Research Application Summary

Over view of impact indicators of soybean rust resistant varieties on Uganda's economy

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Abstract

Herein, we document the contribution of soybean (*Glycine max*) genetic improvement to the economic changes at the community level in Uganda. We have illustrated the case of soybean rust, which has been, and continues to be the greatest obstacle to economic change for communities that primarily depend on soybean. Since the introduction of soybean in Uganda in early 1900s, systematic research only began in the late 1930s. These led to the release of 3 varieties (Kabanyolo 1, Kabanyolo 2 and Congo), that resulted into pioneer large scale planting of soybeans in the 1940s. The opening of the Africa Basic Foods in 1965 (the first soy-foods company) with a focus to produce and market low-cost soy foods, also played a pivotal role in promoting the crop. It suffices to note that soybean breeding between 1939 and 1990 resulted into release of six outstanding varieties that became obsolete upon the outbreak of soybean rust epidemic in 1996. In response to this challenge, breeding for soybean rust resistance became a major breeding objective, and resulted into release of four new varieties (Namsoy 4M, Maksoy 1N, Maksoy 2N and Maksoy 3N). Foundation seed of these varieties was largely (71.7%) disseminated by NGOs. Accordingly, national soybean production showed steady increase from 144,000 hectares in 2004 to 155,000 hectares in 2009, with annual production increasing from 158,000 tons to 181,000 tons respectively. Impact studies showed Maksoy varieties were the most widely planted and accounted for 65% of soybean planted. In parallel, soybean processing capacity increased from 300 tons in 2004 to over 600 tons per day in 2011. Soybean was observed to contribute ~ 1,920,000 Uganda shilling ha^{-1} to the farmers income and export value increased by 288%.

Key words: Breeding, economic impact, soybean rust, Uganda

Résumé

Dans cet article, nous documentons la contribution de l'amélioration génétique du soja *(Glycine max)* pour l'évolution économique à l'échelle communautaire en Ouganda. Nous avons illustré le cas de la rouille du soja, qui a été et continue à être le plus grand obstacle à l'évolution économique pour les communautés qui dépendent principalement du soja. Depuis l'introduction du soja en Ouganda au début des années 1900, la recherche systématique n'a commencé que dans les années 1930. Ceci a conduit à la libération de 3 variétés (Kabanyolo 1, Kabanyolo 2 et Congo), qui a abouti à la plantation à grande échelle des pionniers du soja vers les années 1940. L'introduction des denrées alimentaires de base en Afrique en 1965 (la première entreprise des aliments à base de soja) avec un accent de produire et de commercialiser des aliments à base de soja à faible coût, a également joué un rôle essentiel dans la promotion de la culture. Il suffit de noter que la reproduction du soja entre 1939 et 1990 a abouti à la libération de six variétés exceptionnelles qui sont devenues obsolètes dès le déclenchement de l'épidémie de la rouille du soja en 1996. En réponse à ce défi, la sélection pour la résistance contre la rouille du soja est devenue un objectif majeur de reproduction, et a abouti à la libération de quatre nouvelles variétés (Namsoy 4M, Maksoy 1N, Maksoy 2N et Maksoy 3N). Les semences de base de ces variétés étaient en grande partie (71,7%) diffusées par les ONGs. En conséquence, la production nationale du soja a montré une augmentation régulière de 144.000 hectares en 2004 à 155.000 hectares en 2009, avec une augmentation de production annuelle de 158.000 tonnes à 181.000 tonnes respectivement. Les études d'impact ont montré que les variétés Maksoy étaient les plus largement plantées et ont représenté 65% du soja planté. En parallèle, la capacité de transformation du soja est passée de 300 tonnes en 2004 à plus de 600 tonnes par jour en 2011. Le soja a été observé pour contribuer ~ 1.920.000 Shilling ougandais ha-1 aux revenus des agriculteurs et la valeur des exportations a augmenté de 288%.

Mots clés: Reproduction, impact économique, rouille du soja, Ouganda

Background

Two traits make soybean (*Glycine Max*) hugely popular in the world; its high protein content (40%) and oil (20%), all derived from processed seed. In fact soybean produces the highest amount of protein per unit area among crops. Since the introduction of soybean in Uganda, key landmarks have been attained as outlined in Table 1. Indeed, science-led interventions

Table 1. Key landmarks in the history of soybean improvement and promotion in Uganda.

Year	Major achievement
1913	Soybean introduced in Uganda from both the United States and South Africa
1939	Pioneer trials at Bukalasa & Serere; considerable variation in key agronomic traits
1940s	First officially released varieties: Kabanyolo 1, Kabanyolo 2 and Congo
1946	Large scale planting in Buganda (32,329 acres); Western (7,110) & Eastern (1,813) provinces.
19541965	Soya used for treatment of kwashiorkor at Mulago Hospital, Kampala Africa Basic Foods, started to produce and market low-cost soy foods.
1965	Makerere Grain-legume Improvement program started
1990s	Varieties: Nam 1, Nam 2, and Namsoy 3 released; yield range of 2-3.5 tonnes ha^{-1}
1996	Asian Soybean Rust (ASR) first observed
2010	Soybean production estimated at 180,000 hectares and production of 181,000 tons
2010	Breakdown of ASR resistance in Maksoy 1N, Maksoy 2N and Namsoy 4M

have resulted into steady increase of soybean production from an estimated 158,000 hectares in 2004 to 180,000 hectares in 2010, with corresponding annual production of 158,000tons to 181,000 tons (UBOS, 2010).

Literature Summary

Before 1996, soybean production was based on cultivation of six varieties (Kabanyolo 1, Kabanyolo 2, Congo, Nam 1, Nam 2, and Namsoy 3), whose hectarage varied between regions. The outbreak of soybean rust epidemic in 1996 (Tukamuhabwa *et al*., 2001) for the first time in Uganda rendered all these varieties obsolete! Yield loss studies carried at Namulonge and across the country indicated yield losses of 20-50%.

Yield losses of up to 100% were also recorded in the field. By 2000, farmers had lost interest in growing soybeans as it was no longer profitable. This terribly disturbing trend grossly affected the soybean industry and all previous breeding efforts in Uganda. It's on this premise that soybean rust became a major breeding objective.

Study Description

With the soybean rust pandemic two strategies (short and long term) were adopted for restoring soybean production. The short term strategy involved importing and screening of germplasm from IITA, AVRDC, South Africa and Zimbabwe followed by screening for resistance to soybean rust. This exercise identified genotypes UG5, GC 00138-29, TGX 1035 10E as resistant and potential new varieties. UG 5 and GC 00138-29 were very resistant but suffered from pod shattering and susceptibility to bacterial pustule (*Xanthomonas axonopodis* (syn. *campestris*) pv. *Glycines*). TGX 1035 10E was variable and was subjected

to mass selection which led to development of Maksoy 1N. To address the long term strategy, crosses of GC 00138-299 × Nam 2, GC 00138-299 × Duiker and TGX 1035 10E × Duiker were made resulting in progenies which underwent development along the complete cultivar value chain. Consequently, two new soybean varieties were released in 2004, namely Namsoy 4M and Maksoy 1N. Additional varieties; Maksoy 2N and Maksoy 3N were released in 2008 and 2010 respectively. A seed delivery pipeline that comprised of different stakeholders was constituted to help in variety multiplication and dissemination (Table 2).

Table 2. Total soybean seed disseminated through different avenues to farmers.

Seed propagation channel	Year and season			Total	Total %
	2004-2008	2009-2010A	2010B-2011B		
Government bodies	11,050	30	300	11,380	10.1
Seed companies	2,300	500	7,000	9,800	8.7
Private companies	3,000	880	4,370	8,250	7.3
NGOs/CBOs	900	68,000	12,150	81,050	71.7
Others	1,120	390	1,050	2,560	2.3
Total	18,370	69,800	2,4870	113,040	100.0

Impact indicators for new soybean varieties at community level. With the release of new soybean varieties, soybean production has shown steady increase from 144,000 hectares in 2004 to 155,000 hectares in 2009, with annual production of 158,000tons to 181,000 tons, respectively (UBOS, 2010). This translates into annual growth rate of 2.4%. Indeed, for the first time in the history of Uganda, there was a crossover where production was higher than the area under production suggesting improvement in national soybean productivity (Fig. 1). This change can be attributed to the release and cultivation of improved varieties accompanied by better management practices that were recommended and promoted by the soybean breeding program.

In a recent impact study, soybean and maize had highest adoption rate of 20.5% (AGRA, 2011), with the Maksoy varieties being the most widely planted. The high adoption rates of Maksoy varieties was attributed to the increased commercialization of the crop and the high demand by farmers and local factories that need soybeans for vegetable oil, poultry feeds and food for home consumption. The study also showed that the majority of varieties used by farmers in other crops were largely local except

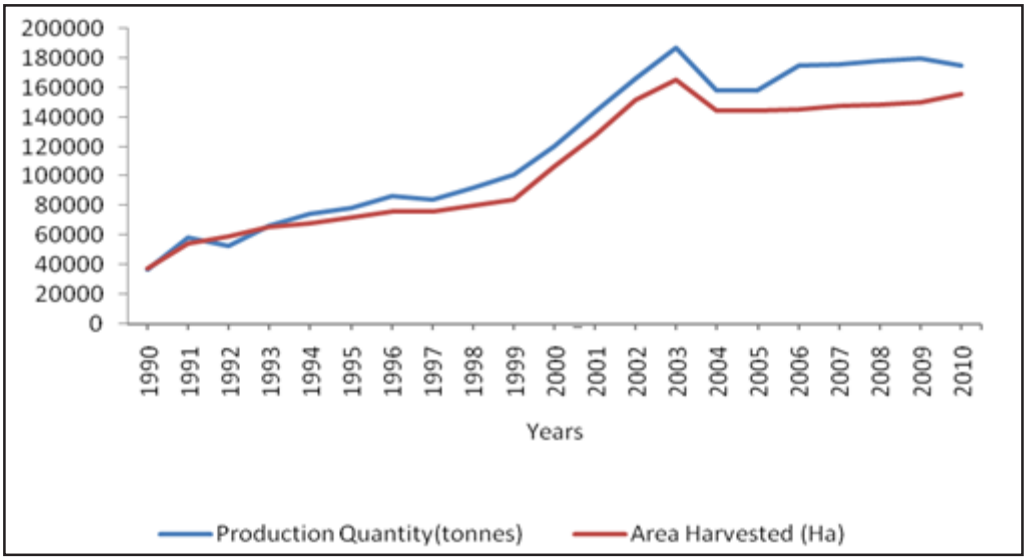

Figure 1. Trend of soybean productitivity in Uganda over a 10 year period; most production is by small-scale farmers.

for soybean and maize which accounted for 65% and 53.2% respectively of improved varieties under cultivation.

Indicators in processing soybean. The processing capacity for soybean increased from 300 tons in 2009 (Anon, 2010) to over 600 tons in 2011 (SNV, 2011). This dramatic increase was due to the installation of Mt. Meru oil mills in 2010 with capacity of 300 tonnes of soybeans per day; Seba Foods with capacity of 7 tonnes per day and Mukwano with 200 tonnes per day. These are relatively heavy investments and were installed on the assurance offered by the high yielding soybean varieties. The existing capacity of other small scale processing plants in Kampala, including East African Basic Foods Ltd, Maganjo Grain Milers, Sesaco Ltd, Ugachick, Kayebe Sauce Packers, Formula Feeds and others accounts for over 300 tons per day (Kawuki, 2004). These investments triggered enormous interest among farmers to grow soybean as a major cash crop because of the readily available market. The demands from these processing companies provide room for competitive prices. For instance the price of soybean has increased from 600 in 2008 to 1000 Uganda shillings per kg in 2011 (SNV, 2011). Ninety percent (90%) of farmers in Northern Uganda believe that the demand for soya bean is increasing compared to only 50% in Rwenzori region. In a report by SNV (2011), the returns from soybean were estimated at Uganda shillings 1,920,000 per ha, while Ssengedo *et al*. (2010) observed that soybean contributed

1,163,000 US dollars in 2009 up from US dollars 300,000 in 2006 in terms of export earnings. This is an increase of 288%. Ssengedo *et al*. (2010) further observed that a wide range of soybean varieties, government investment in soybean research and increasing investments in soybean value chain are major strengths for the soybean subsector in Uganda.

Capacity Building

Soybean rust research conducted since 2000 to date has involved training of six Masters and one PhD student. These gradutes have been equipped with skills in soybean breeding or seed system. Currently, most of these students are involved in research and development activities in different parts of Uganda and/or regional initiatives.

Acknowledgement

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