Impacts of climate variability and change on agricultural systems in Eastern Africa


Regional Team Presentation
4 Nov, 2013
Climate change will affect agriculture
- Higher global temperatures, more precipitation and increased extreme events
- More likely negative effects: where and which crops?
- Climate change effects vary across the landscape, location specific analysis help in understanding the possible impacts of climate change

Adaptation: Agriculture needs
- New drought and heat resistant varieties, changes in crop management practices
- Developing infrastructure for water storage and management in water limited areas
Objectives

- Understanding the potential impacts of climate change in Eastern Africa (Ethiopia, Kenya, Tanzania and Uganda)
- Developing strategic adaptation measures to combat adverse impacts of climate change
### Overview of the study area

<table>
<thead>
<tr>
<th></th>
<th>Ethiopia</th>
<th>Kenya</th>
<th>Tanzania</th>
<th>Uganda</th>
<th>All</th>
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<tbody>
<tr>
<td><strong>Target areas</strong></td>
<td>Adama and Adugodem</td>
<td>Embu</td>
<td>Dodoma</td>
<td>Hoima</td>
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<tr>
<td><strong>Agro-ecologies</strong></td>
<td>3+3</td>
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<td>2</td>
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<td>15</td>
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<td><strong>Climate stations</strong></td>
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<td>3</td>
<td>2</td>
<td>15</td>
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<tr>
<td><strong>Climate change scenarios</strong></td>
<td>20 GCMs * 2 RCPs * 2 time steps</td>
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<tr>
<td><strong>Crop and varieties</strong></td>
<td>Maize – 3 Wheat - 2</td>
<td>Maize - 4</td>
<td>Maize - 3</td>
<td>Maize-3</td>
<td>15</td>
</tr>
<tr>
<td><strong>Soil profiles</strong></td>
<td>3+3</td>
<td>4*3</td>
<td>3*3</td>
<td>3*3</td>
<td>36</td>
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<tr>
<td><strong>Farmers</strong></td>
<td>305+405</td>
<td>440</td>
<td>105</td>
<td>307</td>
<td>1562</td>
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<td><strong>Management</strong></td>
<td>Planting time+variety+plant population+fertilizer+manure</td>
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<tr>
<td><strong>Models</strong></td>
<td>APSIM and DSSAT</td>
<td></td>
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</tbody>
</table>
Map of Project Coverage

- Embu County in Kenya
- Adama County in Ethiopia
- Hoima District in Uganda
- Tanzania
### Kenya assessment

#### LM 5: Lower Midland Livestock-Millet Zone
- **Altitude:** 830–1130
- **Temperature:** 23.9–21.1
- **Rainfall:** 700–800

#### LM 4: Marginal Cotton Zone
- **Altitude:** 980–1220
- **Temperature:** 22.2–21.0
- **Rainfall:** 800–900

#### UM 3: Marginal Coffee Zone
- **Altitude:** 1280–1460
- **Temperature:** 20.7–19.6
- **Rainfall:** 1000–1250

#### UM 2: Main Coffee Zone
- **Altitude:** 1400–1600
- **Temperature:** 20.1–18.9
- **Rainfall:** 1250–1500

#### LM 3: Cotton Zone
- **Altitude:** 1070–1280
- **Temperature:** 22.0–21.0
- **Rainfall:** 900–1100

#### UM 1: Main Livestock-Millet Zone
- **Altitude:** 830–1130
- **Temperature:** 23.9–21.1
- **Rainfall:** 700–800
Soil profiles

Embu
Depth: 200 cm
PAWC: 132, 106, 79
OC (top layer): 2.09, 1.35, 0.65

Gachoka
Depth: 200 cm
PAWC: 100, 87, 77
OC (top layer): 2.29, 1.54, 0.85

Kavutiri
Depth: 200 cm
PAWC: 152, 122, 99
OC (top layer): 3.61, 2.5, 1.2

Machanga
Depth: 120 cm
PAWC: 110, 94, 80
OC (top layer): 0.75, 0.64, 0.51

Data source: Fertilizer use recommendation project (phase 1). Final report Annex III Vol 24 Embu district, June 1987
Crop seasons in EMBU county
1. SR: Short Range
2. LR: Long Range
Crop Modeling - Cultivar calibration

- Calibration done with 3 seasons data (SR 2000, LR 2001, and SR 2001)
- Data on dates of sowing, days to tasseling, days to flowering, days to maturity and grain and dry matter yields was used in the calibration
- Data on biomass at different periods was also available but not used due to errors in the data
- For Katumani variety default parameters available with APSIM fitted well
- In case of H511 and H513, parameters were derived by manipulating the thermal time required to complete various growth stages until the simulated phenology matched the observed phenology
Simulated yields captured fairly well the observed variability in farmer yields across the five agro-ecologies.
Projected changes in maximum temperatures

Climate Change – Maximum Temperature

[Graph showing projected changes in maximum temperatures]
Projected changes in minimum temperatures

<table>
<thead>
<tr>
<th></th>
<th>Annual</th>
<th>SR</th>
<th>LR</th>
<th>Annual</th>
<th>SR</th>
<th>LR</th>
<th>Annual</th>
<th>SR</th>
<th>LR</th>
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<th>SR</th>
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<tr>
<td>4.5 MID</td>
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<td></td>
<td></td>
<td>4.5 END</td>
<td></td>
<td></td>
<td>8.5 MID</td>
<td></td>
<td></td>
<td>8.5 END</td>
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</table>

Minimum Temperature (°C)
Climate Change - Precipitation

Projected changes in rainfall (mm)
Projected changes in rainfall (percent deviation from historic rainfall) and temperatures (absolute change) over Embu County, Kenya.
In general, grain yields are increasing across all climate change scenarios except in double CO2.

Adapted technology yields are further increasing as compared with non-adapted climate change simulations.
Crop growth duration is decreasing with increase in surface temperatures, for every degree rise in atmospheric temperatures crop duration is decreasing by 5 days.
<table>
<thead>
<tr>
<th>AEZ</th>
<th>Planting Time LR</th>
<th>Plant pop. LR</th>
<th>Variety LR</th>
<th>Fertilizer LR</th>
<th>Planting Time SR</th>
<th>Variety SR</th>
<th>Plant Pop. SR</th>
<th>Fertilizer SR</th>
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<tr>
<td>LM3</td>
<td>15-30 Mar</td>
<td>50</td>
<td>H513</td>
<td>60</td>
<td>1-15 Oct</td>
<td>Deka_lb</td>
<td>50</td>
<td>80</td>
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<tr>
<td>LM4</td>
<td>15-30 Mar</td>
<td>50</td>
<td>Deka_lb</td>
<td>60</td>
<td>15-30 Oct</td>
<td>H511</td>
<td>50</td>
<td>70</td>
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<tr>
<td>LM5</td>
<td>15-30 Mar</td>
<td>50</td>
<td>H511</td>
<td>60</td>
<td>1-15 Nov</td>
<td>Deka_lb</td>
<td>40</td>
<td>60</td>
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<tr>
<td>UM2</td>
<td>15-30 Mar</td>
<td>50</td>
<td>H513</td>
<td>80</td>
<td>1-15 Nov</td>
<td>H511</td>
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<td>UM3</td>
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<td>1-15 Oct</td>
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<td>40</td>
<td>60</td>
</tr>
</tbody>
</table>
Conclusions

- Crop yields are increasing in climate change scenarios across all RCPs (4.5 and 8.5) and time periods (mid and end century)
- Projected changes in crop yields are higher in long range season as compared to short range due to increase in rainfall amounts. While, in the short range season changes in crop yields are marginally increasing due to marginal increase in rainfall amounts
- Local varieties (Katumani) is adversely effected due to climate change
- In adapted technology short duration varieties and local varieties are replaced with long duration varieties.
Thank you