How Does Gender Affect Sustainable Intensification of Cereal Production in the West African Sahel?

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Motivation

Population dynamics and climate change exacerbate food insecurity

Household decision-making processes are undergoing changes
  ◦ More women are planting sorghum— a crop traditionally cultivated by men

Understanding gender differences in the adoption of intensification strategies is crucial
Previous work

Women play a major role in agriculture, but they face more constraints than men

Gender differentials in farm productivity
- Access to inputs and resources
- Tenure rights
- Household versus plot

Technology adoption
- Intensification strategies are context-specific
- Gender dimension is often ignored
Objective

Do determinants of adoption of intensification strategy sets differ by gender of the plot manager across cereal crops in Burkina Faso?

- Plot as unit of analysis
- Control for headship
- Farming system
Farming Structure & Gender Dynamics

Sorghum, millet, and maize account for over 70% of total cultivated land.

Family conducts farm work across numerous plots:
- Collective plots are managed by the head of the household
- Individual plots are managed by different household members

Upon marriage, women may have access to individual plots.
Data

Continuous Farm Household Survey (*Enquête Permanente Agricole*)
- Nationally representative (45 provinces, 826 villages)
- 2009/10-2011/12
- 2700 households growing cereals, 11 000 individual cereal plots
- Production, area, livestock holding, income and expenditure, input use

NOAA’s Climate Prediction Center
- Rainfall variability at the commune level
**Empirical Strategy**

Perceived benefits derived from adopting an intensification strategy

(1) \[ y_{it}^* = X'_{it} \beta + u_{it} + c_i \quad i=1,\ldots,n, \text{ and } t=1,\ldots,T \]

The decision to adopt is observable \((y_{it})\)

(2) \[ y_{it} = 1 \text{ if } y_{it}^* > 0 \]
\[ = 0 \text{ Otherwise} \]

Probability of adopting an intensification strategy

(3) \[ \text{Prob} \left( y_{it} = 1 \mid X_{it} \right) = F(X'_{it} \beta + c_i ) \]
Empirical Strategy

Multivariate Probit Model
- Estimating several probit models simultaneously
- Allowing the error terms to be correlated

Chamberlain-Mundlak device
- Allowing for unobserved heterogeneity ($c_i$) to be correlated with observed covariates

\[(4) \quad c_i = \bar{X}_i^\prime \delta + u_i + c, \quad u_i \mid X_i \sim N(0, \sigma_u^2)\]

The reduced form

\[(5) \quad \text{Prob}(y_{it} = 1 \mid X_{it}) = F(X_{it}^\prime \beta + \bar{X}_i^\prime \delta + \alpha_i + c)\]
Defining Adoption

Dependent variables
- Yield-enhancing inputs (set 1) - improved seed and inorganic fertilizer
- Yield-protecting inputs (set 2) - pesticides, fungicides, and herbicides
- Soil and water conservation (set 3) – amendments, anti-erosion, and water-harvesting structures.

Explanatory variables
- Gender of the plot manager and household headship
- Age, education, marital status
- Size, distance to residence, topography, and tenure rights
- Labor availability
- Total landholding, livestock, non-farm income, cotton hectares
- Access to credit and extension service, density of agrodealers
- Coefficient of variation in total annual rainfall
## Descriptive Statistics

### Table 1. Number of plots by gender, type of management, and crops

<table>
<thead>
<tr>
<th></th>
<th>Sorghum</th>
<th>Millet</th>
<th>Maize</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total No. of Plots</td>
<td>18701</td>
<td>11318</td>
<td>10799</td>
</tr>
<tr>
<td>Collectively Managed</td>
<td>12805</td>
<td>7707</td>
<td>9321</td>
</tr>
<tr>
<td>Individually Managed</td>
<td>5893</td>
<td>3608</td>
<td>1475</td>
</tr>
<tr>
<td>Managed by women</td>
<td>3991</td>
<td>2577</td>
<td>533</td>
</tr>
<tr>
<td>Managed by Men</td>
<td>1901</td>
<td>1028</td>
<td>939</td>
</tr>
</tbody>
</table>
## Descriptive Statistics

### Table 2. Plot Adoption Rates (%)

<table>
<thead>
<tr>
<th></th>
<th>Sorghum</th>
<th></th>
<th>Millet</th>
<th></th>
<th>Maize</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Improved seeds</td>
<td>0.8</td>
<td>0.7</td>
<td>1.2</td>
<td>0.7</td>
<td>8.1</td>
<td>3.6***</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>7.3</td>
<td>6.4</td>
<td>7.1</td>
<td>4.7***</td>
<td>33.3</td>
<td>26.6***</td>
</tr>
<tr>
<td>Herbicide</td>
<td>7.9</td>
<td>6.0***</td>
<td>2.1</td>
<td>1.5</td>
<td>17.5</td>
<td>13.0***</td>
</tr>
<tr>
<td>Pesticide</td>
<td>2.9</td>
<td>3.9**</td>
<td>1.9</td>
<td>2.4</td>
<td>2.6</td>
<td>1.7</td>
</tr>
<tr>
<td>Fungicide</td>
<td>9.8</td>
<td>9.2</td>
<td>8.3</td>
<td>7.7</td>
<td>4.4</td>
<td>1.7***</td>
</tr>
<tr>
<td>Manure</td>
<td>16.3</td>
<td>15.1</td>
<td>17.9</td>
<td>12.8***</td>
<td>36.0</td>
<td>28.1***</td>
</tr>
<tr>
<td>Anti-erosion</td>
<td>14.6</td>
<td>12.2***</td>
<td>11.5</td>
<td>11.6</td>
<td>9.6</td>
<td>13.0**</td>
</tr>
<tr>
<td>Yield-enhancing set</td>
<td>8.2</td>
<td>7.2</td>
<td>8.6</td>
<td>5.7***</td>
<td>36.7</td>
<td>28.9***</td>
</tr>
<tr>
<td>Yield-protecting set</td>
<td>19.3</td>
<td>18.1</td>
<td>11.8</td>
<td>11.5</td>
<td>21.5</td>
<td>15.4***</td>
</tr>
<tr>
<td>SWC set</td>
<td>25.4</td>
<td>22.9***</td>
<td>25</td>
<td>21.1***</td>
<td>39.1</td>
<td>33.4***</td>
</tr>
</tbody>
</table>
Econometric Results

Pooled Multivariate Probit (MVP)- significant explanatory variables

- Gender (-)
- Household headship (-)
- Marital status (+)
- Distance (+/-)
- Size (+)
- Landholding (-)
- Credit (+)
- Agrodealers (-)

- Crops (-/+)
- Age (-/+)
- Tenure rights (+)
- Topography (+)
- Labor (+/-)
- Cotton hectares (+)
- Extension services (-)
- Rainfall (+)
Econometric Results

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- Labor (+/-)
- Cotton hectares (+)
- Extension services (-)
- Rainfall (+)
Econometric Results

Separate Multivariate Probit- for each cereal crop

Gender influences the decision and determinants of adoption
  ◦ Being a woman negatively affects the probability of adopting
  ◦ Secure rights over plots positively influence women’s probability of adopting
  ◦ Marital status of men positively influences their decision to adopt
Conclusions

Adoption on individual plots differs across gender and crops
- Lower adoption rates among plots managed by women
- Higher adoption rates for maize

Turning to gender differences,
- Marital status positively influences adoption for men only
- Secure rights positively influence adoption for women

Plot, household and market-related characteristics influence adoption of intensification strategies
Policy Implications

The interrelatedness of adoption strategy sets
◦ Designing mechanisms to encourage the use of combinations of practices

The variation in input use within strategy sets
◦ Farmers are not best approached with a fixed package in mind

Design policies that respect opportunities and incentives for individuals within multigenerational, multi-family farms
Thank you

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