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SPIA Uganda Report 2025: Agricultural Diversity Under Stress

CGIAR Standing Panel on Impact Assessment

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Key Messages

Several agricultural innovations are reaching farmers on a large scale, albeit at very different rates, despite challenging institutional and market conditions. DNA fingerprinting results for six crops show varietal adoption and genetic diversity in Uganda in unprecedented detail.

Widely diffused varieties include drought-tolerant maize, disease-resistant groundnut, and to a lesser extent, disease-resistant cassava. Adoption levels are more limited for biofortified varieties of sweet potato and beans, and new disease-resistant banana cultivars.

We find that household plots across Uganda are typically made up of mixtures of different genetic varieties, either through the farmers' deliberate choices to mix or recycle seed, or inadvertently through reliance on highly informal seed sources. Possibly relatedly, farmers don't necessarily perceive the intended benefits of the breeding efforts, such as disease resistance, and often don't recognize varieties with CGIAR germplasm as being improved. Banana represents a different case as most banana plots are matooke landraces that are all highly genetically similar, even if farmers perceive them as being different.

Introduction

Agriculture is central to Uganda's economy. In support of agricultural development in Uganda, the sustained research collaboration between the National Agricultural Research Organization (NARO) and CGIAR – a global research partnership for a food-secure future - has resulted in numerous innovations related to crops, livestock and the management of natural resources. This report examines the reach and policy influence of the past two decades of this collaborative research in Uganda.

The work to develop this report itself draws on an extensive, sustained collaboration among partners: CGIAR Standing Panel on Impact Assessment (SPIA), World Bank Living Standards Measurement Study team (LSMS), the Uganda Bureau of Statistics (UBoS), NARO, MAIFF, and CGIAR researchers. Uganda is a high priority country for CGIAR with multiple CGIAR centers represented[1]. The partnership for nationally-representative data collection was formed under the auspices of the Uganda Household Integrated Surveys (UHIS), a large-scale panel survey implemented by UBoS with support from the World Bank LSMS team.

In the context of the first round of the UHIS in 2021/22, SPIA integrated plant tissue collection for six major crops (maize, cassava, banana, beans, sweet potato, and groundnuts) into the UHIS. This unprecedented effort is the backbone of this report as it allows us to carry out DNA fingerprinting of crop samples collected from farmers' fields to understand whether farmers are, or are not, obtaining access to improved varieties that originate from the NARO-CGIAR research partnership.

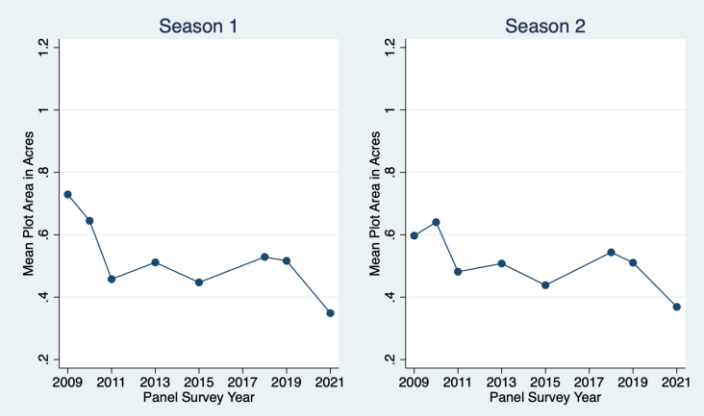
[1] Such as the Alliance of Bioversity International and CIAT, Center for International Forestry Research and World Agroforestry (CIFOR-ICRAF), International Potato Center (CIP), International Livestock Research Institute (ILRI), International Institute of Tropical Agriculture (IITA), the International Food Policy Research Institute (IFPRI), International Maize and Wheat Improvement Center (CIMMYT) and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Context

Uganda's agricultural sector contributed approximately 24% of GDP in 2022 and employs nearly 70% of the labor force. Rapid population growth has increased pressure on land. This has resulted in challenges such as declining soil fertility, increased vulnerability to pests and diseases, and slow progress in tackling food insecurity and poverty. Additionally, low productivity and a weak seed system—with heavy reliance on informal seed banks and limited private-sector involvement—characterize the agricultural sector in Uganda.

Agricultural biodiversity plays an important role in Uganda's food systems, in both harvested species (crops and livestock) and the non-harvested species that support or hamper agroecosystems. Farmers in Uganda plant many different crops, some combinations frequently planted together as inter-crops in the same plot. Over time, land availability has decreased, raising prices and reducing plot sizes, particularly for staple crops like maize, cassava, and banana. See fig 1.

Fig 1. Average plot size over time (UNPS data 2009-2019; UHIS data 2021)



Within this context CGIAR researchers have supported the development of improved crop varieties, in line with the National Agricultural Research Act of 2005.

Methods

The **first step** was identifying CGIAR-related innovations in Uganda. After stakeholder consultations in 2018/19, 49 innovations were identified linked to CGIAR research. Of these, 21 were thought to have been disseminated on a large enough scale that we could look for them in one or more nationally-representative surveys.

The **second step** involved identifying ways to collect data with UBoS regarding these innovations. The UHIS is at the heart of this report, and includes a total sample of 9,288 households across 774 enumeration areas (EA). The SPIA-LSMS-UBoS partnership selected a subsample to implement objective measurement approaches like crop-cutting for maize yield estimation and plant tissue sampling for varietal identification using DNA fingerprinting for six crops. To complement the objective methods, an expanded innovation module related to sustainable land management, seed use, varietal mixing, and agricultural practices was collected on the same sample.

Additionally, SPIA worked with UBOS and MAIFF to integrate agricultural questions into Uganda's National Service Delivery Survey (NSDS), covering extension services, technology adoption, market access, climate change, and disease management.

In collaboration with NARO (for maize, cassava, sweet potato and groundnut), CIAT (for beans), and IITA (for banana), **the third step** involved compiling a comprehensive reference library for the six crops. Researchers documented all released varieties, identified popular landraces, and collected plant tissue samples for genotyping at Diversity Arrays Ltd in Australia. DNA extraction and genotyping were conducted to establish reference profiles for identifying the material collected from farmers' plots.

Finally, we draw on the results of two related projects that spun off from the main data collection effort and that complement our understanding. The first, with CIP and Paris School of Economics, revisits households that were part of an earlier 2011 survey in areas where biofortified beans and orange-fleshed sweet potatoes had been disseminated, aiming to assess the impact of orange flesh sweet potato on child growth outcomes. The second, with CIAT, UC Davis, and the MAAIF Department of Crop Inspection and Certification (DCIC), examines Uganda's maize and bean seed systems, aiming to quantify declines in genetic purity and germination through testing at different points in the supply chain.

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Results

While the samples selected for DNA fingerprinting were designed to be nationally-representative, several logistical challenges during data collection resulted in plant samples only being taken from non-randomly selected subsamples. We therefore caution against over-interpretation of any of the quantitative results. However, based on robustness analysis, we believe the orders of magnitude of different types of varieties found in the sample to be informative on the approximate diffusion (or lack thereof) of different types of varieties and offer the following key insights.

Maize: Improved varieties bred by NaCRRI with support from CIMMYT and IITA, particularly the OPV LONGE 5D, are reaching large shares of the households in Uganda offering the potential for farmers to benefit from important traits such as drought tolerance. We estimate that 57.8% of maize-growing households have at least one plot sample that has a CGIAR-related variety. However, DNA tests show that farmers' fields are very mixed, with farmers both recycling their seed (including hybrids) from season to season and drawing heavily on informal sources of seed. The intended traits introduced by plant breeding therefore do not necessarily materialize on farmer's fields.

Cassava: Diseases are a major problem constraining cassava production in Uganda. Disease-resistant varieties from NaCRRI with support from IITA, are reaching around one third of cassava-growing households in our sample, particularly the relatively recent (2015) releases NAROCASS 1 and NASE 19.

Banana: Most banana-cultivating households (71.1%) grow only matooke landraces that are very genetically similar to each other, making the banana sector in Uganda highly vulnerable to disease outbreaks. Improved, disease-resistant matooke bananas released by NARO in the collaboration with IITA have not yet been taken up by farmers.

Bean: Farmers plant very mixed plots of beans, in line with the informality of the seed system for beans, with most farmers buying grain from the market to use as seed. While breeding efforts have focussed on varieties high in iron and zinc, adoption of these biofortified beans is limited. We find only 6% of bean-producing households having DNA related to one of the biofortified bean varieties (NAROBEAN 1-7) in their plots.

Sweet potato: Of the sweet potato-growing households, around one in ten cultivate a NARO-released variety. Only 3% of sweetpotato-growing households cultivate orange-fleshed sweet potato, despite its demonstrated nutritional and health benefits and evidence of earlier widespread dissemination in a number of CGIAR-supported projects under the HarvestPlus initiative.

Estimations building on combining the sub-country level roll-out data from those national dissemination effort with a targeted panel survey in 106 communities across all regions of the country, show that children's exposure to orange flesh sweet potato during the earliest years of life leads to long-term gains in linear growth (height-for-age), with evidence also showing lower morbidity at the age of 5. Results hence show that the health benefits of OFSP can be obtained at scale, and are suggestive of potential large gains if higher adoption levels could be maintained.

Groundnut: Improved varieties of groundnut were found on farmers' fields, particularly in Eastern Uganda. Overall, more than one third (37.1%) of groundnut-producing households in our sample are cultivating a variety that was released by NaSARRI after 1995 with support from ICRISAT, possibly giving access to disease-resistant traits for farmers adopting them.

Dairy: Artificial insemination for cattle is starting to be made available, particularly in Central Uganda where one third of communities report have the service available (national average of 14.2% of communities).

Natural resource management (NRM) practices: Fruit trees are being planted by households across large parts of Uganda. Overall, 13.5% of rural households across Uganda have planted tropical fruit trees. Banana and coffee inter-cropping, a traditional practice that has been researched by CGIAR agronomists over the past 20 years, is very widely practiced (43.3% of the households that grow either coffee or banana).

Socioeconomic dimensions: The DNA data show that CGIAR-related crop varieties are reaching households with a broad range of socio-economic characteristics, with cassava and groundnut varieties reaching poor households in particular. In contrast, the NRM practices and livestock innovations we were able to measure are

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more likely to reach richer households with higher education levels, while they are less likely to reach younger and female farmers.

Regional variation: Adoption of CGIAR-related maize varieties are relatively high in most regions, with the highest rates observed in Northern, where virtually all the surveyed communities have some farmers with CGIAR-related maize. For the other crops, CGIAR-related varieties were found in at most half of sampled communities, and often much less. There are notably regional differences: while CGIAR related varieties of beans and sweet potato are the strongest in Central region, we found more CGIAR-related germplams for cassava and groundnut in Eastern Uganda, consistent with the focus of some of the regional research stations. Finally, in Western Uganda adoption of CGIAR-related varieties is low for all crops other than maize. Livestock and NRM innovations are more frequently observed in Central, and largely absent in Northern.

Extension: Half of veterinary officer posts, and over a third of agricultural officer posts were vacant at district level in 2021. Agricultural extension officers that were in post report providing information on improved varieties but this varies by crop, with maize being the most common (97% of respondents) and sweet potato the least common (57%).

Seed systems: 29% of bean samples obtained from grain markets retained a distinct varietal identity, compared to 79% from Quality-Declared Seed (QDS) outlets and 50% in agro-input stores. This is likely a major limiting factor for adoption of varieties given that most seed purchases for bean are from the grain market. In maize, when compared to samples taken from in-house seed company fields, seed genetic purity is lower at all subsequent stages (out-grower fields, aggregation, distribution). Mystery shoppers visiting agro-input dealers recieve lower quality seed than those obtained through formal DCIC audits.

Full report and supporting materials available at:

Uganda Strategic Study | IAES | CGIAR Independent Advisory and Evaluation Services

Table 1. *Estimated share of households and communities adopting CGIAR-related innovations in Uganda in 2021/22.*

	% Households	% Communities*
% CGIAR-related crop varieties among sampled HHs		
Maize	57.8	82.7
Cassava	35.1	53.9
Banana	0.4	1.2
Beans	21.6	48.9
Sweet Potato	6.9	17.7
Groundnut	37.1	28.8
% with innovation among rural HHs with large ruminants		
Practices controlled breeding strategy	9.9	22.8
Cross-bred cows	16.3	31.6
% with NRM innovation among all rural HHs		
Banana-coffee intercropping**	43.3	59.7
Plants scattered tropical fruit trees	13.5	56.4
Cultivates improved fruit tree variety***	11.1	22.9

** Community where at least one household (HH) adopts*
***Among households with banana or coffee*
**** Among households with tropical fruit trees*
Source: *SPIA Uganda Report 2025: Agricultural Diversity Under Stress.*

Discussion

This comprehensive report highlights both the opportunities and challenges of the diffusion of agricultural innovations in Uganda. The findings show an innovation system that manages to reach a relatively large share of farmers, but with large variation between innovations and relatively large socio-economic and regional inequalities. While some of the results clearly point to the potential of innovations to contribute to improving resilience and address hidden hunger, they also clearly show that farmers may not be deriving all the intended benefits from the different innovations. This points to both challenges and opportunities around seed systems, extension and other complementary investments that, when addressed, could contribute to augmenting and scaling the intended benefits from the AR4D investments. As environmental pressures continue to growth, such investments together with renewed efforts in breeding could potentially have large returns.

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