Intensification and extensification in mixed farming systems of southern Mali

What is the solution space for agronomy?

Mary Ollenburger
Wageningen University
Agronomy: What is it good for?

• To feed 9 billion people!
• To end poverty!
Agronomy: What is it good for?

Can we actually do that?
Are we really trying?
Is it possible to do both at once?
Africa’s Sleeping Giant

- Increasing production
- Driving growth
- Reducing poverty

- Commercial
  - Brazil’s Cerrado
- Smallholder-based
  - Northern Thailand

Source: IFPRI.
Case Study: Bougouni, Mali

- Population density:
  - 26 people/sq. km.
- High potential
  - Maize Yw 12-16 T/ha (GYGA)
  - 1200 mm rainfall/yr
Crop allocation and cultivated area

- **Household size**
- **Number of people**
- **Crops**
  - Cotton
  - Maize
  - Groundnut
  - Rice
  - Other

**Crop area (ha)**

- **Household size**
- **Land cultivated (ha)**

**Farms**

<table>
<thead>
<tr>
<th>Household size (number of people)</th>
<th>Crop area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
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<tr>
<td>10</td>
<td>10</td>
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<td>20</td>
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<td>30</td>
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<td>80</td>
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<tr>
<td>90</td>
<td>90</td>
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<tr>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

**Farms**

- **Crop area (ha)**
- **Household size**
- **Land cultivated (ha)**

- **Crops**
  - Cotton
  - Maize
  - Groundnut
  - Rice
  - Other
Exploring a solution space with simple scenarios

- Many scenarios, using limited data, to quickly explore options
- Input data:
  - Household survey at district level for yields, input costs (AfricaRISING baselines), market survey for crop prices
  - Rapid characterization of population of 109 farm households in 3 villages (crop areas, livestock and equipment)
  - Trial data estimating potential yields
Scenarios with current crop allocation

- Baseline: 50th percentile yields
- Yield gap reduction:
  - 90th percentile yields
  - Potential yields
Optimization Scenarios

Maximize gross margins by re-allocating crop areas subject to constraints:

- Meet household calorie requirements with staple grains
- Maize area < twice cotton area (fertilizer availability constraint)
- Total cropped area constrained to current area (or a factor thereof)

1. With 50th, 90th percentile yields
2. With experimental potential yields
3. Allowing 50% land area expansion
# Parameters

<table>
<thead>
<tr>
<th>Crop</th>
<th>At 50th percentile yields</th>
<th></th>
<th>At 90th percentile yields</th>
<th></th>
<th>At potential yields</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield (kg/ha)</td>
<td>Gross margin (USD/ha)</td>
<td>Yield (kg/ha)</td>
<td>Gross margin (USD/ha)</td>
<td>Yield (kg/ha)</td>
<td>Gross margin (USD/ha)</td>
</tr>
<tr>
<td>Cotton</td>
<td>900</td>
<td>287</td>
<td>1587</td>
<td>550</td>
<td>3000</td>
<td>1130</td>
</tr>
<tr>
<td>Groundnut</td>
<td>486</td>
<td>290</td>
<td>1020</td>
<td>571</td>
<td>2000</td>
<td>820</td>
</tr>
<tr>
<td>Maize</td>
<td>1600</td>
<td>164</td>
<td>2533</td>
<td>279</td>
<td>5000</td>
<td>630</td>
</tr>
<tr>
<td>Rice</td>
<td>800</td>
<td>190</td>
<td>2400</td>
<td>570</td>
<td>2400</td>
<td>570</td>
</tr>
<tr>
<td>Sorghum</td>
<td>500</td>
<td>107</td>
<td>1050</td>
<td>210</td>
<td>3000</td>
<td>530</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sorghum (fodder)</td>
<td>600 (2500)</td>
<td>Cowpea (fodder)</td>
<td>580</td>
</tr>
</tbody>
</table>
Results: Crop Area

Baseline

Optimization at 50th percentile yield

Optimization at 90th percentile yield

Optimization at potential yield

Crop area (ha)

Farms

Crops
- Cotton
- Maize
- Groundnut
- Sorghum
- Rice
- Other
## Results: Food Self-sufficiency

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Number (percentage) of households below 80% food self-sufficiency from staple grains</th>
</tr>
</thead>
<tbody>
<tr>
<td>50th percentile</td>
<td>10 (9%)</td>
</tr>
<tr>
<td>90th Percentile</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>Potential</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>Optimized 50th percentile</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>Optimized 90th percentile</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>Optimized potential</td>
<td>1 (1%)</td>
</tr>
</tbody>
</table>
Results: Gross Margins

- Gross margin from crops (USD) per active household member

- Optimized 50%
- Optimized 90%
- Potential
- Optimized Potential

- $1.25/person/day poverty level
- $1225 mean yearly income from gold mining
Results: Gross Margins

Gross margin from crops (USD) per active household member

- $1.25/person/day poverty level
- $1225 mean yearly income from gold mining
This system is not designed to be profitable

- Result of intersecting priorities:
  - Malian state:
    - National food self-sufficiency
    - Cotton for export
  - Farmers:
    - Family food self-sufficiency
    - Income is secondary
  - Donors:
    - “Sustainable intensification”
What about saving the world?

• Local food self sufficiency
  • Integrate nutrition for impact
• Feeding 9 billion people
  • hard to generate needed surpluses because…
What about saving the world?

- Small-scale staple grain farming is not very profitable
- Thriving ag sector can have knock-on effects, but only if the context is right
What about saving the world?

- Tailor options to context
- Cross-disciplinary approaches
- Honesty about what is actually possible
Thank You

IFPRI ARBES team
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Africa Research in Sustainable Intensification for the Next Generation
africa-rising.net