Factors Contributing to Zambia’s 2010 Maize Bumper Harvest

by

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ACF/FSRP Research Presented to the Economics Association of Zambia
Pamodzi Hotel, Lusaka
23 September, 2010

Introduction

• Zambian maize production increased by roughly 48% from the 2009 to the 2010 harvests.

• Increases occurred in both the small-scale and commercial farm sectors
Where did the growth in maize production come from?
Objectives

I. Understand the key sources of maize production growth from 2009 to 2010 (yield, minimization of crop loss/abandonment and area expansion)

II. Determine which factors have driven changes in these sources and determine their relative importance (e.g. fertilizer, weather, seed use and others).

III. What can Zambia learn from the 2009/10 bumper harvest.

Data

• Data used comes from the 2005/06, 2006/07, 2007/08, 2008/09 and 2009/10 Crop Forecast Surveys

• Collected annually by the Ministry of Agriculture and Cooperatives (MACO) in collaboration with the Central statistical Office
Contributions to Growth

\[ \Delta \text{ Production} = \Delta \text{ Yield} + \Delta \text{ Ratio of harvested to planted area} + \Delta \text{ Area planted} \]

**Mathematically**

\[ \text{prod} = y \cdot \text{ah} = y \cdot \frac{ah}{ap} \]

Based on the total derivative:

\[ \frac{\Delta \text{prod}}{\Delta \text{prod}} = \frac{\Delta y \left( \frac{ah}{ap} \cdot ap \right)}{\Delta \text{prod}} + \frac{\Delta \frac{ah}{ap} \left( y \cdot ap \right)}{\Delta \text{prod}} + \frac{\Delta \left( y \cdot \frac{ah}{ap} \right)}{\Delta \text{prod}} \]

**Definitions**

- \( \text{prod} = \text{production} \)
- \( y = \text{yield} \)
- \( \text{ah} = \text{area harvested} \)
- \( \text{ap} = \text{area planted} \)
- \( \Delta = \text{change} \)

Contributions Within Each Province to Production Growth

<table>
<thead>
<tr>
<th>Province</th>
<th>% relative contribution to production growth between 2009-2010 harvests from changes in</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield</td>
</tr>
<tr>
<td>Central</td>
<td>45</td>
</tr>
<tr>
<td>Copperbelt</td>
<td>47</td>
</tr>
<tr>
<td>Eastern</td>
<td>102</td>
</tr>
<tr>
<td>Luapula</td>
<td>59</td>
</tr>
<tr>
<td>Lusaka</td>
<td>51</td>
</tr>
<tr>
<td>Northern</td>
<td>39</td>
</tr>
<tr>
<td>Northwestern</td>
<td>56</td>
</tr>
<tr>
<td>Southern</td>
<td>45</td>
</tr>
<tr>
<td>Western</td>
<td>47</td>
</tr>
<tr>
<td>All Zambia</td>
<td>59</td>
</tr>
</tbody>
</table>

Source: Central Statistics Office Crop Forecast Survey 2008/09, 2009/10
Note: Rows sum to 100
Total area planted by small/medium-scale Agricultural households, 2005/06-2009/10

Percent of maize area planted to be harvested, 2000/01-2009/10
National Maize Yield for small/medium-scale Agricultural households, 2005/06-2009/10

Changes in Yield by Farm Size Category

[Diagram showing changes in maize yield by farm size category, with percentage increases for Cat A (+33.3%), Cat B (+30.8%), and Cat C (+34.6%) from 2009 to 2010.]
## Yield Regression Analysis

Using CFS data from 2006-10

<table>
<thead>
<tr>
<th>Management:</th>
<th>Weather:</th>
<th>Interactions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal Dressing</td>
<td>Rainfall</td>
<td>The model allows the yield response rate to fertilizer to be conditional on all other explanatory variables.</td>
</tr>
<tr>
<td>Top Dressing</td>
<td>Rainfall stress</td>
<td></td>
</tr>
<tr>
<td>Seed type</td>
<td>AEZ</td>
<td></td>
</tr>
<tr>
<td>Nitrogen fixer intercrop</td>
<td>Year dummies</td>
<td></td>
</tr>
<tr>
<td>Other intercrop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tillage type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tillage timing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field size</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Post-estimation Simulations

Changes that drove yield increase

<table>
<thead>
<tr>
<th>Simulations changing specific factors from their 2009 to 2010 values. 2010 values used are:</th>
<th>Yield Prediction (kg/ha)</th>
<th>% change vs. 2009</th>
<th>Contribution to total change</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) None (2009 prediction)</td>
<td>2,079</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ii) All (2010 prediction)</td>
<td>2,522</td>
<td>21.3%</td>
<td>100%</td>
</tr>
<tr>
<td>iii) Weather</td>
<td>2,346</td>
<td>12.9%</td>
<td>61%</td>
</tr>
<tr>
<td>iv) Fertilizer</td>
<td>2,219</td>
<td>6.7%</td>
<td>32%</td>
</tr>
<tr>
<td>v) Purchased hybrid seed use</td>
<td>2,099</td>
<td>1.0%</td>
<td>5%</td>
</tr>
<tr>
<td>vi) Weather and fertilizer</td>
<td>2,493</td>
<td>19.9%</td>
<td>94%</td>
</tr>
<tr>
<td>vii) Weather, fertilizer and seed use</td>
<td>2,514</td>
<td>20.9%</td>
<td>98%</td>
</tr>
</tbody>
</table>
Yield Regression Analysis

• Yield increase from 2009 to 2010 was greater than 21%
• If only fertilizer (FISP and private sector) changes, increase is 6.7%
• If only weather changes, increase is 12.9%
• The majority of the increase in yield can be attributed to fertilizer and weather.
• Moderate increase in improved seed use also contributed.

Comparing the 2010 harvest to earlier years
Yield Response to Fertilizer use over time

Yield response to fertilizer (maize kg / fertilizer kg) over years 2006 to 2010. The graph shows two lines: one for the actual estimate and another for the estimate without weather changes. The actual estimate shows a steady increase in yield response over the years, while the estimate without weather changes remains relatively flat.

Conservation Farming

- Highly effective
- Not enough change in adoption to affect change in national production
  - CFS data not designed to sufficiently capture the relatively few households practicing CF on maize production.
  - Initial estimates indicate minimal contribution of CF to the growth in national production.
Conclusions

The difference in Zambian maize harvest from 2009 to 2010 (831,934 mt) can be attributed to:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Unusually favorable weather</td>
<td>47%</td>
</tr>
<tr>
<td>(390,759 mt)</td>
<td></td>
</tr>
<tr>
<td>Increased fertilizer use</td>
<td>25%</td>
</tr>
<tr>
<td>(204,989 mt)</td>
<td></td>
</tr>
<tr>
<td>Area Expansion</td>
<td>23%</td>
</tr>
<tr>
<td>(191,345 mt)</td>
<td></td>
</tr>
<tr>
<td>Increased use of hybrid maize seed</td>
<td>4%</td>
</tr>
<tr>
<td>(32,029 mt)</td>
<td></td>
</tr>
<tr>
<td>Improved management</td>
<td>2%</td>
</tr>
<tr>
<td>(12,812 mt)</td>
<td></td>
</tr>
</tbody>
</table>

What can we learn?

- Though Zambia had a good harvest in 2010, the country remains vulnerable to shifts in weather conditions.
- Under good conditions Zambia can produce a substantial surplus but without a stable maize marketing policy, the development of a vibrant local and export market will continue to be hampered.
What can we learn?

- When trading maize, marketing issues are international, so we can not make policies in a vacuum.
  - We can not set the world price.
  - If world price is below “cost of production,” is this an appropriate method for setting FRA prices and can we afford to use it?
  - Don’t we risk subsidizing other countries who can cross the border to sell to FRA?
- So – how do we provide sustainable incentives to farmers to continue producing maize surpluses?

Acknowledgements

- The authors are grateful for useful comments and assistance from many colleagues, including:
  - Dingi Banda, Michael Isimwaa, Nicolas Mwale, Derrick Sikombe, Nicole Mason, Margaret Beaver, Munguzwe Hichaambwa, Michael Weber, and Steve Longabaugh.
Thank you

Bonus Slides
In 9 districts, 2009/10 expected total S/M maize production more than double 2008/09 level

**Ratio of Harvested to Planted Area in 9 districts**

- Chibombo (Central): +130.4%
- Serenje (Central): +132.9%
- Chingola (Copperbelt): +171.7%
- Masaiti (Copperbelt): +107.0%
- Kafue (Lusaka): +129.5%
- Iteshi-tezhi (Southern): +117.4%
- Kazungula (Southern): +194.6%
- Namwala (Southern): +152.1%
- Senanga (Western): +183.1%

- 2009
- 2010
**Total area planted to maize for 9 districts**

- **Chibombo** (Central): +22.4%
- **Serenje** (Central): +65.4%
- **Chingola** (Copperbelt): +150.3%
- **Masaiti** (Copperbelt): +41.6%
- **Kafue** (Lusaka): +18.3%
- **Iteshi Tezhi** (Southern): -0.5%
- **Kazungula** (Southern): +21.6%
- **Namwala** (Southern): +5.6%
- **Senanga** (Southern): -1.2%

**Yield (kg/ha) changes for 9 Districts**

- **Chibombo** (Central): +61.1%
- **Serenje** (Central): +31.8%
- **Chingola** (Copperbelt): -1.6%
- **Masaiti** (Copperbelt): +42.0%
- **Kafue** (Lusaka): +73.7%
- **Iteshi Tezhi** (Southern): +98.3%
- **Kazungula** (Southern): +75.0%
- **Namwala** (Southern): +77.7%
- **Senanga** (Southern): +72.8%
Increase in 2009/10 maize output due to expected increase in maize price:

<table>
<thead>
<tr>
<th></th>
<th>Price expectation based on prior year price (May-Oct):</th>
<th>%(\Delta) Qmz / %(\Delta) Pmz</th>
<th>Incremental maize output due to change in expected mz price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008/09</td>
<td>943 / 1100 kw/kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009/10</td>
<td>1205 / 1300 kw/kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>difference</td>
<td>+28% / +18%</td>
<td>+0.3</td>
<td>83,000 to 232,000 mt</td>
</tr>
</tbody>
</table>

• Therefore, roughly 83,000 to 232,000 of the 831,934 tons of incremental maize production (10% to 28%) can be attributed to expectation of increased maize price in 2009/10 compared to 2008/09.

• This is consistent with the calculated contribution from area expansion (23%).