Understanding Rwandan Agricultural Households’ Strategies to Deal with Prime Age Illness and Death: A Propensity Score Matching Approach

By
Cynthia Donovan and Linda Bailey
Michigan State University and Baruch College, NY

Paper presented at the IFPRI Conference
HIV/AIDS and Food Security and Nutrition: From Evidence to Action
Durban, April 14-16, 2005

USAID funded this research under Agricultural Sector funding, through the Rwanda USAID Mission and through the Africa Bureau

Overall objective

Main research question:
• Are rural households adopting strategies in response to prime age adult illness and death that include changes in cropping patterns?
  – If so, what crops are affected and in what direction?

Additional research questions:
• Is it important to separately measure impacts during the period of illness and then after the death?
  – Implications of measuring period for interventions
• Is Propensity Score Matching a valuable approach?
Specific Objectives

- Identify agricultural strategies of affected HHs
  - Strategies during illness versus strategies after a death
  - Gender dimensions of those strategies
- Evaluate the impact on agricultural production of key crops at a HH level
- Analyze implications of HH strategies/actions for interventions/programs
  - Compare those during illness versus after a death
- Evaluate how these results might affect estimates of agricultural sector impacts and intervention design

Time as an important dimension to impacts

- Household strategies differ across households but also over time (illness, death, post-death)
  - Demographics
  - Production system
  - Other aspects
- Community/society effects also over time (eg. Mtika)
- “Recovery” or poverty trap
  - Temporary shifts (rent out land, cultivate tubers)
  - Permanent shifts (take out tree crops, sell oxen)
- Agricultural production:
  - Seasonal labor demands/shortages
  - Differences between crops/ cropping systems
- Surveys measure households at specific points in time
  - Cross-sectional and longitudinal
When you measure counts

Impact over time: Hypothetical Households

Data

MINECOFIN households surveys (6000 hhs)
- 2001 Living Conditions Survey

MINAGRI households surveys: (1500 hhs)
- 2000-2002 Seasonal Production data
- 2001 Demographic data
- 2002 Illness & Death data

Year 1= prior to illness; Year 4=illness, just prior to death; Year 10=5 years after death
**Earlier Analysis**

- Affected hhs work to maintain labor in agriculture
  - new labor, hiring, sharing,
  - not shifting solely into labor-saving crops/technology

- Affected hhs more likely to be very poor ex post

- Strategies suggest some households are using strategies that results in a downward spiral into poverty (sales of productive assets)

**Stated effects of mortality or morbidity on household agricultural activities**

**Adult death**
- Reduced farm labor (59%)
- Reduced farm skills (9%)
- Lost access to land (6%)
- No effects stated (for those who have been inactive for at least a year or whose primary activity was non-ag) (25%)

**Chronically ill adult**
- Reduced farm labor (80%)
- Lost access to land (2%)
- Reduced farm skills (2%)
- No effects stated (for those who been inactive for at least a year or whose primary activity was non-ag) (25%)
Assessing effects: Comparing households with a shock to those without

Methodological approach for cross-section or panel data

- Propensity score matching:
  - Create a “propensity score”
  - \( P(x_i) = \text{Prob}(w_i=1|x_i) \) \((0<P(x_i)<1)\)
  - where
    - \( x_i \) are pre-death/illness control variables (predictors of illness or death due to illness)
    - \( w_i \) is \((0,1)\) indicator for having illness or death in HH

- Use the estimated P score to match affected households with unaffected households who have “similar” probabilities and compare their outcomes

<table>
<thead>
<tr>
<th>CROP</th>
<th>Death HHS ATT</th>
<th>t</th>
<th>Illness HHS ATT</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beans</td>
<td>-6.89</td>
<td>-0.51</td>
<td>20.99</td>
<td>0.6</td>
</tr>
<tr>
<td>Cassava</td>
<td>8.81</td>
<td>0.1</td>
<td>101.12</td>
<td>0.73</td>
</tr>
<tr>
<td>Sweet Potatoes</td>
<td>-209.96</td>
<td>-1.26</td>
<td>467.88</td>
<td>2.45 **</td>
</tr>
<tr>
<td>Cooking Bananas</td>
<td>-78.58</td>
<td>-0.75</td>
<td>-102.65</td>
<td>-1.51</td>
</tr>
<tr>
<td>Beer Bananas</td>
<td>-198.91</td>
<td>-3.01 ***</td>
<td>-205.4</td>
<td>-1.82 *</td>
</tr>
<tr>
<td>Fruit Bananas</td>
<td>-41.17</td>
<td>-2.49 ***</td>
<td>-35.81</td>
<td>-0.87</td>
</tr>
<tr>
<td>Coffee</td>
<td>-4.97</td>
<td>-0.94</td>
<td>-9.31</td>
<td>-1.79</td>
</tr>
</tbody>
</table>

Source: FSRP/DSA Surveys. Confidence levels: ***=0.01 ; **=0.05; *=0.1 .

* Significant at 0.1  ;  ** Significant at 0.01

ATT is the Average Treatment effect on the Treated, based on Propensity Score Matching
Crop Shifts

• Less beer banana and less fruit banana (especially after a death)
  – Lower household incomes, particularly for women
  – Possible increase in erosion problems, depending on what enters the cropping system
• More sweet potatoes: (very strong impact during illness)
  – More dispersed labor demand
  – But erosive crop when planted on slopes (better than cassava though)
  – Calories and some nutrients
  – Not a great cash crop (marketing constraints)

Conclusions

• Earlier evidence:
  – Affected hhs: Maintain labor in agriculture
  – Affected hhs more likely to be very poor (ex post)
  – Demographic changes in an attempt to respond
  – Strategies of downward spiral into poverty evident for some (sales of productive assets)

• New Empirical Evidence:
  – Different changes in production evident between illness, death and control households
  – Changes suggest that incomes are declining and subsistence production increasing in the illness period
  – Analysis must be careful to evaluate at different times to help design interventions for before households make irreversible steps of removing trees and selling assets.
  – Propensity Score Matching is a valuable approach, but should be complemented with other methods.
Annex 1:
ATE: estimator of the mean impact of the treatment is

\[
\Delta Y = \sum_{i=1}^{T} \frac{1}{W_i} \left( y_{i1} - \sum_{j=1}^{C} W_{ij} y_{ij0} \right)
\]

where

- \( y_{i1} \) is post-shock outcome for hh\(_i\) (eg. Total crop production)
- \( y_{ij0} \) is outcome of jth non-treated matched to the ith treated
- \( T \) is total number of treatments
- \( C \) is total number of non-treated households
- \( W_i \)'s are the sampling weights to construct mean impact indicator
- \( W_{ij} \)'s are weights applied in calculating average outcome of matched non-participants

Comparisons of Households in 1999/2000

<table>
<thead>
<tr>
<th>Characteristics of Head prior to event*</th>
<th>HH w/ Death</th>
<th>Control HH</th>
<th>HH w/ Illness</th>
<th>Control HH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion Female</td>
<td>0.5</td>
<td>0.31</td>
<td>0.29</td>
<td>0.31</td>
</tr>
<tr>
<td>Head is either married or separated (1999)</td>
<td>0.23</td>
<td>0.42</td>
<td>0.6</td>
<td>0.47</td>
</tr>
<tr>
<td>Age of pre-treatment head in 1999</td>
<td>43</td>
<td>42</td>
<td>41</td>
<td>43</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Household level variables prior to event</th>
<th>HH w/ Death</th>
<th>Control HH</th>
<th>HH w/ Illness</th>
<th>Control HH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household has received remittances</td>
<td>na</td>
<td>na</td>
<td>0.6</td>
<td>0.57</td>
</tr>
<tr>
<td>Distance to primary market (km)</td>
<td>1.83</td>
<td>1.71</td>
<td>2.4</td>
<td>1.77</td>
</tr>
<tr>
<td>Total income in 2000</td>
<td>na</td>
<td>na</td>
<td>141058</td>
<td>159603</td>
</tr>
<tr>
<td>Length of residence in cellule</td>
<td>10.44</td>
<td>9.4</td>
<td>7.83</td>
<td>8.27</td>
</tr>
<tr>
<td>N</td>
<td>78</td>
<td>1051</td>
<td>65</td>
<td>761</td>
</tr>
</tbody>
</table>

*Some data imputed. Control households represent households were matched using Propensity Score Matching, radius of 0.01.