Assessment of Climate Change Impacts on Agriculture on Cayo District, Belize

Roger Rivero Jr., Roger Rivero, Zoltan Rivero
Cuban Institute of Meteorology
Aim and objectives

To empower policy makers and stakeholders with insights of the implications of the plausible climate change expected to probably happen in a near future.

To contribute to the understanding that major agricultural research should be conducted seeking for better adapted varieties and for new or improved technology productions.
• To compute expected crop behaviour with climate change the DSSAT v4.5 suite of models was used.

• For the livestock sector, the SPUR2 v2.2 and LIFE-SIM models were used.

• Climatic input data was provided by CARIWIG upon the results of the coupled RCM (Regional Climate Model) named PRECIS with two different Global Climatic Models to enhance resolution.

• Maps were provided by the from the Ministry of Agriculture and Baseline Production was provided by the Institute of Statistics, Belize, and the Livestock National Association.

• Interviews with farmers and producers from different sectors were conducted in site.

• Further weather variability on climatic variables in the uncertain future were provided from the Weather Generator developed in the Project.

• Base climate provided by the Meteorology Office.
The findings

BASE CLIMATE CONDITIONS

[Graph showing climate conditions with labels for temperature and precipitation over months.]

INSMET

CARIWIG
The findings

DRY BEANS

Example of top productive variety (potential)

INSMET  CARIWIG
The findings

DRY BEANS

HadCM3 (aenwh) GCM
Mean of potential for top 5 varieties

ECHAM5 GCM
The findings

CORN

Yields [kg/ha dm]

INSMET

CARIWIG
The findings

EXPECTED YIELD BY THE END OF THE CENTURY FOR TOP, MIDDLE AND LOWER PRODUCTIVE VARIETIES RELATIVE TO BASELINE PRODUCTION (CORN)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Name</th>
<th>Final Yield on L-Group</th>
<th>Final Yields on Lowest Yielding Cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GL 482</td>
<td>67 %</td>
<td>23 %</td>
</tr>
<tr>
<td>2</td>
<td>PIO 3475 orig</td>
<td>70 %</td>
<td>22 %</td>
</tr>
<tr>
<td>3</td>
<td>EXCELER</td>
<td>69 %</td>
<td>23 %</td>
</tr>
<tr>
<td>4</td>
<td>CORNL281</td>
<td>63 %</td>
<td>25 %</td>
</tr>
<tr>
<td>5</td>
<td>V.SHORT SEASON</td>
<td>52 %</td>
<td>26 %</td>
</tr>
<tr>
<td>6</td>
<td>PIO 31G98</td>
<td>63 %</td>
<td>25 %</td>
</tr>
</tbody>
</table>
The findings

VEGETABLES

PEPPER

TOMATO

Legend
- 7,500 to 8,000
- 7,000 to 7,500
- 6,500 to 7,000
- 6,000 to 6,500
- 5,500 to 6,000
- 5,000 to 5,500
- 4,500 to 5,000
- 4,000 to 4,500
- 3,500 to 4,000
- 3,000 to 3,500
- 2,500 to 3,000
- 2,000 to 2,500
- 1,500 to 2,000
- 1,000 to 1,500
- 500 to 1,000
- 0 to 500
The findings

LIVESTOCK FOOD (Pastures biomass)

- Negative impact on grassland’s net primary productivity, decreasing natural food availability for grazing animals
- With a stocking rate of 1.2 animals/ha – typical of extensive management conditions – a modest 1.3% decrease in milk production was obtained at the end of the century
- Potentially, for some scenarios, the stocking rate resulting in the highest production in an isolated year was about 5 animals/ha. For a value of 6 animals per hectare surviving problems started to appear in the simulations
- Other scenarios allowed a maximum of 0.15 animals/ha to produce a minimum of 201 liters/ha-year of milk
Implications for policy & planning

All results obtained through the simulation of crop yields and grassland/livestock responses to climate change inferred from a Regional Climate Model (PRECIS) point in the direction of the decrease in land productivity during this century.

A National Program to Cope with Climate Change negative and harmful impacts should then be implemented.

This program should take into account that actions should be planned according to the fact that the entire Caribbean basin will be impacted in a similar way.
Implications for policy & planning

WORK TO IMPROVE EFFICIENCY

Modelled impact results show that there exist a so-called “yield gap” between simulated potential and water limited yields or productivity with actual ones, gap which is usually named as “technological efficiency ratio”.

• By improving technological efficiency, we could achieve higher agricultural production even if potential productivity is decreasing due to climate change.

• Seek for better adapted varieties or replace by better adapted crops.
LIVESTOCK

The analysis of these results and other data suggests that livestock practices and obtained yields in actual climate are very far from its potential values.

In consequence, even if climate change will strongly impact in grass yields and its nutritional values, a parallel increase in livestock production could be obtained by introducing better technological practices and management that are not applied today.

Notwithstanding this we should remark than any improvement in livestock management should be strictly assessed before introducing it and only after making thorough cost/benefits studies.
Implications for policy & planning

GENERAL ACTIONS

• Support professional research
• Promote experience exchange between farmers
• Build capacities in agro management practices among farmers, especially of newbie ones
Feedback on the tools

RCM outputs look to work well for current climate, but the effect on the model outcomes implies a huge increase on variability which looks unrealistic.

Some bugs (internal issues) where found in LIFE-SIM, so the authors of this report had to work around them to solve the problems, because source code for this model is not available.
What more could be done?

• To calibrate models to simulate current varieties used in Belize instead of using built-in varieties of the models, which might resemble, or not, varieties used in Belize (research required).

• To simulate rain fed and irrigated yields on real soil profiles instead of generic built-in profiles. Time and resources were not enough to develop the require tools, which actually do not exists, thought actual soil information was collected, we still have to match soil map polygons with soil data and create a two-way interface between information layers and models.