Potential for Cropland Expansion in Africa: Estimates under Alternative Assumptions

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Land and people in SSA

FACT #1

• Despite urbanization trends, rural populations still growing at 1 to 2.5% per year

• Arable land resources are generally taken to be abundant, BUT: indicators of declining land availability in high-density areas
  – Downward trends in farm size & fallow rates
  – Persistently concentrated rural settlements
Growth of rural populations in SSA

These patterns are true for both high and low density countries

Source: World Development Indicators, World Bank
Clustering of rural populations in SSA

<table>
<thead>
<tr>
<th>Region</th>
<th>top 1%</th>
<th>top 5%</th>
<th>top 10%</th>
<th>top 20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>East/Central</td>
<td>17%</td>
<td>44%</td>
<td>61%</td>
<td>76%</td>
</tr>
<tr>
<td>Southern</td>
<td>14%</td>
<td>37%</td>
<td>53%</td>
<td>73%</td>
</tr>
<tr>
<td>West</td>
<td>13%</td>
<td>36%</td>
<td>51%</td>
<td>70%</td>
</tr>
<tr>
<td>SSA</td>
<td>16%</td>
<td>42%</td>
<td>58%</td>
<td>76%</td>
</tr>
</tbody>
</table>

Rural populations are highly spatially concentrated

Source: AfriPop (rural areas only)
Clustering of rural populations in SSA

<table>
<thead>
<tr>
<th>Region</th>
<th>top 1%</th>
<th>top 5%</th>
<th>top 10%</th>
<th>top 20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>East/Central</td>
<td>15%</td>
<td>40%</td>
<td>57%</td>
<td>74%</td>
</tr>
<tr>
<td>Southern</td>
<td>12%</td>
<td>32%</td>
<td>47%</td>
<td>66%</td>
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<tr>
<td>West</td>
<td>10%</td>
<td>29%</td>
<td>43%</td>
<td>60%</td>
</tr>
<tr>
<td>SSA</td>
<td>14%</td>
<td>36%</td>
<td>52%</td>
<td>70%</td>
</tr>
</tbody>
</table>

even after throwing out areas with <400 mm rainfall

Source: AfriPop (rural areas only)
Land and people in SSA

FACT #2

• Intensification is taking place, but in limited ways (Headey and Jayne)
  – Decreasing fallows, shift to higher value crops
  – Limited input intensification, limited yield gains

FACT #3

• Rising investor interest in large-scale land acquisitions
  – ostensibly in surplus land
Facts → Policy questions

• What is the appropriate response to stagnant productivity in densely populated areas?
  1. Intensification
  2. Extensification
  3. Rural-urban migration / NFRE
  4. Rural-rural migration

• How much surplus land is there in SSA?
  – Resolving this question is critical
  – Suggests tradeoffs to land-oriented FDI
How much land is there really?

• Recent assessments have been widely commented on
  – 200 million ha, half of which in just 4 countries...
How much land is there really?

• Our approach builds on this earlier work
• Incorporates newer, higher resolution data
  – Rural population distributions
  – Land cover: cultivated areas, forest resources, etc.
• Argues for a more nuanced approach to viewing the economics of expansion
  – Agronomic potential → potential yields
  – Economic remoteness → spatial prices
• Not the definitive answer! Incremental advance in how best to address the question
5” spatial database for SSA

- Land cover
  - Cultivated area
  - Forest cover
- Population
- Potential yields
- Accessibility
- Prices
Defining “available” land

1. **Criteria for determining expansion envelope:**
   - Unpopulated, uncultivated, non-forest, non-PA

2. **Criteria for determining economic viability:**
   - For each grid cell: economic returns to expansion calculated for 9 crops (rainfed, low & med. inputs)
   - Returns calculated for gross margins from most profitable crop mix in a particular grid cell

\[
\text{yield (MT/ha)} \times \text{output price ($/MT)} - \text{variable production costs ($/ha)}
\]
Potential yields

• GAEZ database: estimates of agroclimatically attainable yield
  – Distill large amts of biophysical production info
  – Crop-specific
  – Allows different levels of inputs & types of water mgt

• Rainfed production: low & medium inputs
  – Estimates are (much) higher than observed, so we define scaling factors for attainable % of pot. yields
    • Low inputs: obtain 40% of potential yields
Output prices

• Transfer costs imply spatial prices

\[ P_{i, farmgate} = P_{j, market} \cdot e^{-d_{ij}/\max(d_{ij})} \]

• Output prices decline with remoteness
• Start with wholesale prices in urban markets
• Distance decay function
Output prices

WB Pink Data
• Maize
• Sorghum
• Rice
• Barley
• Wheat
• Banana
• Coffee
• Cotton
• Soybean
# Cost of production

Based on Zambia household data

<table>
<thead>
<tr>
<th>Costs (USD/ha)</th>
<th>Low inputs</th>
<th>Medium inputs</th>
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</thead>
<tbody>
<tr>
<td>Family labor</td>
<td>368</td>
<td>362</td>
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<tr>
<td>Hired labor</td>
<td>16</td>
<td>36</td>
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<tr>
<td>Animal traction</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>0</td>
<td>94</td>
</tr>
<tr>
<td>Herbicides</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Seed</td>
<td>0</td>
<td>64</td>
</tr>
<tr>
<td><strong>Total variable costs</strong></td>
<td><strong>397</strong></td>
<td><strong>576</strong></td>
</tr>
</tbody>
</table>

![Graph showing cost of production](chart.png)

- **Graph**: Comparison of variable costs for low-level and medium-level inputs over hours to market.
Baseline
Replicate DB/FS estimates:
• suitable
• unforested
• not protected
• low density

Refined economic criteria
1. Gross margins > 0, assuming agroclimatically attainable yield
2. Gross margins > 0, realistically attainable yield
3. Gross margins > 250, realistically attainable yield
4. Gross margins > 500, realistically attainable yield

Alternative data sources
• Currently cultivated land
• Forest cover
• Population distributions
<table>
<thead>
<tr>
<th></th>
<th>baseline</th>
<th>v1</th>
<th>v2</th>
<th>v3</th>
<th>v4</th>
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<td>Angola</td>
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<td>DRC</td>
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<td>26,700</td>
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<td>22,800</td>
<td>900</td>
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<td>Congo, Rep.</td>
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<td>14,200</td>
<td>14,200</td>
<td>12,500</td>
<td>220</td>
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<td>Ethiopia</td>
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<td>Gabon</td>
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<td>Kenya</td>
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<td>Madagascar</td>
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<td>19,200</td>
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<td>Mozambique</td>
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<td>4,656</td>
<td>190</td>
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<td>East/Central</td>
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<td>37,889</td>
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<td>Southern</td>
<td>55,239</td>
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<td>10,315</td>
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<td>6,456</td>
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<td>200,343</td>
<td>96,474</td>
<td>96,474</td>
<td>54,660</td>
<td>3,868</td>
</tr>
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Imposing economic criteria & more realistic attainable yields leads to declines >90% in area estimates!
More recent land cover data indicates greater % of land already under cultivation

Cultivated area data from GAEZ

Cultivated area data from GlobCover

~20% reduction in estimates of surplus land
Sensitivity of estimates

Assumptions about attainable yields are important (particularly in Eastern/Central)

low-input management

medium-input management
Conclusions

• Earlier estimates appear very optimistic
  – Sensitive to input data
  – Sensitive to assumptions about prices & costs

• With few, very conservative additional assumptions about economic feasibility, the estimate of suitable surplus land declines by up to 90%
  – Note that we are almost certainly underestimating true costs of expansion
Meanwhile, back on the farm...

• Evidence that continuously cultivated lands in high-density rural areas are experiencing a reduction in responsiveness to standard intensification recipes (Dreschel et al. 2001)

• Reduced fallow → soil organic carbon losses → reduced responsiveness to inorganic fertilizer

• Soil rehabilitation in severely mined areas is expensive and lengthy

• Upshot: bringing new land may be cheaper than intensification as a development pathway – but with potentially major global environmental costs
Fertilizer response rates in degraded areas

Estimated marginal value product of nitrogen fertilizer conditional on plot soil carbon content

Ksh/kg N

Source: Marenya & Barrett 2009
Policy implications

• Reducing barriers to economic exploitation of remote [waterlogged, disease-prone, etc.] land may enable spontaneous re-settlement
  – E.g. white gold of Gokwe, Zimbabwe

• Under conditions of land constraints, the political process of land allocation will influence whether smallholder agriculture has a future

• The limited scope for extensification, absorption by non-farm sector, and sustainable intensification → suggests the importance of keeping the rural-rural pathway available