quality seed use by farmers and low soil health, yields remain low with 11.6 t/ha.

The aim of the study was to understand the current situation of the formal and informal potato seed supply system in Rwanda. The study was conducted in the Nyabihu, Musanze, Rubavu and Burera districts from the end of June to the end of September 2016. In order to gather agronomic and socio-economic information, qualitative and quantitative data were collected using 3 social science instruments: formal-informal interviews and expert interviews.

Currently, the private sector is the principal actor involved in mini-tubers production having a market share of 71%, while the public one has a 29% share. The actual mini-tubers production could cover between 13% to 30% of the actual Rwandan national demand. However, due to a potato seed leak along the certification process and to a lack of actors who multiply lower seed categories into upper ones, the same figure is not reflected into the actual production of certified seed, which represents 5% of the national required demand.

Potato cultivation represents the largest household income source for the sectors with the highest potatoes production levels in the region. In fact, it generates 57% of the average gross income per year per household, which is equal to 621,750 FRw (731 USD). Farmers obtain potato seed from four main sources: his/her own harvest, other farmers, the local markets and the formal seed sector. The large majority (85%) is not able to keep their own seed each season. Indeed, only 15% always keeps at least a small part of their potato seed and the remaining quantity is bought off-farm when necessary. On average, the off-farm purchase is done in 57% of the cases showing a high dependency on the off-farm seed sources. Moreover, farmers use certified seed in few cases (3%), because of their unawareness of the certified seed presence in the market, the high price, the low seed availability along with the unwillingness to buy certified seed. With the goal of increasing the seed quality among farmers, it is recommended to introduce or extend the utilization of good agronomic practices, positive selection, plot techniques and the use of certified seed. Aiming at increasing the certified seed quantities, primarily we recommend to optimize the current multiplication process by improving the current agricultural practices and by increasing the multiplication bodies exclusively involved in the last certification phases. Only when the last phases are well organized, the mini-tubers production can be increased by augmenting the screen houses number and/or their exploitation rate.

In conclusion, in order to supply Rwandan farmers with high quality seed, the formal and informal systems must be complementary and mutually dependent. The certified seed production must be combined with the development of strong and target linkages (e.g. Farmer Field School) along with the informal seed sector. The promotion of integrated-participative approaches in breeding, seed production and distribution would help increase the complementarity between the two systems.

**Keywords:** *Solanum tuberosum*, potato, seed, formal, informal, agricultural policies

## 1. Introduction

Rwanda is part of the Tropical African Highlands, together with Uganda, Burundi and Ethiopia. The largest part of the land is located over 1000 m a.s.l. (Nyabyeda 2005). It is often called the “country of thousand hills” due to the hills numbers on which many farms are scattered. At the same time, following the first half of the 1990s genocide it is also named the country of the “thousand sorrows” (Braeckman 2014).

Despite its past, the country has reached a stable political situation and it is considered a development model for many sub-Saharan countries (Huggins 2014). Despite the positive improvement, the primary sector still plays a central role in the Rwandan economy, producing approximately the 36% of the GDP and employing the 79% of the population (MINAGRI 2014). In order to overcome this situation, the government started an ambitious project called the “Rwanda Vision 2020” with the prospective of an “African Green Revolution”. The program aims to transform Rwanda from an agricultural subsistence to a knowledge-based economy by 2020 (ibid.). To achieve the “Rwanda Vision 2020” the Crop Intensification Program (CIP) was put in place in September 2007. Its principal aim is to increase the agricultural yields, focusing on six priority crops namely: maize, wheat, rice, Irish potato, beans and cassava, and to consolidate land, which is known under the name of the Land Use Consolidation (MINAGRI 2011).

The Rwandan potato (*Solanum tuberosum*) production is constantly increasing and potatoes represent one of the key staple crops being an important source of calories for the population (Tenge et al. 2012). Potatoes are principally cultivated at high altitudes, from 1800 to 2600 m a.s.l., in the Northern and Western provinces, which are the main producing potato areas of the country. Potato farming is found as well as in the South provinces but plays a minor role. The Nyabihu, Musanze, Rubavu and Burera districts, due to their favorable climatic conditions, are the 4 most productive districts counting about 60% of the national potato production (MINAGRI 2013). However, the average potato yields in these districts remains low corresponding to 11.6 t/ha (NISR 2015). This is principally due to the low utilization of quality seed by farmers (Nshimiyimana et al. 2015).

Currently the formal seed supply system in Eastern Africa is able to supply less than 1% of the country potato seed demand with high quality seed (Schulte-Geldermann 2015). The remaining 99% is guaranteed by the informal seed system, also known under the name of local or traditional seed system.

A USAID funded project, using the so called “3G seed potato” strategy was implemented in Kenya, Rwanda and Uganda from 2008 till 2011 in order to increase the availability of high quality potato seed. The project result in Rwanda was that the mini-tubers number produced increased from 75,000 in 2008 to 715,000 mini-tubers in 2013 (Demo et al. 2015).

Although the pre-basic production has increased no clear data on the current Rwandan certified seed production levels are available. Moreover, no documents describe in a detailed way the actual formal seed potato program in its multiple-aspects. In addition, a complete lack of information on the Rwandan informal potato seed system exist.

In order to fill these gaps, the aim of the paper is that of providing a detailed description of the Rwandan formal and informal potato seed supply systems. Interaction between the two systems and overall possible improvements will also be described.

## 2. Material and Methods

The survey has been implemented in the Rwandan districts of Muzanze, Burera, Nyabihu, Rubavu. The 4 districts were selected as representative of typical potato production regions in Rwanda. The area is characterized by a high population density of 670 inhabitants per km<sup>2</sup> for a total population of 1,137,900 within a total area of 2090 km<sup>2</sup>. The large population majority is rural (80%). The rainfall pattern is bimodal with the short, most reliable and important rain season from September to January (Season A); the long rain season (Season B) has high intensity rainfall and runs from mid-February to May (Nabahungu and Visser 2011). The 5 Rwandan administrative levels are: Province, District, Sector, Cell and Village (Imidugudu). The survey has been conducted from the end of June to the end of September 2016. In order to gather the agronomic and socio-economic information on seed potato production and management, qualitative and quantitative data were collected. Three instruments, used in social science, were applied during this research: formal and informal interviews and expert interviews. To assess the actual status of the formal potato system a total of 28 interviews were performed. To describe and evaluate the potato seed management by farmers, a total of 40 formal interviews were implemented.

## 3. Results and Discussion

### 3.1 Formal seed potato system

The Rwanda Agricultural Board (RAB) Northern Zone, with its headquarters in Ruhengeri, is the heart of the formal potato seed program. Its aim is to produce certified seed in order to increase the availability of high quality potato seed for the Rwandan market. The main certified seed production is located in the 4 districts of Muzanze, Burera, Nyabihu and Rubavu, whereas only the smallest part of it is produced in the Southern Province. Nowadays, the formal seed sector is mainly organized and managed by the RAB under the supervision of the MINAGRI. The RAB is in charge of the breeding program and the seed multiplication phases are shared between it and the private sector. The RAB's long-term goal is gradually to quit the multiplication phases by increasing the share of the private sector in the formal potato seed market (Senkeshu 2016).

The seed potato multiplication is carried out by the public sector (RAB) and by the private one following a 6-generation scheme. The production of vitro plantlets is guaranteed due to the tissue culture laboratories of the RAB and the Ruhengeri Institute of Higher Education (INES). Rooted cutting are then planted in nursery beds, located in aphid proof screen houses. Then the multiplication is continued in the open field producing "basic seed 1" and "basic seed 2". The last production phases, certification 1 and 2, are produced by cooperatives and by the Groupes Producteurs de Semences (GPS). Nowadays, the "certification 2" is only produced in few cases.

Almost the totality (93%) of the vitro plantlets production is guaranteed by the public sector, whereas the private ones play a smaller role (7%). The opposite situation appears when we look at the mini-tubers production: the public sector became the principal actor having a market share of 71%, while the private has a share of 29%. The public sector and the private one produce annually a totality of about 5,140,300 mini-tubers (season A, 2016).

Nowadays, with the actual production levels in the field, the multiplication of 5,140,300 mini-tubers could produce about 18,000 tons of certified seed. Subtracting the actual sales of the different seed categories along the multiplication process, we could reach a production potential of about 12,800 tons of certified seed. By improving the actual cultural techniques, the multiplication rates in the field could be increased achieving an annual production potential of about 40,700 tons.

However, those scenarios are never achieved due to a potato seed leak along the certification process and to a lack of actors' who multiply lower seed categories into "certification 1". The improvement management and the current actors organization involved in the "certification 1" production, such as cooperatives and the GPS, should be the first step to be done. They should be specialized in seed production and should exclusively multiply certified seed. In addition, the produced "certification 1" should be sold outside of the multiplication bodies in order to maximize the certified seed diffusion. The second step should be the number increase of the multiplication bodies that produces "certification 1" at the national level. As a general rule, the certification seed production process should act as a closed cycle. Once the last multiplication phases are well organized, the production of mini-tubers can be increased. Three scenarios would be envisaged: The first one would use the actual infrastructures by increasing the exploitation degree of the screen houses currently present. The second scenario is the construction of new screen houses increasing the infrastructures for producing mini-tubers. The third and the last option is to increase the pre-basic seed production by directly planting the vitro plantlets surplus in the open field (ibid.).

Another important aspect about developing an efficient seed system is the creation of a clear seed pricing policy. The price along the year must not be fixed, but adapted several times along the year. More specifically, the seed potato price should be increased by at least 50% compared to the ware potato price and follow the yearly ware potato price curve. With the application of this pricing policy, the seed potato sale as ware potato should be avoided or at least declined. A discussion with the principal credit institutions should be open in order to facilitate the lending process for actors involved in the primary sector. The repayment schedule should be prolonged in order to allow the seed multipliers to repay their loan, made at the beginning of the season after the storage period. The multiplication scheme must be clearly understood by the different actors involved in the process and by the buyers. The creation of a national potato seed association, which already existed in the past, could represent a strong signal that underlines the strengthening of the seed industry. In addition, the association can increase the bargaining power of its members with the public-private sector and international agencies or donors.

### **3.2 Informal seed potato system**

Potato represents the largest source of income for the household and is by far the most important cash crop for the sectors with the highest production levels in the region. Farmers consider potatoes a source of money and at the same time an important source of food due to its short growing season. The average gross income per year per household for the sectors with the highest potato production levels in the region is 621,750 FRw (731 USD). The sale of potatoes originates 57% of their income, 15% derives from the sale of milk or animals, 15% by off-farm activities. The remaining 13% is the result of the sale of cereals, beans and other crops.

Farmers generally cultivate potatoes 2-3 times a year using a solo cropping system without varietal mixture. The majority of the farmers produce seasonally only one potato variety and almost half of the land per household is cultivated with potatoes.

Farmers obtain potato seed from four main sources: his/her own harvest, other farmers, the local markets and the formal seed sector. The large majority (85%) is not able to keep their own seed each season. Indeed, only the 15% always keeps at least a small part of their potato seed and the remaining quantity is bought off-farm when necessary. On average, the off-farm purchase is done in 57% of the cases showing a high dependency on the off-farm seed sources. The principal reason is the poor yield and/or the poor seed quality during season A and B. Moreover, farmers use certified seed in few cases (3%), due to the unawareness of the certified seed presence in the market, the high price, the low seed availability along with the unwillingness to buy certified seed.

Farmers, in order to increase the seed potato quality, practice seed selection. The seed production is not fully integrated into the normal crop production, meaning that seeds are not selected from the stored harvest before the planting time. Producers select their seed before storage stoking them separately from the ware potato. This ensures a next step in the selection level compared to fully integrated systems. Nevertheless, the seed is not generally produced in separate plots indicating a not excessive degree of specialization in seed production.

### 3.3 Interaction between formal and informal seed systems

In order to maximize the impact of the formal seed program specific linkages have to be established with the informal system:

First of all, common objectives on varietal development should be defined in a clear way together with farmers using participative approaches. This will increase the new varieties adoption rates by farmers repaying the effort of the breeding program and increasing the farmers' recognition. At the same time, important varieties widespread among farmers should be a part of the multiplication objectives of the formal seed sector.

The certified seed has to be "injected" into the informal seed system at right sites and points in order to maximize their diffusion among small farmers. In order to do so, we recommend the following strategies:

Firstly multiplication bodies, present in the territory, should sell certified seed outside the bodies' selves.

Secondly, the quantity sold should be fixed up to a maximum of 400 kg per purchaser and no minimum quantity should be established. This measure avoids that more commercial oriented farmers, who may directly produce ware potato from purchased seed, will buy much of the certified seed.

Thirdly, the sale priority should be given to facilitators involved the Farmer Field Schools (FFS). The facilitators must use certified seed or new varieties for teaching purpose, for instance comparisons among seed coming from different sources and varieties could be tested. At the end of the evaluation process, tubers must be distributed among the FFS members. Neighbors and acquaintances, by observing their fields, will in turn adopt part of their practices generating a knock-on effect. This measure has the objective to distribute clean genetic material and new varieties widespread on the territory. At the same time, it also helps to increase the knowledge of the certified seed presence among farmers. This option, which involves local partners, well known in the farming community, would probably avoid problems that could slow down the certified seed diffusion process such as: social differences within the communities, ethnic and geographic boundaries, and diffusion of potato seed from large to small farmers (Prain and Scheidegger 1988; Almekinders et al. 1994). Extension service as the IMBARAGA and the BAIR should introduce FFS- facilitators to the proposed system. Moreover, they should help the facilitators get in touch with the certified multipliers. In this case, the TWIGIRE extension model would play a double function: the extension service and the starting "injection" point for certified seed and new varieties within the traditional seed flows. The right price, the sale time and the physiological age of certified tuber at the moment of the sale should meet the farmers' expectations. A clear pricing policy should be established in order to sell affordable certified seed to farmers. The moment of sale and the tubers physiological age should not represent a large problem to farmers due to the high time variability they have in planting potatoes.

## 4. Conclusions

In conclusion, the formal seed sector supplies 5% of the national seed demand with certified seed, whereas the informal one supplies the remaining 95%. In order to supply Rwandan farmers with high quality seed, the formal and informal systems must be complementary and mutually dependent. It is suggested that the certified seed production must be combined with the development of strong and targeted linkages along with the informal seed sector. At the same time, the strengthening of the informal seed system must be improved to increase the seed quality produced by farmers.

The promotion of the integrated-participative approaches in breeding, seed production and distribution would help improve the complementary between the two systems. By doing this, the actual quantity of certified seed could have a major impact on the overall seed supply and increase the seed quantity in the country.

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