Evaluating the impact of climate, soil and management on spatial variation of maize yield in Malawi

Lin Liu and Bruno Basso
Objectives

(1) To evaluate maize grain yield in 1980-2010 across Malawi under different management.

(2) To quantify the impact of biophysical factors (soil and weather) on spatial and temporal variability of maize yield.
Management simulation scenarios:
(a) continuous unfertilized maize
(b) maize-pigeonpea rotation
(c) continuous maize with pigeonpea residue incorporation
(d) continuous fertilized maize with 69 kgN/ha.
Simulation inputs

- **Cropland**
  ~29 000 cropland pixels extracted from global cropland product (Fritz et al., 2015)

- **Soil**
  1 km resolution soil maps developed by AfSIS

- **Weather**
  0.25° resolution daily weather in 1980-2010 from AgMERRA (Ruane et al., 2015)

- **Crop parameters**
  validated maize and pigeonpea crop parameters

- **Threshold approach for biophysical constraining factors**
  - Poor soil: <= 0.5% soil organic carbon
  - Unfavorable weather: < 800 mm or > 1300 mm rain
Median maize grain yield in 1980-2010 under different management

(a) Unfertilized maize
(b) maize-PP* rotation
(c) Maize with PP* residue incorporation
(d) Fertilized maize (69 kgN/ha)

*PP: pigeonpea
Biophysical factors constraining maize yield

- Poor soil: \( \leq 0.5\% \) soil organic carbon
- Unfavorable weather: \(< 800 \text{ mm} \) or \( > 1300 \text{ mm} \) rain

- Poor soil & unfavorable weather condition: 28.5%
- Poor soil: 70.8%
- Unfavorable weather condition: 0.2%
- Not constrained: 0.5%

*Poor soil: \( \leq 0.5\% \) soil organic carbon*
*Unfavorable weather: \(< 800 \text{ mm} \) or \( > 1300 \text{ mm} \) rain*
## Implications to Food Security

Estimated average maize grain yield (kg/ha) in 1980-2010, and production (million tonnes/yr) for different management strategies in a total cropland area of 2.912 million ha in Malawi

<table>
<thead>
<tr>
<th>Management</th>
<th>Average yield</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfertilized maize*</td>
<td>699.02</td>
<td>2035.55</td>
</tr>
<tr>
<td>Maize with pigeonpea residue incorporation*</td>
<td>1306.66</td>
<td>3804.99</td>
</tr>
<tr>
<td>Maize with 69 kgN/ha fertilizer added*</td>
<td>1631.06</td>
<td>4749.65</td>
</tr>
<tr>
<td>Fertilized maize with 69 kgN/ha fertilizer added*</td>
<td>3387.01</td>
<td>9862.97</td>
</tr>
</tbody>
</table>

* Averaged for 30 years the continuous maize systems
** Averaged for 15 years when maize is grown under maize-pigeonpea rotation

Thank you for your attention!