Adaptation and Adoption of Improved Seeds through Extension: Evidence from Farmer-Led Groundnut Multiplication in Uganda
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Overview

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Background: Agriculture and Development

- Rural households (HH) in developing countries rely heavily on subsistence-level farming for food and fiber.
- Risk of crop failure and limited access to markets can lead to nutritional inadequacies or famine, and has been cited as an important contributor to starvation worldwide.
- Technological progress is important for reducing such risk.
- Yet availability of new technologies does not always lead to adoption, and education and outreach are critical tools to promoting uptake.
- Also, because of the capital constraints faced by these HHs, it is necessary to promote economically feasible alternatives, where the expected returns are sufficiently high and require little or no additional capital expenditures, i.e.,

\[ U_{Adopt} - U_0 > 0 \]  (1)
Improved Seed & Groundnut Production in Uganda

- Improved seed varieties are a particularly cost-effective approach to improving yields and returns to farmers.

- Hence, our research examines the adoption of high-yielding drought and disease resistant groundnut varieties (RRVs) in rural Uganda.

- Uganda is a major regional producer of groundnuts, with an estimated 421,000 hectares harvested in 2012.

- Groundnuts are an important source of food in the region and are commonly used to make sauces (Shiferaw et al. 2010).

- A 2011 study by Kassie et al. suggest that groundnut producers in Uganda benefit significantly from improved varieties with a 35% average yield increase and a 41% average cost reduction.
The purpose of the LIFE survey was to collect information on the major issues faced by farmers in the study area.

The results indicated that groundnuts were not being grown by poor farmers because of the high risk associated with production, even though groundnuts are highly profitable compared to other regional crops.

The problem stems from the high seeding rate associated with groundnuts and the risk of crop failure from disease.

In response, AT Uganda implemented a project to increase the adoption of high-yielding disease resistant varieties through widespread seed multiplication and dissemination in the study region.
Map of Program Area
Farmer-Led Seed Multiplication and Dissemination

During the project from 2001-2004, AT Uganda facilitated access to new varieties through the delivery of the following outputs:

- Extension staff, local authorities and farmers trained in groundnut production, multiplication, and storage
- Foundation seed for new rosette resistant varieties obtained and multiplied by farmer-group members
- Multipliers return double the amount of planting materials received, for redistribution and further multiplication
- The process of collection, redistribution, and monitoring of multiplied seed is effectively handed over to local leadership for management

Two surveys were conducted to assess the effectiveness of the project in achieving its goals, one in 2004 immediately after the project and another in 2014 10-years later to examine lasting impacts.
The Sample: Beneficiaries and Controls

- The following describes sample selection:
- Randomization was employed at each level within district: sub-county, parish, and farmer groups
- The sample of **beneficiaries** consisted of 8 sub-counties, 8 parishes, 24 groups (10 members per group), for a total of 240
- The control is composed of two groups: **neighbors** and **parish** (i.e., non-neighbors)
- 15 neighbors were sampled in each project parish, 5 for each farm group, for a total of 120 neighbors surveyed
- For the parish group, 120 HH’s were sampled from 8 randomly selected non-project parishes from the same districts
- The full control group is composed of 240 HH’s
- In sum, the study sample, beneficiaries + controls, includes 480 HH’s
The initial survey was done in 2004 at the end of the project (EOP)

The survey was conducted by the AT Uganda organization, and consisted of a questionnaire that recorded HH demographic and agricultural production data:

- Household: demographic and socioeconomic characteristics (age, sex, and education of all members, expenditures, etc.)
- Agricultural Production: acres planted, crop varieties grown, farmer association membership, farming experience (in years), etc.

A follow-up survey of the same HHs was conducted in 2014 and included some additional questions on production and aflatoxin awareness.
Initial Considerations and Ordinary Least Squares

- Project not designed with research outcomes in mind, thus a multi-faceted approach to evaluation is taken
- Changes in perceived HH-level welfare 2004-14 (Figure 1)
- Measure of extensive versus **intensive** margin of adoption
- Extensive: proportion of total HH’s that grow RRVs (Figure 2)
- Ordinary Least Squares (OLS) estimation of intensive margin (1) using data from the 2014 survey (Table 1):

\[ Y_i = \alpha_0 + \beta X_i + \gamma P_i + \epsilon_i \]  

(2)

- where, Y is the proportion of total groundnut area planted in RRVs, X is a vector of HH-level characteristics, P is a dummy variable for project participation
Given the long period of time between EOP and 2014 survey, spillover effects from the project are virtually guaranteed.

We exploit the structure of the control, along with Propensity Score Matching (PSM) and Instrumental Variables (IV) to address these effects.

The assumption is that project spillover is limited to the neighboring control group.

PSM is then used to control for selection on observables between participants and controls.

Selection on unobservables and endogeneity is handled using an IV for intent to treat (ITT), program participation is estimated with a probit and the predicted participation is used in the OLS model (1) (following Cavatasi et al. 2011).
Figure 1. Changes in Mean Perceived HH Welfare by Group from 2004 to 2014
Figure 2. Changes in Extensive Margin of Adoption by Group from 2004 to 2014
Table 1. Estimates of Intensive Margin of Adoption as the Proportion of Total Groundnut Production Area in RRVs

<table>
<thead>
<tr>
<th>Model Specification</th>
<th>Coefficient Estimate</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLS: Beneficiaries (Ben)</td>
<td>0.1420***</td>
<td>0.0456</td>
</tr>
<tr>
<td>OLS: Neighbors (C_In)</td>
<td>0.1330**</td>
<td>0.0525</td>
</tr>
<tr>
<td>OLS: Project Village (PV)</td>
<td>0.1389***</td>
<td>0.0427</td>
</tr>
<tr>
<td>PSM: Ben vs. C_Full</td>
<td>0.0724</td>
<td>0.0462</td>
</tr>
<tr>
<td>PSM: Ben vs. C_In</td>
<td>0.0280</td>
<td>0.0570</td>
</tr>
<tr>
<td>PSM: C_In vs. C_Out</td>
<td>0.1154**</td>
<td>0.0540</td>
</tr>
<tr>
<td>PSM: PV vs. C_Out</td>
<td>0.1353***</td>
<td>0.0528</td>
</tr>
<tr>
<td>PSM: Ben vs. C_Out</td>
<td>0.2151***</td>
<td>0.0520</td>
</tr>
<tr>
<td>IV: intent-to-treat (ITT)</td>
<td>0.2115***</td>
<td>0.0667</td>
</tr>
</tbody>
</table>

*Note:* *, P < 0.10; **, P < 0.05; ***, P < 0.01.
Summary, Concluding Remarks, and Extensions

- In sum, we observe significant differences between beneficiaries and control groups in terms of adoption of RRVs.
- This is an important result as it documents the sustainability of the project outcomes, which is often discussed as being an important part of development projects but rarely measured.
- In this way we utilize a unique dataset to analyze the sustainability of the 2001-04 extension efforts.
- Findings also suggest significant differences in yield between beneficiaries and controls, which is in line with other recent studies of groundnut producers in Uganda.
- An additional avenue for inquiry is to examine the risk mitigation behavior of farmers, who balance marketability of risky groundnut varieties with the reliability of improved varieties for home consumption.