Comparative Evidence on Yield Growth and Input Use in East African Agriculture

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1. Background and Motivation

- Agriculture is a large sector throughout East Africa, both in terms of employment and output.
- Crop yield growth may have significant impacts on aggregate well-being and specifically on poverty reduction.
- Important to understand recent trends in yield and to make sense, where possible, of the differential experiences of East African countries.
- This presentation focuses on the Ethiopia findings of the study.
Ethiopia’s rapid growth in agricultural production
Enormous success or statistical anomaly?

- Within East Africa, Ethiopia stands out for an astonishing rate of growth in crop production.
- Reported *average annual growth rates* for the decade 1999-2008:

<table>
<thead>
<tr>
<th>Crop</th>
<th>2008 Production (million mt)</th>
<th>Yield Growth, 1999-2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>2.463</td>
<td>9.8%</td>
</tr>
<tr>
<td>Maize</td>
<td>3.776</td>
<td>3.8%</td>
</tr>
<tr>
<td>Sorghum</td>
<td>2.316</td>
<td>7.7%</td>
</tr>
<tr>
<td>Millet</td>
<td>0.484</td>
<td>4.2%</td>
</tr>
<tr>
<td><strong>Total Cereals</strong></td>
<td><strong>6.577</strong></td>
<td><strong>5.1%</strong></td>
</tr>
</tbody>
</table>
Rapid production growth

- These growth rates imply massive increases in total cereal production.
- Total production of the four major cereals averaged 6.159 million mt in 2004-08, compared to 2.465 in 1991-95 – a 2.5-fold increase!
- Potentially vast implications for well-being.
Ethiopia’s production growth begs a number of questions:

- Are the data accurate?
- Did other East African countries experience similar growth?
- What are the sources of Ethiopia’s production growth?
  - Yield or area?
  - Inputs or TFP?
- Do we find evidence of consumer benefits?
- What lessons can we learn from Ethiopia’s record?
Previous studies have questioned whether yield measures in national data are accurate.

Questions about reported yield levels relative to measures in household survey data.

Questions about yield growth rates compared to other countries.

⇒ Are there simply problems with the data?
Outline

1. Background
2. Methodology and Approach
3. Production, Area, and Yield
4. Puzzles
5. Preliminary Conclusions
6. Further Questions
2. Methodology and Approach

- No new primary data.
- Review data on output, yield.
- Look at evidence on inputs.
- Consider data on trade, prices, etc.
- Interpret results.
- Identify specific targets for further data collection.
Comparisons

- Compare Ethiopia with Kenya, Uganda, and Tanzania – both in levels and growth rates.
- Compare Ethiopia’s experience in cereals with evidence from other crops and commodities.
- Compare recent period with longer time trends.
3. Production, Area, and Yield

- Production is rising rapidly in Ethiopia; how do these changes compare to other countries?
- First, consider cereals...
- Caveat: no data on teff!
Maize production, 1961-2008
Sorghum production, 1961-2008
Millet production, 1961-2008
Grain production in Ethiopia

- Ethiopia’s production of cereal grains is rising rapidly.
- Other countries are experiencing rapid production growth in other crops, but Ethiopia’s crop production is growing relative to the region’s total.
- The data suggest that Ethiopia’s total cereal production has risen from 25% of the region’s total in the early 1990s to over 40% in recent years.
- This *differential* success is striking.
- Is this coming at the expense of other crops?
- Consider root crops, beans, coffee and sugar
Potato production, 1961-2008
Bean production, 1961-2008

Million mt

Ethiopia  Kenya  Tanzania  Uganda  Four-Country Total
Coffee production, 1961-2008
Sugar production, 1961-2008

- Ethiopia
- Kenya
- Tanzania
- Uganda
- Total

Million mt.
Other crops in Ethiopia

- Production of almost all crops appears to be growing rapidly.
- With some exceptions, growth is faster than in other countries.
- Is this a Green Revolution?
- What are the sources of growth?
  - Area
  - Labor
  - Fertilizer
  - Irrigation
  - Other inputs
Growth in total area

- Area harvested is growing rapidly for most major crops.
  - Ethiopia’s growth in area harvested, 1993-2008

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area Growth</th>
<th>Crop</th>
<th>Area Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beans</td>
<td>7.69%</td>
<td>Sorghum</td>
<td>5.24%</td>
</tr>
<tr>
<td>Coffee</td>
<td>2.42%</td>
<td>Sugarcane</td>
<td>3.01%</td>
</tr>
<tr>
<td>Maize</td>
<td>2.57%</td>
<td>Sweet Potato</td>
<td>9.21%</td>
</tr>
<tr>
<td>Millet</td>
<td>3.66%</td>
<td>Wheat</td>
<td>5.84%</td>
</tr>
<tr>
<td>Potato</td>
<td>2.28%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- The total area harvested to these crops has increased at 4.2% annually for the past 15 years.
Making sense of area growth

- Is the area growth plausible?
- Where does the land come from?
- Area harvested from all crops appears to have risen by 35% in the decade between 1997-99 and 2008.
- This is very rapid growth, relative to historical experience elsewhere.
- Potential environmental implications?
- Double cropping?
Area growth explains a lot of the increases in production, but reported yield growth is also extremely rapid.

In the past decade, yield growth for all four grains averaged over 3 percent annually; yield growth in beans was almost 6 percent annually.

These rates are far higher than in the previous decade, and they are far in excess of the long-term trends.
## Yield growth in Ethiopian crop agriculture

<table>
<thead>
<tr>
<th>Period</th>
<th>Wheat</th>
<th>Maize</th>
<th>Sorghum</th>
<th>Millet</th>
<th>Beans</th>
<th>Coffee</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961-2008</td>
<td>0.019</td>
<td>0.016</td>
<td>0.013</td>
<td>0.018</td>
<td>0.000</td>
<td>0.033</td>
</tr>
<tr>
<td>1999-2008</td>
<td>0.048</td>
<td>0.035</td>
<td>0.032</td>
<td>0.040</td>
<td>0.058</td>
<td>-0.031</td>
</tr>
<tr>
<td>1989-2008</td>
<td>0.013</td>
<td>0.021</td>
<td>0.008</td>
<td>0.017</td>
<td>0.009</td>
<td>0.002</td>
</tr>
<tr>
<td>1989-1998</td>
<td>-0.002</td>
<td>0.007</td>
<td>-0.010</td>
<td>-0.012</td>
<td>0.009</td>
<td>0.002</td>
</tr>
<tr>
<td>1979-1988</td>
<td>0.013</td>
<td>-0.004</td>
<td>-0.050</td>
<td>0.003</td>
<td>-0.079</td>
<td>0.047</td>
</tr>
<tr>
<td>1961-1988</td>
<td>0.021</td>
<td>0.024</td>
<td>0.020</td>
<td>0.033</td>
<td>0.002</td>
<td>0.035</td>
</tr>
<tr>
<td>1961-1978</td>
<td>0.020</td>
<td>0.021</td>
<td>0.016</td>
<td>0.039</td>
<td>0.000</td>
<td>0.026</td>
</tr>
</tbody>
</table>
4. Puzzles

- These data pose some puzzles.
  - Why has yield growth increased, even at the same moment that area growth is rising?
  - In a Ricardian world, we would expect the “new” area to be less productive than those areas that were farmed previously.

- Are the Ricardian effects being offset by increased use of inputs?
  - This would be expected, for example, in a world in which agricultural prices are rising.
  - In that case, production would respond on both the extensive and intensive margin.
  - How much has input use increased?
Labor use

- Data on labor use in agriculture are poor; no good measures of hours worked at the national level. No data on hours worked by crop.
- FAO reports data on “economically active population in agriculture”.
- This measure has grown for the past 15 years at about 3.1% annually.
However, there has been much smaller growth in labor per unit of land: 1.0% annually.

Increased labor intensity should bring some increase in yield, but this is not quantitatively sufficient to explain the increases that Ethiopia has observed.

The measure has also declined in recent years.
Labor use per unit of land

Economically Active Population in Agriculture Per Hectare of Agricultural Land Areas in Ethiopia

- Population per Hectare of Arable Land
- Population per Hectare of Arable + Permanent Cropland

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East African Yield Study
Irrigation use

- Irrigated area is very small relative to total crop area.
- Irrigation has apparently increased slightly, but the changes are quantitatively so small that this cannot explain the observed yield increases.
Fertilizer consumption in Ethiopia actually fell in the years following 1998. It has risen in the most recent years, but the level of fertilizer per hectare of arable land remains lower than before. Moreover, levels of fertilizer use remain extraordinarily low. This is not enough to explain the yield trends.
Fertilizer use per ha

Fertilizer Consumption Per Total Cropland (Arable + Permanent) Area by Country

- Ethiopia
- Kenya
- Tanzania
- Uganda

Fertilizer Consumption (tonnes of nutrients/1000 Ha)

Year


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Agricultural price data are difficult to interpret. Prices of different commodities track together.

Rising prices could induce expansion in area simultaneously with expansion in yields – increased production on both the extensive and intensive margins.

But the production increases precede the large price increases of the past several years.

There does not seem to be a close relationship between reported prices and reported production or input use.
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5. Preliminary conclusions

- It is difficult to find a coherent story that is consistent with the data.
- An increase in prices – due to rising demand, improved policies, or better infrastructure, for example – might induce the kinds of responses in area and yield that are reported.
  - But typically the aggregate elasticity of supply in agriculture is low.
  - And there is no evidence for increases in input use sufficient to generate observed changes in area and yield.
An increase in TFP – a new Green Revolution – might also lead to increases in both area and yield.

- But this would typically favor some specific crops at the expense of others.
- And this kind of supply increase would lead to declining prices or increased exports.
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- Are the data in fact reliable?
- Sampling issues are complicated, because patterns of population and production change over time.
- With urban growth, area sampling frameworks can easily overweight intensive production that is close to cities.
- Many other possibilities for sampling error and misreporting.
Does it matter?

- Very important not to make policy decisions based on misunderstanding of agricultural output levels and trends.
- Can lead to complacency about agricultural sector.
- Can lead to dangerous policy decisions; e.g., if grain is thought to be abundant, then governments might encourage using it for animal feed – to the detriment of the poor.
- Crucially important to reconcile the agricultural statistics with information coming from other sources.
Gathering fodder