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IITA's genebank, cowpea diversity on farms, and farmers' welfare in Nigeria

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Introduction

Cowpea is one of the preferred food crops in Nigeria, in terms of land area and production. This is partially related to cowpea conservation and improvement efforts at the International Institute of Tropical Agriculture (IITA), and adoption of improved cowpea varieties in Nigeria.

IITA initiated research on cowpea improvement in 1970 and now more than 50 countries, including Nigeria, have identified and released improved cowpea varieties from IITA for general cultivation.

Our study contributes to the literature, focusing on the genebank of IITA and cowpea production in Nigeria.

HIGHLIGHTS

- Area planted to cowpea in Nigeria increased from 0.117 million hectares in 1981 to 4.3 million hectares in 2019.
- 41% of Nigerian households are growing at least one improved cowpea variety as the main crop, the majority of which has a genebank ancestor in its pedigree.
- On average, an improved cowpea variety grown by Nigerian farmers has 39 appearances of IITA ancestors with nine unique ancestorst in its pedigree tree.
- Growing an improved cowpea variety that has a genebank ancestor is not significantly associated with richness—either positively or negatively, showing that these improved varieties do not displace other cowpea varieties or landraces.
- Growing an improved cowpea variety that has a genebank ancestor is related to significant increases in the yield of cowpea and household consumption of cowpea as food.

Although the primary role of IITA's genebank is the maintenance of crop diversity outside its natural environment, few studies have attempted to investigate its impact on farms, including the linkage to the genebank and to cowpea variety diversity on farms and other measures of farmers' welfare.

BOX 1 IITA's genebank

IITA's genebank holds over 28,000 accessions of major African food crops. This germplasm is held in trust on behalf of humanity under the sponsorship of the United Nations. It is distributed without restriction for use in research for food and agriculture.

Started in the mid-1970s the genebank helps in crop improvement and also provides "seeds of hope" for people affected by flood, fire, wars, and other disasters.

The main crops stored in the genebank are cowpea, cassava, plantain and banana, yam, soybean, bambara groundnut, and maize. In addition, substantial collections of wild cowpea relatives and miscellaneous legumes have been collated over the past 30 years. More recently a small collection of African yam bean, an underused legume, has been put together.

By far the most important crop in the genebank is the cowpea. The IITA genebank holds the world's largest and most diverse collection

of cowpeas with 15,122 unique samples from 88 countries, representing 70% of African cultivars and nearly half of the global diversity. This incredible collection makes IITA integral in the protection of the cowpea species.

Our objective is twofold. First, we establish the link between the IITA's genebank and the development of improved cowpea varieties. We relate this link to measures of on-farm cowpea varietal diversity in Nigeria. Second, we examine the impact of IITA's genebank, through the adoption of improved varieties, on cowpea yield and farmers' welfare in Nigeria.

Data and methods

The data for the study come from two sources. The first source is the household survey conducted by the IITA's Tropical Legumes III project in Northern Nigeria in 2016 and 2017. The second source comes from IITA's genebank data management system. Improved cowpea breeding lines and their pedigrees are collected, using reports on IITA's cowpea breeding programme, the database (or information management system) of the cowpea programme of IITA, and Helium, a multi-platform pedigree visualization tool with phenotype display (Figure 1).

Using these data, we compute spatial diversity indices, including the Menhinick, Shannon, Berger-Parker and Herfindahl indices (Table 1), to measure on-farm cowpea varietal diversity, analyze the pedigrees of improved cowpea varieties grown by farmers, and apply two econometric models to fulfil our research objectives.

First, we apply a recursive mixed-process model to measure the impact of IITA's genebank on the varietal diversity of cowpeas on farms. Second, we apply a multinomial endogenous treatment effect model to measure the impact of IITA's genebank on cowpea yield, cowpea consumption and cowpea sale.

Key findings

Table 3 presents the contribution of IITA's genebank to the ancestry of the improved cowpea varieties grown in Nigeria. We found that most of the improved cowpea varieties grown by Nigerian farmers were released recently (between 2005 and 2015) and had a genebank ancestor.

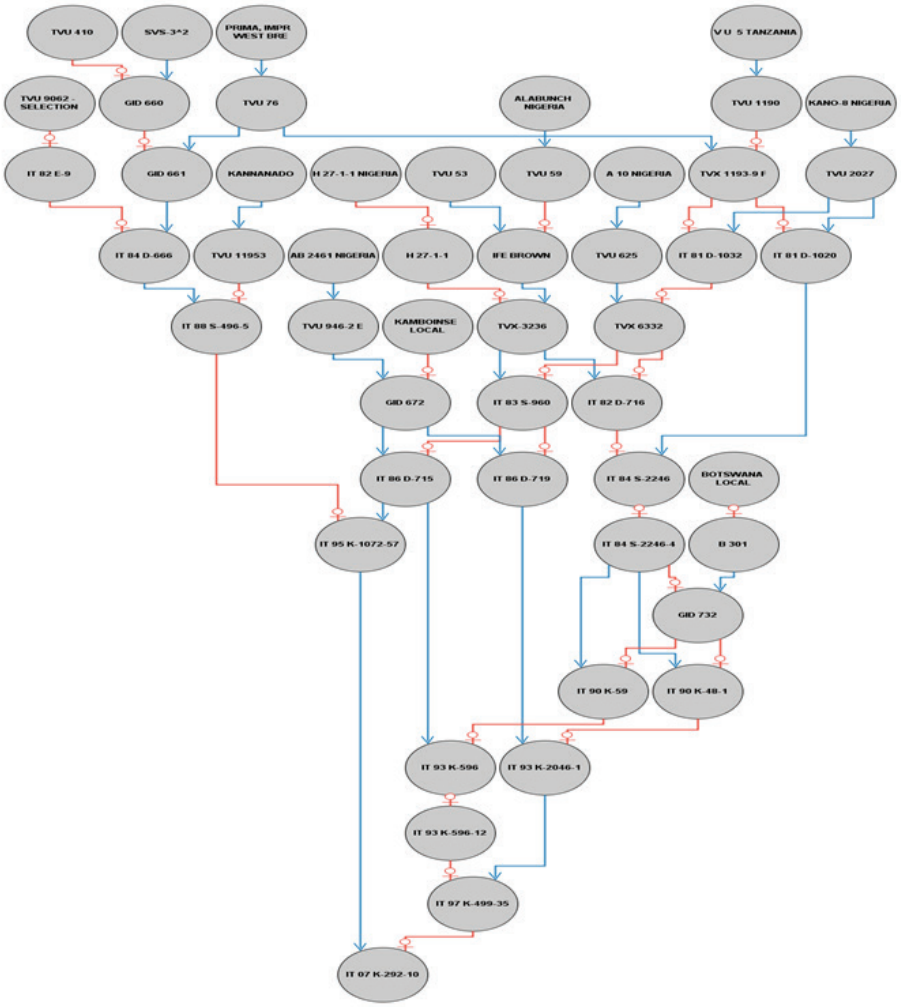

Figure 1. Diagram depicting the pedigree tree of an improved cowpea variety (IT07K-292-10/ Sampea 16)

Woman trader selling cowpea at Bodija market Ibadan, Nigeria. Photo: IITA

The first research objective consisted of measuring the spatial diversity of cowpea varieties on farms, and testing their association with genebank ancestry in the pedigrees of improved cowpea varieties. On average, most Nigerian households were growing one cowpea variety per plot. Only nine households (0.58%) were growing two different cowpea varieties per plot. In addition, 41.29% of households were growing at least one improved cowpea variety as the main crop, whereas 40.91% were growing at least one improved cowpea variety that has a genebank

Table 1. Descriptive statistics for indices of the spatial diversity of the cowpea varieties grown in Nigeria.

Index	Mean	SD	Minimum	Maximum
Total				
Menhinick index	2.032	1.120	0.404	15.811
Shannon index	0.341	0.041	0	0.693
Berger-Parker index	3.142	1.825	1	33.333
Herfindahl index	0.165	0.123	0.001	1
North West region				
Menhinick index	2.161	1.187	0.404	15.811
Shannon index	0.340	0.043	0	0.693
Berger-Parker index	3.190	1.919	1	33.333
Herfindahl index	0.165	0.128	0.001	1
North East region				
Menhinick index	1.780	0.925	0.442	12.910
Shannon index	0.344	0.034	0	0.367
Berger-Parker index	3.044	1.615	1	25
Herfindahl index	0.165	0.112	0.002	1

Table 2. Repartition of households over main cowpea varieties grown.

Cowpea varieties	North West		North East	
	Total are planted (in ha) as main cowpea variety	Number of households growing it as main cowpea variety	Total area planted (in ha) as main cowpea variety	Number of households growing it as main cowpea variety
Improved cowpea varieties				
IT99K-216-24-2/Kwankwaso	33.544	110	18.777	27
IT90K-277-2/Sasakawa	26.363	62	12.732	18
IT89KD-288/Sampea-11	32.724	92	39.210	45
IT97K-499-35/Sampea-10	10.041	25	3.062	5
IAR48/Sampea 7	2.538	4	3.326	3
IT89KD-391/Sampea 12	4.224	9	4.656	6
IT99K-573-1-1/Sampea-14	18.191	45	9.605	13
IT98K-573-2-1/Sampea 15	5.746	22	2.209	6
IT93K-452-1/Sampea 8	2.543	6	1.304	3
IT98K-131-2	2.068	6	0.118	1
IT98K-491-4	13.355	30	13.064	26
IT07K-318-33/Sampea 17	0.605	1	0.429	1
IT07K-292-10/Sampea 16	4.596	16	2.99	7
IT98K-205-8	5.8	18	1.532	3
UAM09-1055-6	21.104	64	18.960	32
UAM09-1046-6-1	2.923	5	0	0
Cowpea landraces				
Silver (Local)	8.282	16	15.08	25
Portiskum (Local)	27.431	36	25.252	33
Kananado Brown (Local)	3.130	13	16.951	22
Kananado White/Dan Bokolo	94.548	175	67.997	103
Gwalam	24.205	60	17.176	56
Bosadp	8.461	24	13.783	30
Other improved cowpea varieties	2.657	10	0	0
Other cowpea landraces	213.654	358	131.773	162

Table 3. Contribution of IITA's genebank to the ancestry of the adopted improved cowpea varieties in Nigeria.

Cowpea variety	Does the cowpea variety have a genebank ancestor? (0/1)	How many genebank ancestors are in the pedigree respective of number of appearances?	How many genebank ancestors are in the pedigree relative to unique counts?	Year of release
IT90K-277-2 (Sasakawa)	1	14	7	2005
IT89KD-288/Sampea-11	1	13	7	2009
IT99K-216-24-2 (Kwankwaso)	1	22	7	Not yet released
IT89KD-391/Sampea12	1	16	8	2009
IT97K-499-35/Sampea-10	1	55	8	2008
IT93K-452-1/Sampea8	1	29	13	2005
IT99K-573-1-1/Sampea-14	1	43	12	2011
IT99K-573-2-1/Sampea-15	1	43	12	2011
IT98K-131-2	1	33	7	Not yet released
UAM09-1046-6-1	1	56	8	Not yet released
UAM09-1055-6	1	56	8	2016
IT98K-205-8	1	55	9	Not yet released
IAR48 /Sampea 7	Not Available	Not Available	Not Available	Not available
IT98K-491-4	1	Not Available	Not Available	Not Available
IT07K-318-33/Sampea 17	1	50	13	2015
IT07K-292-10/Sampea 16	1	67	14	2015

ancestor as the main crop. Finally, 68.50% of households were growing at least one cowpea landrace as the main crop.

We find that growing an improved variety with genebank ancestry is not significantly associated with lower spatial diversity among cowpea varieties—while they may introduce new traits through ancestry, these varieties do not displace other cowpea varieties or landraces. We also find that genebank ancestry is positively and significantly associated with cowpea yield and farmers' welfare.

Conclusion

These findings suggest that, on farms, IITA's genebank contributes to cowpea yield and farmers' welfare, showing additional benefits from IITA's genebank in Nigeria. In addition, this study shows that growing cowpea varieties with genebank ancestry does not displace other varieties, including cowpea landraces. Policymakers and practitioners should consider these findings when analyzing the benefits from conserving crop genetic diversity in genebanks and on farms.

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Additional details can be found in the paper on which this brief is based: Kouakou, Abel-Gautier, Ademola Ogundapo, Melinda Smale, Nelissa Jamora, Julius Manda, Michael Abberton. 2021. IITA's genebank, cowpea diversity on farms, and farmers' welfare in Nigeria. Genebank Impacts Working Paper No. 16. CGIAR Genebank Platform, International Institute of Tropical Agriculture, and the Crop Trust

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