Explaining Agricultural Technology Adoption Using Choice Experiments and System Dynamics

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NEW DATA RELEASED in June 2013 by the United Nations predicts a global population of more than 10.8 billion by 2100 — 800 million higher than the U.N.’s 2010 estimate. Population growth is expected to be unevenly distributed across the planet, and the rural to urban migration will continue to explode.

PROJECTED POPULATION CHANGE FOR SELECT COUNTRIES (2010 to 2100)

Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat. World Population Prospects: The 2012 Revision

Graphic: ensia.com
What is a perennial and why do we care?

1. Reduced costs in preparing fields
2. Reduced erosion
3. Faster establishment in subsequent years
4. Improved soil fertility - larger root mass contributes to soil carbon

Audobon.org
Perennial Pigeonpea in Malawi

Image: Dr. Sieg Snapp, MSU
What’s unique about this study?

- Combining system dynamics and choice experiments (consumer theory and diffusion of innovation)
- Incorporating environmental factors, stochasticity into adoption trajectory
System Dynamics - Stocks and Flows

Diagram showing the relationship between adoption and disadoption processes:
- Never used perennial
- Adoption
- Adaptors
- Readoption
- Disadopters
- Disadoption
## Choice Experiments

### CARD 1 VERSION 1

<table>
<thead>
<tr>
<th></th>
<th>MAIZE SEED A</th>
<th>MAIZE SEED B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed Price</td>
<td>P 2700</td>
<td>P 2700</td>
</tr>
<tr>
<td>Yield loss due to Pest</td>
<td>70%</td>
<td>40%</td>
</tr>
<tr>
<td>Seed Type</td>
<td>Bt Corn</td>
<td>Bt Corn</td>
</tr>
<tr>
<td>Seed Payment</td>
<td>Cash only</td>
<td>Cash or credit</td>
</tr>
<tr>
<td>Information</td>
<td>Farmer</td>
<td>Input Supplier</td>
</tr>
</tbody>
</table>

Neither Maize Seed A nor Maize Seed B: Given these options, I would prefer to cultivate the seed I now grow.
Perennial Pigeon Pea Adoption

- Focus on southern Malawi and farmers who already grow annual pigeon pea
- Simulate adoption decision of 1000 farmers over 25 years

<table>
<thead>
<tr>
<th></th>
<th>Annual</th>
<th>Perennial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1 - growing season</td>
<td>Maize - pigeon pea intercrop</td>
<td>Maize - pigeon pea intercrop</td>
</tr>
<tr>
<td>Year 1 - dry season</td>
<td>Destructive harvest</td>
<td>Harvest and ratoon</td>
</tr>
<tr>
<td>Year 2 - growing season</td>
<td>Maize - pigeon pea intercrop</td>
<td>Maize - pigeon pea intercrop (higher competition)</td>
</tr>
<tr>
<td>Year 2 - dry season</td>
<td>Destructive harvest</td>
<td>Destructive harvest</td>
</tr>
<tr>
<td>Year 3 - growing season</td>
<td>Sole Maize</td>
<td>Sole Maize</td>
</tr>
</tbody>
</table>
Base scenario - average yields held constant

- Perennial system has advantage over annual system
- Probability of adoption is 92%
- Gradual gain in trust and skills
Base scenario - average yields held constant

![Graph showing the adoption of technology over years with different metrics on the x-axis and y-axis.]
Coarse analysis of cumulative environmental benefits

- Reduced erosion - 61.3% of agricultural land has greater than 2% slope in Southern Malawi (Landsat 30m x 30m)
- Reduced N leaching - from 1.66 kg N/ha with sole maize to 0.72 kg N/ha (30 year average from SALUS)
Stochastic climate effect on production
(95% confidence intervals - 1000 runs)

- Year 1 intercropped maize 800-2500 kg/ha
- Year 1 pigeon pea 100-600 kg/ha
- Year 2 perennial pigeon pea 400-2000 kg/ha
Conclusions

- Even for technologies that are clearly beneficial for farmers and the environment, stochasticity limits adoption rates
  - Why? Feedback effects
  - Who cares?
Thank you - Any questions?

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