Southern Africa Agricultural Model Inter-comparison and Improvement Project (SAAMIP)

Y. Beletse, W. Durand  
Agricultural Research Council, South Africa

C. Nhemachena  
Human Science Research Council, South Africa

Matthew Jones  
South African Sugar Research Institute, South Africa

O. Crespo  
University of Capetown, South Africa

S. Walker and W. Tesfahuney  
University of the Free State, South Africa

M. Teweldemedhin  
Polytechnic Namibia, Namibia

T. Mpuisang  
Botswana College of Agriculture, Botswana

Mduduzi Sunshine  
Meteorological Services, Swaziland

Patrick Gwimbi  
National University of Lesotho, Lesotho

Davide Cammarano  
University of Florida, USA

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Southern Africa Agricultural Model Inter-comparison and Improvement Project (SAAMIP)

International effort linking the climate, crop and economic modeling communities to produce the next generation of climate impact projections for the agriculture sector.
Map of Project Coverage

Five countries in SA
Five crops
• Maize, Wheat, Sorghum, Sugarcane & Potato

Two crop models
• DSSAT (Maize, Wheat, Sorghum, Sugarcane )
• APSIM (Maize, Wheat, Sorghum & Potatoes)

Econ Model`
• TOA-MD (All crops)

Southern Africa is largely dual agricultural system, with both well-developed commercial farming and subsistence-based production.
In the last three decades several biophysical (GCMs and crop models) and economic simulation models have been developed and used to assess the impacts of climate change (CC).

Weakness on CC impact assessment:

- Methods used to date on impact of CC and adaptation are not well suited to assess socio-economic impacts of CC and adaptation potential (Antle, 2012)
  - Fail to represent heterogeneity and technological detail essential to analysis of adaptation
Objectives

• To compare historical and future maize production systems (mean yield and distribution/variability across fields) simulated using DSSAT and APSIM crop models for a selected district using past and future climate data (5 GCMs)

• To characterise risks of future maize production systems in a selected district using Trade-Off Analysis for Multidimensional Impact Assessment (TOA-MD) economics model
The Free State Province contains the most important maize-producing areas in South Africa and production in this province is a good indicator of national and regional (SADC’s) maize production.
Crop modelling: data description

- detailed description of maize farming practices was required for integrated CC impact assessment
- 400 maize fields mapped using satellite imagery
- data was obtained
  - objective yield surveys,
  - land type classification,
  - digitized field crop boundaries,
  - telephonic interviews

- field size, climate, soil and ag. management was associated for each field.
- soil characteristics were calculated for each field individually using the land type data base and pedo-transfer functions.
- management factors (such as planting density and row width) were obtained from objective yield survey of the Free State.
- yield was simulated using historical (1980-2009) climate data and projected climate data for 2040-2069 using 5 GCMs, 400 maize fields were simulated using DSSAT and APSIM
• Climate is predicted to be hotter in the future (+2.0 to +3.5°C), with greater variability in rainfall.
• Future rainfall/precipitation projections are less consistent, with different climate models revealing different projections.
Climate analysis, Bethlehem baseline, mid-century (all GCMs) and RCP 8.5

- Annual mean temperature showed consistent increase.
- Temperature variations in winter (June, July, August) is relatively small compared to other months.
- Mean annual precipitation vary across all GCMs.
- Projections do not significantly differ from the baseline (*) whether on a monthly, seasonal or annual basis.
Model evaluation with district level yield and site-specific data inputs DSSAT and APSIM

Commercial farmers

DSSAT Observed Vs Simulated yield

Small scale farmers

APSIM Observed vs Simulated yield
Comparison Sim, Base and future

Box-and-whisker plot of climate effect (for the baseline and each of the 5 GCMs (E,I,K,O,R)) for two crop models (DSSAT and APSIM).
Yield frequency distribution

Probability of exceedance plots showing climate effects on maize yields simulated by the DSSAT and APSIM crop models. Lines represent means for each year of each field, averaged over 30-years of weather data, for baseline and each GCM. Spatial variability is reflected in these plots.
Representative Agriculture Pathways (RAPs) narrative: “Positive development pathway, low challenges to adaptation”

Government policies aim to expand agricultural production with
• improved land productivity;
• improved agricultural support services lead to greater benefit from improved crop varieties;
• reduce in poverty levels;
• people take more adaptation strategies to climate change.

Priorities for adaptation
• Variety change-three variety were tested: short, medium, long season varieties
• Different levels of fertilizer application (0% change, +10%, -10%, +30% and -30%.)
• Organic matter: -30%, -20%, -10%, +0%, +10% as proxy for adopting/not adopting conservation agriculture-type activities
Economic analysis

78% gainers

Gains from adaptation

25% losers

Adaptation (ADP1):
1. Increase in fertilizer application
2. Change variety to long season varieties

RAPo+ADPo

RAPo+ADPo

RAPo-Current technology
ADPo- No adaptation

75% gainers
22% losers

78% gainers

Gains from adaptation
Economic analysis…cont

**Adaptation (ADP1):**
1. Increase in fertilizer application
2. Change variety to long season varieties
• Projections of future changes in climate showed an increase in temperature and variability in rainfall.

• Further analysis of the crop model simulations is necessary to understand why the models produced such different simulations of the same crop.

• **Positive development pathway, without adaptation** indicated significant adverse impacts on maize production systems (i.e., about 70% will be losers due to climate change).

• **Positive development pathway, with adaptation indicated** about 80% of maize producers would gain from climate change.
Acknowledgement

Thank you