A Regional Assessment of Agricultural Production, Climate Change, Agricultural Trade and Food Security

Nancy M. Laibuni,
Agriculture in the EAC

- Contributes over 30% GDP
- 60% of employment
- Foreign exchange earnings
- 80% of the total population lives - rural areas
- 75% involved in agriculture

**EAC maize production, imports, exports and consumption**

- Yield gap
- Food and nutrition insecurity – hidden hunger
- Poverty
- Population
Agricultural Trade in the EAC

- Total Agricultural Trade
- Total EAC Trade

Before Customs
After Customs Union

- Agriculture trade / Total Trade (%)
- Agric. Trade Growth rate (%)
Objectives

1. Explore the spatial effects of climate change on agricultural production and food security in the East African Community region, examining current medium as well as long-term effects.

2. Explore the Implications on regional agricultural policy across political boundaries, within and across national boundaries.

3. Examine the potential trade effects of climate change on food security in the EAC region.
Methods

1. Spatial and temporal effects of climate change
   - Downscaled CORDEX models
   - Historical-1971 to 2000, Scenarios 2016 to 2045 as mid century and 2071 to 2100 as end century
   - Projections use Representative Concentration Pathways (RCPs) scenario 4.5wm² and 8.5wm²

1.1 Spatial effects of climate change on agricultural production
   APSIM Crop model in simulating crop production in EAC
Methods

2. Explore the Implications on regional agricultural policy across political boundaries, within and across national boundaries
   - Supply response models for different crops with and without CC
   - Partial Equilibrium Model: Maximize Consumer and Producer Welfare
     - With CC
     - With CC and Policy change

3. Examine the potential trade effects of climate change on food security in the EAC region

CGE models
   - The base scenario - no climate change
   - Scenario 1: where there are productivity changes due to temperature changes accompanied by an intra EAC export/import ban.
   - Scenario 2: where there are productivity changes due to rainfall changes accompanied by an intra EAC export/import ban.
Spatial Analysis of Baseline Climate

Annual precipitation over EAC (1971-2000)

a) CCCma
b) CNRM
c) ICHEC
d) MIROC
e) MOHC
f) MPI
g) NCC
h) NOAA
i) Ensemble CORDEX RCMs
Spatial Analysis of Baseline Climate

Annual Maximum Temperature over EAC

a) CCCma  
b) CNRM  
c) ICHEC  
d) MIROC  
e) MOHC  
f) MPI  
g) NCC  
h) NOAA  
i) Ensemble CORDEX RCMs
Spatial Analysis of Baseline Climate

DJF Maximum Temperature over EAC

a) CCCma
b) CNRM
c) ICHEC
d) MIROC
e) MOHC
f) MPI
g) NCC
h) NOAA
i) Ensemble CORDEX RCMs
Spatial Analysis of Baseline Climate

Annual Minimum Temperature over EAC

a) CCCma  
b) CNRM  
c) ICHEC  
d) MIROC  
e) MOHC  
f) MPI  
g) NCC  
h) NOAA  
i) Ensemble CORDEX RCMs
Spatial Analysis of Baseline Climate

DJF Minimum Temperature over EAC

a) CCCma
b) CNRM
c) ICHEC
d) MIROC
e) MOHC
f) MPI
g) NCC
h) NOAA
i) Ensemble CORDEX RCMs
Spatial Analysis of Projected Precipitation
Spatial Analysis of Projected Max. Temperature

Spatial Analysis of Maximum Temperature during a) DJF b) MAM c) JJA d) OND seasons and e) Annual based on RCP 4.5 scenario (2016 -2044)

Spatial Analysis of Maximum Temperature during a) DJF b) MAM c) JJA d) OND seasons and e) Annual based on RCP 4.5 scenario (2071 -2100)

Spatial Analysis of Maximum Temperature during a) DJF b) MAM c) JJA d) OND seasons and e) Annual based on RCP 8.5 scenario (2016 -2045)

Spatial Analysis of Maximum Temperature during a) DJF b) MAM c) JJA d) OND seasons and e) Annual based on RCP 8.5 scenario (2071 -2100)
Spatial Analysis of Projected Min. Temperature
## Supply response elasticities for different crops in EAC

<table>
<thead>
<tr>
<th>Crop</th>
<th>Kenya</th>
<th>Rwanda</th>
<th>Burundi</th>
<th>Tanzania</th>
<th>Uganda</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SR</td>
<td>LR</td>
<td>SR</td>
<td>LR</td>
<td>SR</td>
</tr>
<tr>
<td>Maize</td>
<td>0.54</td>
<td>0.73</td>
<td>0.061</td>
<td>1.97</td>
<td>0.16</td>
</tr>
<tr>
<td>Beans</td>
<td>0.20</td>
<td>0.81</td>
<td>0.16</td>
<td>0.63</td>
<td>0.19</td>
</tr>
<tr>
<td>Rice</td>
<td>0.097</td>
<td>0.21</td>
<td>0.09</td>
<td>0.13</td>
<td>0.7</td>
</tr>
<tr>
<td>Sorghum</td>
<td>0.68</td>
<td>1.04</td>
<td>0.13</td>
<td>0.34</td>
<td>0.11</td>
</tr>
<tr>
<td>Millet</td>
<td>0.79</td>
<td>1.26</td>
<td>0.57</td>
<td>1.65</td>
<td>0.01</td>
</tr>
<tr>
<td>Wheat</td>
<td>0.197</td>
<td>0.21</td>
<td>0.59</td>
<td>2.31</td>
<td>0.81</td>
</tr>
</tbody>
</table>

NB: Due to lack of price data, the supply response estimates for Tanzania were estimated from literature.
## Own Price elasticities of demand in EAC

<table>
<thead>
<tr>
<th>Crop</th>
<th>EAC Partner States</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Burundi</td>
</tr>
<tr>
<td>Sorghum</td>
<td>-0.29</td>
</tr>
<tr>
<td>Wheat</td>
<td>-1.72</td>
</tr>
<tr>
<td>Millet</td>
<td>-1.50</td>
</tr>
<tr>
<td>Maize</td>
<td>-0.22</td>
</tr>
<tr>
<td>Rice</td>
<td>-1.27</td>
</tr>
</tbody>
</table>
### Income elasticities of demand in EAC

<table>
<thead>
<tr>
<th>Crop</th>
<th>Burundi</th>
<th>Kenya</th>
<th>Rwanda</th>
<th>Uganda</th>
<th>Tanzania</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>0.99</td>
<td>1.37</td>
<td>0.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>2.71</td>
<td>1.00</td>
<td>1.56</td>
<td></td>
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</tr>
<tr>
<td>Millet</td>
<td>0.03</td>
<td>0.11</td>
<td>0.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>1.14</td>
<td>1.08</td>
<td>1.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td>1.71</td>
<td>0.76</td>
<td>1.11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Policy Simulations

### Expenditure and CV in EAC with price change (MT)

<table>
<thead>
<tr>
<th></th>
<th>EAC Partner States</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Burundi</td>
</tr>
<tr>
<td><strong>Current Expenditure</strong></td>
<td>3043.25</td>
</tr>
<tr>
<td><strong>Expenditure price increases</strong></td>
<td>7212.49</td>
</tr>
<tr>
<td><strong>Compensating Variation (CV)</strong></td>
<td>4169.25</td>
</tr>
</tbody>
</table>
## Base and Future Production with climate change (MT)

<table>
<thead>
<tr>
<th>Period</th>
<th>Crop</th>
<th>EAC Partner States</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Burundi</td>
</tr>
<tr>
<td><strong>Base (2001-2010)</strong></td>
<td>Maize</td>
<td>126,194</td>
</tr>
<tr>
<td><strong>Future (2015-2045)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>without climate change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Future (2015-2045)</td>
<td></td>
<td>154,591</td>
</tr>
<tr>
<td>with climate change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Future (2015-2045)</td>
<td></td>
<td>139,132</td>
</tr>
</tbody>
</table>
## Price change due to climate change

<table>
<thead>
<tr>
<th>Variable</th>
<th>EAC Partner States</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Burundi</td>
</tr>
<tr>
<td>Base production</td>
<td>12,938</td>
</tr>
<tr>
<td>Future production with climate change</td>
<td>126,194</td>
</tr>
<tr>
<td>Producer price (US$/Ton)</td>
<td>0.1830</td>
</tr>
<tr>
<td>Supply Elasticity</td>
<td>0.25</td>
</tr>
<tr>
<td>Percent Price Change</td>
<td>7.50</td>
</tr>
</tbody>
</table>
### Expenditure and CV in EAC with climate change

<table>
<thead>
<tr>
<th>Crop</th>
<th>EAC Partner States</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Burundi</td>
<td>Kenya</td>
<td>Rwanda</td>
<td></td>
</tr>
<tr>
<td>Current Expenditure (/MT)</td>
<td>3043.25</td>
<td>953.75</td>
<td>2312.88</td>
<td></td>
</tr>
<tr>
<td>Expenditure with climate change (/MT)</td>
<td>6208.22</td>
<td>2050.56</td>
<td>4926.43</td>
<td></td>
</tr>
<tr>
<td>Compensating variation</td>
<td>3164.97</td>
<td>1096.82</td>
<td>2613.55</td>
<td></td>
</tr>
</tbody>
</table>
Summary

- The rainfall pattern over eastern Africa is highly variable both in space and time.
- Precipitation has decreased over EAC between March and May.
- Projected precipitation increased especially during OND and MAM seasons.
- Temperature fields are well represented by the all the CORDEX RCMs and the ensemble.
Summary

Climate change: **Maize**

**Kenya**
- maize prices by 23%
- expenditure to increase to Ksh. 2051.
- Compensation Variation Ksh. 1097 -115%.

**Burundi,**
- the current expenditure is BFr. 3043 increase to BFr. 6208
- Compensating variation of 3165, increment of 104%

**Rwanda,**
- increase expenditure to RFr. 4926 from the current RFr. 2313.
- Compensating variation of RFr. 2614, an increase of 113%
Conclusions

- The yields gaps in the region are wide – room for productivity gains.
- Trade policies in the region should not impede smooth flow of imports and exports in the region.
- Agricultural policies in individual countries influence – the practice of agriculture and input use
- Climate change is a global phenomenon, potential effects are not expected to be uniform; they are unevenly distributed, both between and within countries.