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Research Application Summary

Effect of improved seed system on potato yields in Uganda

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Abstract

Potato seed quality is an important determinant of crop performance, final yield and quality. The quality of seed used by farmers depend on the existing seed system. In Uganda, since the formal sector has limited capacity to produce and deliver certified potato seed, the informal sector prevails providing over 93% of potato seed used by farmers. The informal sector is not regulated thus informal seed that is often used by farmers is usually of poor quality which has stagnated national yields at 7.5 t ha^{-1}. This review looks at the general potato seed system in Uganda with an emphasis on potato seed quality while giving recommendations on how this problem can be alleviated. This is a narrative review organized under sub-topics to give the reader a comprehensive overview and easier tracking of the afore mentioned reviewed topic. In summary, this review revealed that although intervention have been used to improve quality and quantity of potato seed, a big gap still exists thus more interventions are needed both in the formal and informal sector. In addition, it revealed that if the quality of potato seed used by farmers can be improved either by making certified seed more available and affordable or improving the quality of seed obtained from the informal sector, it would be possible to increase potato yields in Uganda substantially.

Key words: Potato production systems, seed quality, *Solanum tuberosun*, Uganda

Resume

La qualité des semences de pommes de terre est un déterminant important de la performance des cultures, du rendement final et de la qualité. La qualité des semences utilisées par les agriculteurs dépend du système semencier existant. En Ouganda, étant donné que le secteur formel a une capacité limitée pour produire et livrer des semences de pommes de terre certifiées, le secteur informel prédomine en fournissant plus de 93% des semences de pommes de terre utilisées par les agriculteurs. Le secteur informel n'étant pas réglementé, les semences informelles qui sont souvent utilisées par les agriculteurs sont généralement de mauvaise qualité, ce qui a maintenu les rendements nationaux à 7,5 t/ha. Ce document examine le système de semences de pommes de terre en Ouganda en mettant l'accent sur la qualité des semences tout en donnant des recommandations pour atténuer ce problème. Il s'agit d'un examen narratif organisé en sous-thèmes pour donner un aperçu complet et un suivi plus facile du sujet examiné. En résumé, cette revue a révélé que bien que des

interventions aient été faites pour améliorer la qualité et la quantité de semences de pommes de terre, un gap important existe toujours, et donc plus d'interventions sont nécessaires à la fois dans le secteur formel et informel. En outre, il a révélé que si la qualité des semences de pommes de terre utilisées par les agriculteurs pouvait être améliorée soit en rendant les semences certifiées plus disponibles et plus abordables, soit en améliorant la qualité des semences obtenues du secteur informel, il serait possible d'augmenter considérablement les rendements des pommes de terre en Ouganda.

Mots clés: Systèmes de production de pommes de terre, qualité des semences, *Solanum tuberosun*, Ouganda

Introduction

Potato (*Solanum tuberosum* L.) is an important crop for food and income generation grown in more than 150 countries worldwide. Although the crop can adjust to a wide range of climatic conditions, potato is majorly a temperate region crop grown mainly in highland areas. Globally, potato is placed in third position as the most consumed food crop after rice and wheat. In terms of volume produced, the crop is also ranked fourth among all food crops and first among root and tuber crops with an approximate production of 320 million tonnes per annum obtained from about 20 million hectares (FAO, 2013). Being a high yielding crop that fits well in various cropping systems predominant in tropical and sub-tropical environments, the increasing role of potato in curbing food insecurity especially in developing countries is indispensable. In sub-Sahara Africa, the crop is a cheap source of vital nutrients such as carbohydrates, dietary fibre, lipids, proteins, minerals, vitamins, and other useful phytonutrients. In Uganda, potato has become a staple food in many households and it is not only viewed as a hunger reliever during times of critical food need but also as a quick source of income due to its ability to mature faster (Byarugaba *et al.,* 2017). In addition, potatoes are increasing being utilized as raw materials by food processing industries to make value- added processed products for example potato chips, potato crisps, French fries and potato flour, among others.

Despite the importance of potato, average yields in Uganda have remained very low at 7.5t ha^{-1} compared to the world's average of 17 t ha^{-1} and also to those in other countries such South Africa (34 t ha^{-1}), Kenya (20.3 t ha^{-1}) and Rwanda (14.2 t ha^{-1}) (FAOSTAT, 2010). Potato production in Uganda is impended by numerous constraints such as poor agronomic practices, low soil fertility, pests and diseases, high cost of inputs, and use of poor quality seed. Among the constraints, use of poor quality seed is a fundamental factor contributing to the low potato yields attained (Byarugaba *et al.,* 2013). In Uganda, there is high demand for potato seed yet the formal sector has limited capacity to produce and distribute certified seed (KAZARDI, 2014). Due to the wide seed supply-demand gap, the little available certified seed becomes expensive which in turn forces potato farmers to resort to the informal sources such as own-saved, other farmers and local markets with potato seed which is relatively affordable, adequate in amounts and easily accessible (Muthoni *et al.,* 2011). The informal seed system is not organized and has no regulations to control seed health, production, handling, delivery and use thus most of the potato seed obtained from these sources is often of poor quality. Unconventional techniques such as aeroponics, tissue culture, positive seed selection and seed plot technique are currently being used to solve the

challenge of limited quantities of certified seed and poor quality of farmers' seed. However, these have not been effective due to resource limitation, limited adoption and they also require additional supportive policies. This paper seeks to review the general potato seed system in Uganda with an emphasis on potato seed quality which is a major problem in potato production. The paper also provides recommendations on how potato production system, especially seed quality, can be alleviated.

Potato seed quality and its significance. Since potato is mainly propagated vegetatively by use of tubers, field performance, final yield and quality are determined by the quality of potato seed sowed. Quality of potato seed is determined by both physical and biological attributes. The physical attributes include variety purity, size and uniformity, weight, shape, and color, among others. These mainly affect seed price but to some extent also affect the productivity of potato. The biological attributes include level of disease infection and physiological age of the seed tubers. These attributes are the main influencers of potato productivity. The physiological age of the seed tubers determines the growth rate of the crop with old seed faster growing plants when young but senescing earlier leading to relatively lower final yields. In disparity, at an early age, the development of young seed is slow but it remains vigorous throughout the growing period thus higher final yields are obtained. Potato tubers are prone to a large number of diseases such as early blight, late blight, bacterial wilt, fusarium wilt, soft rot, potato leaf roll virus and potato virus Y caused by viruses, bacteria, fungus and other pathogens. The common practice of continuous use of seed tubers for several croppings by farmers before renewing, leads to accumulation of diseases within the tubers causing losses in quality and quantity of the final yield obtained over the years (Kinyua *et al.,* 2011). This indicates that to ensure harvest of quality potatoes and increased productivity, use of good quality seed is critical. It is estimated that potato yields can increase between 30% to 50% when using good quality seed compared to farmers' seed. Similarly, effectiveness of fertilizers and other crop management practices could be more achieved when good quality seed is used (Gildermacher *et al.,* 2011). It is therefore important to use good quality seed for profitable production.

Potato seed system in Uganda. The quality of seed used by farmers depend on the existing seed system. In Uganda, the potato seed system is a combination of both formal and informal sector with the informal sector being the largest contributor providing over 93% of the seed farmers use (Aheisibwe *et al.,* 2015)

Formal sector. In Uganda, the formal sector contributes less than 1% of the potential demand for seed potato due to its limited capacity (resources and personnel) to produce and deliver certified seed (KAZARDI, 2014). This sector is not well built but it operates through a semi-formal institutional arrangement with Kachwekano Zonal Agricultural Research and Development Institute (KAZARDI) solely responsible for conducting research on potatoes and also mandated to produce and deliver certified potato seed of improved varieties across the country. KAZARDI produces different classes of seed, namely, breeder seed (variety released and maintained by breeder), basic/foundation seed (progeny of breeder seed) and certified seed which is produced by multiplication of basic seed either by seed growers contracted by KAZARDI or registered seed multipliers to whom this seed is sold. The fields used for multiplication of basic seed are supervised by a team from the National Agricultural

Research Organization (NARO) to identify any manifestation of diseases. Later, samples of the harvested potato are collected by this team and are tested for biological quality and percentage germination. The seed lots that pass these tests are certified, graded, packaged and sold to farmers mainly for ware production but they can also be used as home-saved seed. This process is done through a "flush-out" system where basic seed is multiplied for just one season and sold to the farmer thus ensuring that the seed multipliers renew their starter seed often which maintains the quality of the seed produced.

Seed production methods under the formal sector. Seed production in the formal sector in Uganda is principally under three methods and these include; conventional method, tissue culture/micro-propagation and aeroponics.

The conventional method is the easiest and the most widely used. It involves field multiplication of breeder seed for several cycles to produce large quantity of basic seed which is given to contract seed growers or registered seed multipliers to multiply it further to produce certified seed which is later sold to farmers. The disadvantages of this method include lengthiness of the process and a low multiplication rate (1:10) resulting in a shortfall of certified seed. In addition, there is also a high risk of acquiring diseases by the tubers during the multiplication process and also there might be a problem of transportation due to the bulkiness of the tubers.

In the case of tissue culture/microprogation method, an explant from potato is propagated in vitro on a nutrient culture medium in a test tube under sterile controlled conditions in the laboratory. Plantlets are produced which are transplanted to wooden boxes containing soil mixed with sand in the screen house. From the plantlets, potato mini-tubers (basic seed) are produced which are multiplied by contract seed growers or certified seed producer and later sold to farmers. This method quickens the production of high quality disease-free plantlets which are genetically and physiologically uniform. However, there is reduction in genetic diversity, method is expensive and if care is not taken, the whole stock may be lost due to contamination.

In the aeroponics method, potato plantlets obtained from tissue culture are grown in an air/ mist environment on an aggregated media lined with insect proof quarantine mesh in a screen house. The roots which are suspended and enclosed in a dark chamber are regularly misted with a nutrient solution. The stems are supported and the mini-tubers are continually harvested to acquire the desired size. This method allows rapid multiplication of large numbers of healthy mini-tubers which are easily harvested. However, the size of water droplets affects the plant physiology and performance, method is costly and needs constant power supply.

Seed production methods under the informal sector. At present, the informal sector prevails in Uganda thus meeting the largest proportion of farmers potato seed requirement (Aheisibwe *et al.,* 2015). The informal sector is not organized and has no regulations to control seed health, production, handling, delivery and use. This sector is characterized by production of both traditional and modern varieties, field management, storage and marketing of seed by farmers, visual determination of seed quality and farmers meeting

their own research needs (Byarugaba *et al.,* 2017). The informal sector has various seed sources such as own-saved, local market, neighbors and merchants with own-saved being the major informal seed source. Since this sector is not regulated, informal seed is usually of poor quality. Moreover, big tubers are usually eaten or sold thus the unmarketable small size tubers (chatts) are often saved as seed under poor storage conditions. These tiny tubers produce single stems, produce few tubers and are susceptible to soil and seed-borne insect pests and diseases. In addition, informal seed is usually recycled for several croppings before renewing leading to an accumulation of diseases within the tubers thus causing seed degeneration.

Potato seed production under the informal sector is largely done using farmers' traditional knowledge. Although medium sized tubers are also used as seed, the usual practice of potato seed production by farmers in Uganda involves wholesome harvesting of potato, sorting out the tinniest tubers to be used as seed and the remaining harvest is either eaten or sold (Gildemacher *et al.,* 2009). However, interventions to improve the quality of farmers' seed and availability of adequate quantities of good quality seed have been used. These include seed plot technique, positive selection and negative selection.

Conclusions

Inadequate quantities, inaccessibility and high costs of certified potato seed force farmers to resort to poor quality seed from the informal sector. Although interventions have been used to improve the quality and quantity of potato seed, a lot is still lacking thus more interventions that will alleviate this problem are still needed. If the adequate quantities and good quantity potato seed is availed to farmers, it can be possible to increase potato yields in Uganda.

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