The impact of future climate change on sweet potato production

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The aim: To assess the impact of future climate change on field grown sweet potato production.

The objective: to determine the percentage change in yield, biomass, reference evapotranspiration (ETo) and water productivity across three varieties of sweet potato for 2041-2070 relative to 1981-2010

Downscaling from GCM (HadCM3Q0) was done so that:
• Output from the CARIWIG weather generator was used, as
• Input to the FAO AquaCrop model.

The three varieties examined are Gania, Uplifta and Yellow Belly.
Which tools were used? How & why?

- The **FAO AquaCrop Model** is a user-friendly crop-water productivity model that simulates yield response to water of herbaceous crops and is particularly suited to address conditions where water is a key limiting factor in crop production.

- The **CARIWIG Weather Generator** used to generate daily series of rainfall, maximum and minimum temperature and vapour pressure for two periods: **1981-2010** and **2041-2070** (A1B-HadCM3Q0).

- Data for the **1981-2010** period were generated from observed rainfall and maximum and minimum temperature from Worthy Park in Jamaica.

- The **FAO ETo Calculator** was used to calculate Reference Evapotranspiration (ETo) for both periods.

- **CARIWIG Wx Generator** Outputs: rainfall, temperature, relative humidity, vapour pressure and ETo (from **FAO Calculator**) were used as input to the “calibrated” AquaCrop Model; (% difference in Mean values between present vs future period calculated)
Which tools were used? How & why?

Worthy Park Data

Parameters:
- Rainfall
- Temperature
- Relative Humidity
- \( E_T \)

GCM

WX Generator

CC Data

AquaCrop Model Explained

- Biomass = WP \times \sum \text{Tr}
- \( ET = E + \text{Tr} \)
- WP normalised for ET and CO\(_2\)
- \( Y = B \times \text{HI} \) [Yield]
- Robust, Accurate yet simple

Randomised Complete Blocks (RCBs)

Canopy cover, Biomass (above & Below)
## The findings

<table>
<thead>
<tr>
<th>Rainfall (mm)</th>
<th>Maximum Temperature (°C)</th>
<th>Minimum Temperature (°C)</th>
<th>Vapour Pressure</th>
<th>Relative Humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Min</strong></td>
<td><strong>Mean</strong></td>
<td><strong>Mx</strong></td>
<td><strong>Min</strong></td>
<td><strong>Mean</strong></td>
</tr>
<tr>
<td>-0.75</td>
<td>-0.32</td>
<td>0.04</td>
<td>1.8</td>
<td>1.9</td>
</tr>
</tbody>
</table>

## Change

<table>
<thead>
<tr>
<th>Change</th>
<th>Biomass (t/ha)</th>
<th>Yield (t/ha)</th>
<th>Evapotranspiration (mm/day)</th>
<th>Water Productivity (kgm(^{-2})mm(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Absolute</strong></td>
<td><strong>Min</strong></td>
<td><strong>Mean</strong></td>
<td><strong>Max</strong></td>
<td><strong>Min</strong></td>
</tr>
<tr>
<td>3.68</td>
<td>4.37</td>
<td>5.06</td>
<td>1.9</td>
<td>2.3</td>
</tr>
<tr>
<td><strong>Percentage</strong></td>
<td>30.0</td>
<td>34.4</td>
<td>40.0</td>
<td>28.5</td>
</tr>
</tbody>
</table>
Implications for policy & planning

• The results suggest that sweet potato may be a potential 'climate change' adaptation crop particularly with respect to:
  * Its moderate drought tolerance
  * Relatively low agronomical inputs required for development of the tuber.

• More, the crop can be grown on marginal lands, is highly adaptable to multiple agro-ecological conditions and is not exposed to destructive winds of tropical cyclones.

• Sweet potato may be thus viewed as a resilient and reliable food source even in times of adverse weather.

• The potential to mainstream crop modelling in routine operations of the Agricultural sector in the Caribbean should be pursued.
Feedback on the tools

The weather generator provides the ability to produce series of daily data at present and future periods.

- Tool is quite advantageous to investigating a number of climate scenarios; interfaces well with FAO AquaCrop Model.
- Additionally the weather generator output showed good skill in representing mean and extreme variability.

There was some challenge working across 100 ensemble members for each scenario.
What more could be done?

Future work could involve:

• Quantifying improvements in production resulting from the optimisation process using the application of weather generated data.
• Application of the Weather Generator to multiple sites across the Caribbean and for other crops.
• Development of techniques to select random and representative means from data generated by the Weather Generator.
• Specifically, 3000 years need effective filtering mechanism.
• Potential to be the “Best or B.E.S.T.”-However defined!!