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The contribution of ICRISAT genebank to groundnut improvement and rural poverty in Malawi

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HIGHLIGHTS

- The ICRISAT genebank serves as a world repository for the collection and conservation of germplasm of many legume crops, including groundnuts
- According to Mendelian principles, a 10% increase in genebank ancestry is associated with a 13.8% increase in the area under improved groundnuts
- Adoption of improved groundnut varieties increases income by US$766, equivalent to a 48% income gain at the mean
- Adoption also reduces poverty by 7.2% and 11.7% for households living below the US$1.25 and US$2.00 poverty lines respectively.
- The ICRISAT genebank contributes to income, asset and livestock accumulation while reducing poverty in Malawi.

The adoption of improved tropical legumes can be both pro-poor and environmentally friendly (Verkaart et al. 2017). Improved legume varieties contribute to poverty reduction by improving market access and income of farmers (Tabe-Ojong et al. 2020) and are key to maintaining environmental sustainability due to their ability to fix atmospheric nitrogen, reducing the use of inorganic fertilizers (Giller 2001). The drought-tolerant, disease-resistant and high-yielding improved groundnut (*Arachis hypogaea* L.) varieties produced and released by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) are particularly propitious. The ICRISAT genebank partners with other global and national breeding programs in conserving plants accessions and germplasm with varied traits and characteristics (Crop Trust 2016).

ICRISAT genebank and varietal improvement

We analyzed the impact of ICRISAT's genebank on varietal improvement and rural poverty in Malawi. We sought to answer the following research questions: (1) What has been the role of the ICRISAT genebank to varietal improvement? (2) Has the ICRISAT genebank contributed to

BOX 1 The ICRISAT Genebank

The ICRISAT Genebank serves as a world repository for the collection of germplasm of the six mandate crops: sorghum, pearl millet, chickpea, pigeonpea, groundnut, finger millet; and five small millets: foxtail millet, little millet, kodo millet, proso millet and barnyard millet. With 128,960 germplasm accessions assembled from 144 countries through donations and collection missions, it is one of the largest international genebanks.

ICRISAT has regional genebanks at Nairobi, Bulawayo and Niamey to facilitate easy access of regional and global diversity to partners in the region. Several landraces now conserved in the ICRISAT genebanks have disappeared from their natural habitats in Africa and Asia. The collection serves both as insurance against genetic erosion and a sources of tolerance to diseases and pests, environmental stresses, higher nutritional quality and traits related to yield for crop improvement.

Germplasm conserved at ICRISAT genebank has become an important source of diversity available to researchers in both public and private sectors throughout the world. Between 1975 and 2021 the ICRISAT genebank distributed over 809,450 samples of its mandate crops and small millets to users in 148 countries in addition to over 714,300 samples to scientists within the institute.

PHOTO: MICHAEL MAJOR

poverty reduction through the adoption of improved groundnut varieties?

With regards to the role of the genebank in varietal improvement, we trace the improved varieties to breeding materials from ICRISAT's genebank, thus establishing genetic ancestry. In other words, we elicit the percentage of the genetic composition of improved varieties derived from groundnut accessions housed by the ICRISAT genebank (Table 1). To establish the relative genetic contribution of the various progenitors from the ICRISAT genebank, we applied the relative contribution of provenance based on pedigree data. From this, the Mendelian rule of inheritance was used to apportion the genetic components of these varieties to individual ancestors which we then used as a key interest variable in the first stage of a two-staged econometric model.

Our research contributes to two strands of literature. Firstly, it contributes to the growing literature on the role of genebanks in varietal improvement and subsequent socio-economic outcomes. Secondly, it adds empirical evidence and learning on the impacts of improved legume varieties in rural Africa both from a short-term and long-term welfare perspective. Previous research on the impact of improved legumes exists but with little insight on the role of genebanks. Our research, therefore, adds to this lacuna in the literature.

Data and methods

Employing a unique panel dataset of 447 households in rural Malawi, we first employ the Tobit model to understand the extent of adoption of improved varieties and how it is affected by the genetic contribution of genebank ancestors. We can interpret this variable as an indicator of the access of groundnut breeding programs to diverse genetic materials maintained in the ICRISAT genebank. In the next step, we estimate the impact of the extent of adoption on several welfare indicators, capturing the levels of income, productive assets, non-productive assets, livestock ownership, and income poverty. To control for time-invariant heterogeneity and endogeneity, we explore the use of the correlated random effect model and an instrumental variable approach. Applying the chain rule in linking the above two-stage regression, we find significant positive impacts of the ICRISAT genebank on the income and asset levels of households. Similarly, income poverty was also reduced. The main mechanism through which this happened was through the extent of adoption of the improved groundnut varieties with breeding materials from the ICRISAT genebank.

As a measure of robustness, we employed different specifications (considering adoption as a dummy) and used the Linear probability model and lasso linear model. Our findings are consistent under different specifications, further bolstering our claim on the significant positive role of the ICRISAT genebank in varietal improvement and reducing poverty in rural Malawi.

Table 1. Pedigree of adopted groundnut varieties in Malawi

Variety	Pedigrees	Year	Provenance	Ancestry
CG 7	(USA 20 x TMV 10) F2-P3-B1-B1-B1-B1-B1B1-B1-B1	1990	100%	1
Nsinjiro	(RG 1 x Manipintar) F2-P23-P59-P59-B1-B1-B13-B1	2000	50%	1
JL24/Kakoma	(Unknown source, improved variety)	2000	0%	0
Baka	(Sourced from genebank, landrace)	2001	100%	1
Chitala	(ICGV 93437 X ICGV-SM 94586) F2-P10-P4-B1-B1-B1-B1	2005	100%	1
Manipintar	(Unknown source, landrace)	1955	0%	0

Notes: F here refers to filial generation, B refers to the bulk selection, and P represents the progenies.

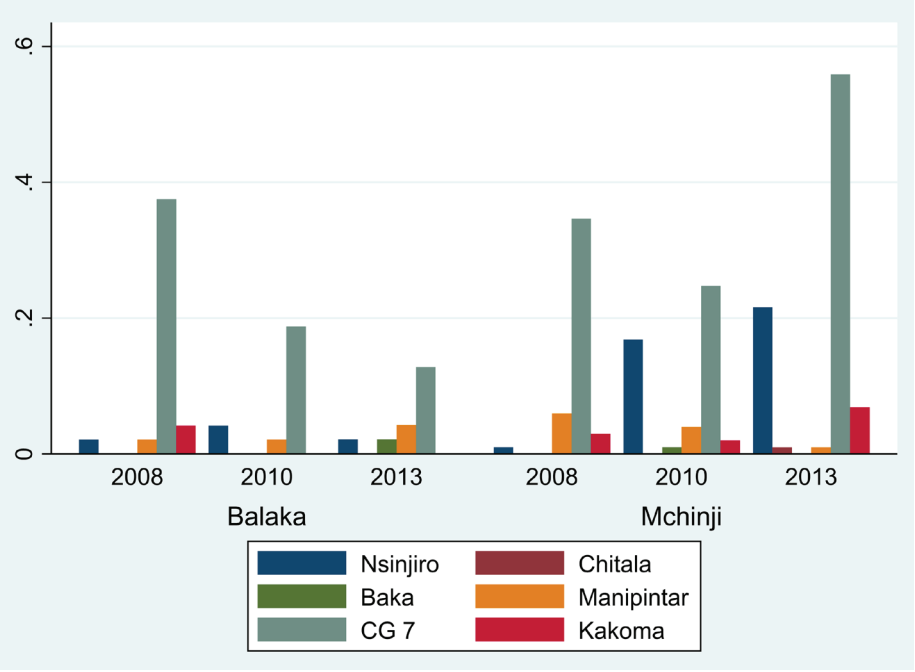

Figure 1. Adoption of improved groundnut varieties over time, by districts

Effect of genebank contribution on adoption

Figure 1 shows the distribution of the improved varieties used by farmers over the three panel years in the Balaka and Mchinji districts. In both districts, the most cultivated variety is CG 7, followed by Nsinjiro, Manipintar and Kakoma.

Roadside groundnut sales, Malawi. Photo: Swathi Sridharan (ICRISAT)

Our analysis shows that a percentage point increase in the access of materials from the genebank is associated with a 0.013% increase in the area under the adoption of improved groundnut varieties.

Apportioning genebank contribution based on any ancestral link to the genebank, we find that 10% increase in any genebank ancestry is associated with a 13.8% increase in the area under the adoption of improved groundnuts. This increase in magnitude is justified by the fact that unlike in the relative provenance case where we calculate genebank contribution in relative terms, we only apportion contribution based on whether or not any genebank ancestor is present. This is an important finding, strengthening the idea that scales of measurement do matter. That notwithstanding, the results all speak to the significant role of the genebank in driving the adoption of improved groundnut varieties.

Effect of adoption on income, assets, and poverty

The results suggest that adoption of improved groundnut varieties increases household income by US$766 which is equivalent to an income gain of approximately 48% at the mean. Adoption also has a statistically significant impact on the values of unproductive assets held by households. Over the years of the panel data, the adoption of improved groundnut varieties increases unproductive assets by US$118. Furthermore, significant effects are obtained for productive assets and the ownership of livestock. Adoption increases the value of productive assets by US$115, equivalent to an asset gain of above 100%.

Table 2. Estimates from the chain rule

Outcomes	Adoption impacts	Genebank ancestry
Income	766.509***	9.9646***
Unproductive assets	118.750***	1.5437***
Productive assets	115.827***	1.5057***
Livestock ownership	21.111***	0.2744***
Poverty	-0.072**	-0.0009**
Medium poverty	-0.117***	-0.0015***

Notes: *** p<0.01, ** p<0.05, * p<0.1

The sizeable, positive impacts of adoption on income and assets also contribute reductions in income poverty. The adoption of improved groundnut varieties reduces income poverty by 7.2% for households living below the US$1.25 poverty line. Similarly, adoption reduces the probability of households living below the median income poverty line (US$2.00) by 11.7%. We thus conclude that the adoption of improved groundnut varieties can raise rural households both under the median poverty line as well as the poorest households out of poverty.

Applying the chain rule to the estimates presented above, we derive the contribution of the genebank to our welfare outcomes (Table 2). On average, a 10% increase in the availability of materials from genebanks increases household income by US$99.6, unproductive assets by US$15.4 and productive assets by US$15. It also increases livestock ownership by 2.7 livestock units.

In terms of reducing income poverty, a 100% increase in the relative contribution of genebank provenance lifts households below the US$1.25 poverty line by 0.09% and those below the medium poverty line by 0.15%. Overall, our findings support recent studies that reported the importance of various genebanks in varietal development as well as its productivity and yield impacts.

Conclusion

Given that we observe large effects of adoption on the income and asset levels of households, especially with the ability of adoption to lift the poorest households out of poverty, we lend empirical support to the design, development, and dissemination of improved crop varieties as a significant way out of poverty. We

Groundnut harvesting at Chitedze Agriculture Research Station, Malawi. Photo: Swathi Sridharan (ICRISAT)

also provide learning to the targeting and upscaling of improved crop varieties as this may have the intended welfare increasing and poverty reduction effects. As genebanks are an important source of germplasm and advanced breeding lines, it may be largely inconclusive to ignore the genebanks in such efforts. Significant policy and institutional support should be provided to the genebanks to strengthen their role in conserving and ensuring the availability of crop germplasm, breeding materials, and related information.

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Additional details can be found in the paper on which this brief is based: Tabe-Ojong, Martin Paul Jr., Melinda Smale, Nelissa Jamora, Surendra S. Manohar, Patrick Okori and Vania Azevedo. 2021. The contribution of the ICRISAT genebank to groundnut improvement and rural poverty in Malawi. Genebank Impacts. Working Paper No. 13. CGIAR Genebank Platform, IRRI, and the Crop Trust.

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