Utilization of Animal Draft Power in Zambia: Drivers & Effects on Household Income and Commercialization

Mary Lubungu, Nicole M. Mason, and Rhoda Mukuka-Mofya

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Motivation

- Smallholder agric. sector characterized by
  - Rural poverty is high ~ 80%
  - Low crop productivity- e.g maize yields ~ <2 ton/ha
  - Low commercialization - about 20% of crop produce is marketed

- Recent past increases in production in Zambia due to expansion in area cultivated
  - Requires more labor but many HHs are labor constrained
  - Animal Draft Power (ADP) could help overcome labor constraints

- ADP raises maize yields (Burke, 2012)
Motivation

- But only 30% of smallholder use ADP
- 1% use mechanized power
- Rest use manual labor

- Why only 30%?
- Are there other benefits beyond yield effects?

Research Questions

1. What are the determinants of the use of animal draft power (ADP) for land preparation by smallholder farm households in Zambia?
   - Previous studies suggest that
     - land size
     - previous land use
     - type of crop grown
     - location
     - soil type
     - animal disease
     - extension services
   - are important determinants
Research Questions

2. To what extent is ADP used?

3. What are the *ceteris paribus* effects of ADP use on gross value of crop production, crop commercialization and per capita income among these households?
   - Per capita household income includes-Crop, livestock and off farm income
   - Household Commercialization Index – concept of marketable surplus or market orientation
     - $\text{HCI} =$ value of crop sales/gross value of crop production

Contributions of the study

  - found that ADP increases average income
  - based on cross sectional data
- We use panel data
  - Provide greater leverage to reduce bias due to time constant unobserved effects
- Also address the potential endogeneity of ADP
- This is the first study to estimate these effects in Zambia
Outline

- Brief background on Zambia
- Data sources
- Descriptive results
- Initial thoughts on econometric approach
- Potential policy implications

Zambia

- Landlocked, about the size of Texas
- Population: 13.9 million (64% rural)
- GDP/cap: US$1,600 (26/47 in SSA)
- Rural poverty rate: 80%
- Agriculture accounts for
  - 20% of GDP
  - 85% of labor force
- Single rainy season (Oct.-Apr.)
Data

- Nationally representative HH survey
- 394 standard enumeration areas (map)
- Smallholder HHs (cultivate <20 ha)
- Farm & non-farm activities, demographics, assets

- Wave 1: 2001 (6,922 HHs)
- Wave 2: 2004 (5,358 HHs)
- Wave 3: 2008 (4,286 HHs)

Results

- Descriptive for the important determinants of ADP use
- Comparisons of mean outcomes for users and non-users
Pathways of ADP users

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</thead>
<tbody>
<tr>
<td>Users</td>
<td>129,054 (19.2%)</td>
<td>20,178 (3%)</td>
<td>108,876 (16.2%)</td>
<td>213,469 (31.8%)</td>
</tr>
<tr>
<td>Non-user</td>
<td>62,301 (9.3%)</td>
<td>30,014 (4.5%)</td>
<td>33,603 (5.0%)</td>
<td>457,139 (68.2%)</td>
</tr>
</tbody>
</table>

Percent of HHs by ADP user category

- User to non-user: 8%
- Non-user to user: 11%
- Consistent ADP users: 16%
- Consistent ADP non-users: 57%
- All other: 8%
ADP user category by source of ADP

- Consistent ADP users
- User to non-user
- Non-user to user
- All other

Percent of HHs borrowed or hired

ADP user by cattle ownership

- Percent of HHs using ADP
- Do not own cattle: 18%
- Owning cattle: 74%
IS ADP USE MORE COMMON AMONG HHS WITH LARGER LANDHOLDINGS?

Land distribution among smallholder farmers

- Less than 1 ha: 35%
- 1 - 2 ha: 30%
- 2 - 5 ha: 28%
- 5 ha or more: 7%
ADP users by land holding size

<table>
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<tr>
<th>Land Holding Size</th>
<th>Percent of HHs using ADP</th>
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<tbody>
<tr>
<td>less than 1 hectare</td>
<td>20%</td>
</tr>
<tr>
<td>1 - 2 hectares</td>
<td>26%</td>
</tr>
<tr>
<td>2 - 5 hectares</td>
<td>37%</td>
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<tr>
<td>5 or more hectares</td>
<td>52%</td>
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How does the use of ADP vary across provinces?
Use of ADP within each province

HOW DOES THE USE OF ADP VARY ACROSS SOIL TYPES?
Zambia’s soil types

- 21 different soil types in Zambia
  - Soil types vary across regions

- Most common soil types are Acrisols, Arenosols, Leptosols, Lixisols, and Associations

Use of ADP within each soil type

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Percent of HHs using ADP</th>
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<tbody>
<tr>
<td>Acrisols</td>
<td>21%</td>
</tr>
<tr>
<td>Arenosols</td>
<td>41%</td>
</tr>
<tr>
<td>Leptosols</td>
<td>40%</td>
</tr>
<tr>
<td>Lixisols</td>
<td>46%</td>
</tr>
<tr>
<td>Association</td>
<td>38%</td>
</tr>
<tr>
<td>Other types</td>
<td>26%</td>
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</tbody>
</table>
IS USE OF ADP MORE COMMON AMONG CERTAIN ETHNIC GROUPS?

Ethnicity and use of ADP

- Zambia has more than 70 tribes
- Group the households into five ethnic groups
  - Bemba, Kaonde, Nyanja, Lozi and Tonga
Use of ADP within each ethnic group

Ethnic group of household head

<table>
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<tr>
<th>Ethnic Group</th>
<th>Percent of HHs using ADP</th>
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<tbody>
<tr>
<td>Nyanja</td>
<td>29%</td>
</tr>
<tr>
<td>Lozi</td>
<td>18%</td>
</tr>
<tr>
<td>Tonga</td>
<td>41%</td>
</tr>
<tr>
<td>Bemba</td>
<td>5%</td>
</tr>
<tr>
<td>Kaonde</td>
<td>4%</td>
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ARE THERE STATISTICALLY SIGNIFICANT DIFFERENCES BETWEEN ADP USERS AND NON USERS WITH REGARD TO THE POTENTIAL OUTCOMES?
Potential outcomes variables

- Gross value of crop production
- (Gross) Household income
- Household Commercialization Index
  - Value of crop sales/gross value of crop production

Mean gross value of crop production: ADP non-users vs. users

<table>
<thead>
<tr>
<th></th>
<th>Mean gross value of production (ZMW)</th>
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<tbody>
<tr>
<td>non users</td>
<td>1146</td>
</tr>
<tr>
<td>users</td>
<td>2157</td>
</tr>
</tbody>
</table>
Mean gross household income per adult equivalent: ADP non-users vs. users

Mean household commercialization index (HCI): ADP non-users vs. users
FINDINGS

Potential determinants

- Descriptive results suggest that ADP use may be more likely among households that
  - Own cattle
  - Have large land holding size
  - Belong to Tonga ethnic group
  - Found in southern or western provinces

- Need a multivariate analysis
  - to determine which are statistically significant determinants
Mean differences for potential outcomes

- Descriptive results show differences between ADP users and non-users
- But cannot conclude that using ADP has a positive causal effect on
  - gross value of crop production
  - household income
  - commercialization
- Descriptive results do not control for other factors
- To draw such conclusions, we turn to the econometric estimations

Thoughts on econometric estimation

- Identifying factors affecting and extent of using of ADP
  - Field level and HH-level analyses; control HH fixed effects (CRE Double hurdle)
  - Also considering distinguishing between own and rented/borrowed ADP

- Effects of ADP on gross value of crop production, HH income and commercialization
  - Household level analysis and control for household fixed effects (Pooled CRE)
Thoughts on econometric estimation

- Challenges
  - Identification strategy
    - Is it ADP use affecting the outcome or vice versa?
    - Omitted variables bias
  - Potential solutions to challenges
    - Instrumental variable approach
      - Though have problems coming up with an IV
    - Combining CRE with PSM

Potential policy implications

- Poverty reduction
  - Feed into poverty reduction programs

- Targeting interventions
  - For both NGOs and government projects
Thank you for coming