



Photo: Neil Palmer (CIAT)

Impact of Bean Research in Rwanda and Uganda

Standing Panel on Impact Assessment (SPIA)
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Key messages

- Beans are vital sources of protein, iron and other micronutrients in Rwanda and Uganda.
- The average yield gain over local varieties from adopting improved bean varieties is 53% in Rwanda and 60% in Uganda.
- Rwandan households planting improved bean varieties gain, on average, an extra 42 kg of the crop over local varieties per agricultural season, increasing household revenue by US\$50.
- Farmers in Uganda benefit from an average yield gain of 40 kg per household per agricultural season by adopting improved varieties of bean, corresponding to additional income of US\$47.
- In Rwanda, 16% more households would have been food insecure without the improved bean varieties; in Uganda 2% more households would have been food insecure.
- Poverty would have been about 0.4% and 0.1% higher in Rwanda and Uganda respectively, in the absence of varietal improvements to this vital subsistence crop.

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Background

In the late 1990s, a global initiative on the impact assessment of crop varietal change estimated that improved varieties accounted for about 22% of the growing area of primary food crops across Sub-Saharan Africa (Evenson and Gollin, 2003). This baseline has recently been updated, widened and deepened in a CGIAR project 'Diffusion and Impact of Improved Crop Varieties in Sub-Saharan Africa' (DIIVA), supported by the Bill and Melinda Gates Foundation. Seven CGIAR Centers and more than 200 individuals – mainly crop improvement scientists in national programs – participated in the DIIVA Project, which was directed and coordinated by the Standing Panel on Impact Assessment (SPIA) of the CGIAR and administered through Bioversity International. For detailed results from the DIIVA project, see SPIA Impact Brief 42, 'Adoption of

This brief is based on the study: Larochelle, C., Alwang, J., Norton, G.W., Katungi, E. & Labarta, R.A. forthcoming. *Ex-post impact of adopting improved bean varieties on poverty and food security in Rwanda and Uganda*. ISPC Secretariat, Rome.

modern varieties of food crops in Sub-Saharan Africa' (<http://impact.cgiar.org>).

As part of this effort, SPIA commissioned several studies to investigate the impacts on household well-being from the diffusion of improved varieties. These impact studies used modern treatment effect (TE) methods to isolate the causal impact of adoption on household- and market-level outcomes. TE approaches enable the consistent measurement of impacts by simulating a counterfactual – what would have occurred in the absence of the improved varieties – based on non-experimental (or 'observational') data from surveys of adopters and non-adopters.

Key results from a DIIVA-related study titled, 'Ex-post impact of adopting improved bean varieties on poverty and food security in Rwanda and Uganda' are presented in this Impact Brief. The study uses primary data collected from smallholders in the two countries to determine the impacts on field-level yields, costs of production, and household farm incomes of adopting new bean varieties. Effects are also examined so that the number of people escaping poverty due to the diffusion of improved varieties can be calculated. The study also examines the effects of adopting improved bean varieties on food security among rural households. The full report can be accessed at: <http://impact.cgiar.org>

The value of beans

Common bean (*Phaseolus vulgaris*) is an important subsistence crop for smallholders in Rwanda and Uganda – it is a major source of protein and provides other nutrients such as iron and zinc. In Rwanda, around 29 kilograms (kg) of beans are consumed per person per year – the highest consumption in the world. The country is a relative newcomer to the bean export market and traded up to 6,500 tons of dry beans per year during 2005–2010. Ugandans consume

around 11 kg of beans per person per year, and during 2000–2010 exported as much as 30,000 tons of dry beans in a single year.

As a result of this importance, the agricultural research systems in both countries have devoted substantial resources to bean variety improvement. Up until the 1990s, public sector bean research had focused on improving bean yields, but as yields improved, the selection criteria changed to attributes such as disease-resistance, adaptability to low soil fertility, and high iron content.

In the study, a variety is considered to be 'improved' if it has been enhanced genetically through breeding programs or improved through a selection process. These improved varieties are released by the National Agricultural Research System (NARS) within each country. Since 1998, Rwanda has released 20 improved bean varieties and Uganda 11.

Data collection

The primary data for the study were obtained using nationally representative household surveys of bean-producing households. A total of 1,298 and 1,722 bean-producing households were surveyed in Rwanda and Uganda, respectively. In both countries, these surveys were carried out in two phases. The first round was conducted after planting during the 2011–2012 cropping seasons; the second after harvesting and marketing activities had taken place in the same seasons. Households were selected at random and were encouraged to keep careful records of activity during the growing season – in particular, on inputs including fertilizer and labor, and quantity harvested. The surveys also covered farmers' knowledge on improved varieties, participation in social groups, market access and participation, consumption expenditures, asset ownership and food security.

In the consumption survey, respondents – usually the person preparing and cooking the food – were asked to recall household food consumption over the past 7-day period. Here, ‘consumption’ referred to food that was purchased, produced at home, or received as a gift or in-kind payment by any household member. The questionnaire also inquired about the value of food consumed away from home, non-food expenditures over the last 30 days, and housing and land expenditure.

Interviews were also conducted with village focus groups. These community questionnaires collected information on village characteristics and included questions around crop prices and access to market, availability of seeds and seed distribution programs / improved cultivars, access to extension specialists and input distributors, and agroclimatic shocks.

Challenges

Despite being a critical measure of the impacts of crop genetic improvement (CGI), identifying the varieties in farmers’ fields is not an easy task. In Rwanda, for example, farmers reported over 400 different names to describe the varieties of bean they planted. Working together, the International Center for Tropical Agriculture (CIAT), Virginia Tech and the Rwanda Agriculture Bureau (RAB) team grouped these 400+ bean names into 165 unique varieties classified as ‘improved’, ‘selected’ (i.e. purified local varieties), ‘local’, ‘uncertain’ or ‘unknown’. Experts could identify with confidence around 15% of the ‘uncertain’ or ‘unknown’ bean varieties named by farmers in the Rwandan survey.

In Uganda, more than 500 bean names were given by farmers to describe the varieties planted. With inputs from the Uganda National Agricultural Research Organization and CIAT, the names representing the same

variety were grouped together using the same scheme as in Rwanda, resulting in 278 varieties. In the Ugandan survey, the ‘uncertain’ category accounts for about 14% of observations, while ‘unknown’ varieties represent 16% of observations. This means that for the country as a whole, around 30% of bean varieties could not be identified with confidence.

Survey statistics

Adoption was measured at the household and plot levels. Full adopters are farmers who plant only improved varieties on their plot(s), while partial adopters devote a certain fraction of their bean land to improved varieties. In Rwanda, 33.5% of farmers have adopted new improved bean varieties; 17.6% are considered full adopters and 15.9% partial adopters. About 28% of bean plots were sown fully or partially with improved varieties. Adoption rates are lower in Uganda. About 27% of households cultivate improved bean varieties, 22.6% of which are partial adopters and 3.9% full adopters. Roughly 20% of bean plots in Uganda are sown partially or fully with improved seeds.

In both countries, the amount of land under bean cultivation is significantly smaller among full adopters. Partial adopters tend to cultivate more land and bean plots and, therefore, benefit from a greater bean harvest than full adopters and non-adopters.

Household size is also significantly smaller among full adopters, whose heads of household are more likely than partial adopters and non-adopters to have some level of secondary education. However, the age and gender of the household head does not differ significantly between the different types of adopter. Other relevant characteristics of the study sites are detailed in Table 1.

Table 1. Study site characteristics for adoption of improved bean varieties in Rwanda and Uganda

	Rwanda	Uganda
Average household size (people)	5.1	6.4
Head of household average age (years)	45	46
Head of household male/female ratio	74/26	80/20
Head of household education level		
primary (%)	68	58
secondary (%)	4	26
uneducated (%)	28	16
Average bean plot size (ha)	0.14	0.15
Total area of land devoted to bean production		
partial adopters (ha)	0.26	0.26
non-adopters (ha)	0.19	0.24
full adopters (ha)	0.16	0.18
Bean-producing households that plant some improved bean varieties – Total (%)	33.5	26.5
full adopters (%)	16	3.9
partial adopters (%)	17.5	22.6
Bean plots sown with local seeds only (%)	72	80.5
Bean plots sown with improved seeds only (%)	22	9.6
Bean plots sown with a mixture of improved and local seeds (%)	6	9.9
Bean plots that are intercropped* (%)	47	65
Average time to walk from home to bean plot (minutes)	17	22
Average quantity of beans harvested per household member (kg)	22	25

Impacts on yields, profitability and poverty

The study identifies significant impacts on field-level yields for households adopting improved varieties of bean. Average yield gains, compared to what would have been experienced in the absence of the improved varieties, are similar in the two countries: 53% over non-improved yields in Rwanda and 60% in Uganda.

The change in farm profit among adopters is examined by calculating the differences

for improved versus traditional varieties between additional revenues and production costs, including seeds and increased labor requirements. Annual profits (accounting for two growing seasons in each country) are US\$74 and US\$63 in Rwanda and Uganda, respectively, compared to what they would have been in the absence of the improved varieties. The change in farm profit affects household income – including those of poor adopters of improved bean varieties – and when incomes with the technology are compared to those without it, we find

that poverty would have been about 0.4% and 0.1% higher in Rwanda and Uganda respectively in 2011, in the absence of bean CGI. These impacts are relatively modest due to the small areas planted to bean and the relatively small contribution of bean income in total household income.

Impacts on dietary diversity and food security

The impacts on food security were found to be greater than on household income, as increases in income are normally associated with greater diet diversity and thus improved nutrition. Improved varieties can have positive impact on income other than through enhanced yield, as for example shorter production cycles can



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free up labor, allowing household members to engage in additional income-generating activities. Higher productivity can also allow households – especially in land-constrained settings – to reallocate resources to other crops, which can increase food consumption diversity.

The study applied a Household Dietary Diversity Score (HDDS), a measure of food security based on the number of food groups consumed, to consumption expenditure information gathered from 648 households in Rwanda and 777 in Uganda – about half of the sample in each country.

Based on the HDDS score, in Rwanda, 12% of bean-producing households are considered food secure, 75% moderately secure and 13% food insecure. Households in Uganda have a greater dietary diversity than those in Rwanda, and consequently the average food security in Uganda is higher; i.e. 39.1% of bean-producing households are considered food secure while 55% are moderate food secure and 6% food insecure.

An econometric analysis to assess what the food security situation should be in each country in the absence of improved bean varieties was conducted. Results indicate that without improved bean varieties, food insecurity in Rwanda would increase from the current 13% to 29%. In Uganda, the absence of improved bean varieties, food security would drop from 39.1% to 31.7%.

Conclusions

Bean represents an important component of the agriculture and diet in many areas of Rwanda and Uganda. Recognizing this importance, governments have increasingly

invested in bean research while policy-makers are more and more interested in the impacts of these investments. Food security outcomes are becoming increasingly important because NARS and CGIAR Centers are now developing bean varieties that are drought-tolerant and grow over shorter seasons, mitigating the effects of climate change, as well as varieties that are more nutritious.

Importantly, evidence from Uganda shows that poorer bean-producing households are less likely to adopt the new bean varieties compared to the non-poor. This finding suggests that greater poverty reductions could occur in Uganda if poorer producers can gain access to bean technologies.

In Rwanda, it is reported that agricultural extension services are available in most regions of the country, favoring the spread of new varieties. This highlights the critical role that specialists and distributors can play, as well as important differences in the quality and quantity of agricultural extension services in both countries.

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