



## MRR INNOVATION LAB PROJECT IN BRIEF

# ASSESSING SEED SYSTEM RESILIENCE WITH STRUCTURED GENOTYPING IN UGANDA

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### Project Partners

CGIAR Standing Panel on Impact Assessment (SPIA), Diversity Arrays, International Center for Tropical Agriculture (CIAT), International Food Policy Research Institute (IFPRI), Uganda Department of Crop Inspection and Certification (DCIC), Uganda Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Uganda National Agricultural Research Organization (NARO)

**Development Innovation**  
Seed system resilience

**Commodity**  
Maize and legumes

**Targeted Population**  
Small-scale farmers

**Country/Location**  
Uganda

**Timeline**  
2020-2022

**Funding**  
\$250,005 (USAID)

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Recent studies suggest that Uganda's seed systems supply farmers with low-quality seeds, undermining their productivity and resilience. An MRR Innovation Lab research team is conducting the first comprehensive, nationally-representative and rigorous study of the genetic integrity of the maize and bean seed systems in Uganda. The team is leveraging recent advances in DNA fingerprinting to test maize and bean seeds from across supply chains to identify leaks responsible for low-quality seeds reaching farms. The results will provide directed policy to enhance seed system resilience in Uganda.

### The Challenge

Seeds are at the foundation of food security for small-scale farmers in developing countries. In Uganda there is evidence that seed system failures are letting through low-quality seeds, compromising farmers' productivity and resilience.

This is particularly critical for maize and beans, cornerstone crops in Uganda. The maize seed system is shaped by a unique mix of public- and private-sector involvement with a relatively high degree of concentration. There is widespread concern about outright counterfeiting, as quality standards are not enforced. The bean seed system is more informal, and the informal bean seed system has no written rules and regulations.

There could be many reasons why low-quality seeds reach farmers. Studies examining seed counterfeiting in Uganda have sampled material from seed companies to check on adulteration at lower levels in the seed supply chain but have not assessed the highest levels in the seed system. Without evidence on exactly where the problems lie, policy responses are unlikely to succeed.

### Research Design

An MRR Innovation Lab research team is conducting a comprehensive study of Uganda's maize and bean seed value chains to identify sources of failures

### RESEARCH INNOVATION

DNA fingerprinting plant material from farmers' fields in Africa is a growing area of research. To conduct DNA fingerprinting, researchers sample plant tissue from the farm and extract its DNA in a laboratory. They then compare the allelic profile of the sample DNA to reference genetic material obtained from breeders. Following a series of pilots carried out by CGIAR centers between 2013 and 2018, there is now consensus on good practice for DNA fingerprinting different categories of crops.<sup>1</sup>

Empirical studies have used DNA fingerprinting to identify the true varieties farmers are planting across different crops and in different African countries. These studies have shown that the true varieties frequently do not correspond to farmers' beliefs about the varieties they are growing.<sup>2</sup> However, no empirical study yet has complemented farm-level sampling with seed-system sampling to identify causes of this mismatch.

<sup>1</sup> Poets, A., et al. forthcoming. "DNA Fingerprinting for Crop Varietal Identification: Fit-for-Purpose Protocols and their Cost and Analytical Implications." CGIAR Standing Panel on Impact Assessment.

<sup>2</sup> Wossen, T., et al. 2019. "Estimating the productivity effects of technology adoption in the presence of misclassification." *American Journal of Agricultural Economics*; Mareida, M.K., et al. 2016. "Testing Alternative Methods of Varietal Identification Using DNA Fingerprinting: Results of Pilot Studies in Ghana and Zambia." MSU Working Paper.



in seed quality. The study is built upon genotyping, which establishes plant material's true variety and origins with a sample of its DNA. The team is comparing the DNA fingerprints of seeds on individual farms and is following the genetics upstream by sampling seeds at key links in the supply chain all the way to breeders. This approach makes it possible to identify leaks responsible for low productivity, poor disease resistance and low nutritional values.

The study of the maize seed system includes seeds sampled at three broad levels: production, distribution and on-farm. For seed production, the team is sampling at different points after breeder's seed is available for multiplication. The focus is on identifying any mix-ups in identifying varieties and whether the steps to certified seed introduce impurities.

Seed distribution encompasses the supply chain from seed companies to wholesalers, retailers and agrodealers as well as government-run distribution programs. The team is collecting seeds from wholesalers and retailers through combinations of mystery shopping and declared audit visits from the DCIC.

On-farm sampling is being carried out by SPIA in partnership with the Ugandan Bureau of Statistics (UBOS) and the World Bank Living Standards Measurement Study Integrated Surveys of Agriculture (LSMS-ISA). UBOS is incorporating maize crop-cuts in its forthcoming wave of the Ugandan National Panel Survey (UNPS). Crop cut harvests provide an excellent sample to identify varieties and their genetic sources.

Reference DNA for maize is made up of breeder's seed obtained through a collaboration with the National Crops Resources Research Institute (NaCRRI) for varieties released by the National Agricultural Research Organization (NARO) and from private sector seed companies via a register held by the Uganda Department of Crop Inspection and Certification (DCIC).

The study of Uganda's bean supply chain is being conducted at a smaller scale with a focus on bio-fortified bean seed and its nutritional properties. Over the past decade, the ISSD, CIAT via PABRA and NARO have supported the community-based Local Seed Businesses (LSBs) that have contributed to the reach of five newly released "bio-fortified" varieties that contain higher levels of iron and/or zinc.

The team is sampling bean seeds at the same three levels as with maize. For seed production, the team is sampling each seed grade in NARO stock from seed companies and community-based production. For seed distribution, samples come from NGOs, seed companies, agrodealers, local government extension offices and government initiatives such as Operation Wealth Creation. On farm, SPIA is collecting samples from bean producers as part of the 2020 Ugandan National Panel Survey wave, in collaboration with UBOS.

In addition to genotyping, the team is identifying beans that are bio-fortified and testing soil samples from the plots where the beans are cultivated for their micronutrient content. These additional analyses will reveal interactions between bean varieties and local soils to determine the crop's micronutrient content at scale.

### Development Impact

Realizing Uganda's agricultural potential requires resilient seed systems that consistently deliver high-quality planting material. The insights and methods from this work could benefit producers and consumers across Sub-Saharan Africa.

This project could enable significant improvements in the most important seed systems. These improvements could translate directly into household welfare gains through increased agricultural productivity and improved nutrition both on-farm and through local food markets, and greater food security through more remunerative and reliable livelihoods.



### Development Opportunity: Uganda

- 42.7** : Population in millions (2018)
- 41.7%** : Poverty rate at \$1.90/day, 2011 PPP (2016)
- 32.6** : Rural population in millions (2018)
- 70.8%** : Total employment in agriculture (2018)
- 41.4%** : Prevalence of undernourishment (2016)
- 28.9%** : Prevalence of stunting for children under 5 years (2016)

Source: World Bank

Agriculture is the backbone of Uganda's economy, employing about 71 percent of the country's labor force predominantly in rural areas. The sector enjoys favorable soil conditions and climate with rainfall that allows continuous cultivation.

Despite impressive agricultural resource endowment, agricultural productivity lags behind that of other countries in the region and its contribution to GDP remains low. For example, the total factor productivity growth in agriculture has been negative over the last 18 years.<sup>1</sup>

Given that more than 3 million households in Uganda rely on agricultural production for their livelihoods, innovation in this sector can have direct and potent welfare effects. Increasing agricultural productivity through improved technology and production practices has been a persistent priority at both national and international levels.

<sup>1</sup> World Bank

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