Impact of projected climate change scenarios on the production of potatoes in South Africa

Beletse YG[1], Steyn JM[2], Crespo O[3], Ruane A[4] and D. Cammarano[5]

1. Agricultural Research Council, South Africa; 2. University of Pretoria, South Africa; 3. University of Cape town, South Africa; 4. NASA,USA; 5. James Hutton Institute, Scotland, U.K

1. Introduction

Potatoes are one of the most important non grain crop world wide (FAO, 2010). In Sub-Saharan Africa, Egypt and Algeria produce about 4.5 mil tons per year. South Africa is second largest potato producer in Southern Africa (FAOSTAT, 2014) with an annual production of about 2.1 mil tons from 51, 000 ha (Potatoes SA, 2011). Potatoes are produced throughout the year in South Africa. The production areas have diverse climatic condition and farmers get substantial difference in yield. Crop models simulate temporal effects of multiple stresses on crop production, they can be a good representation of reality if they reproduce observed data with acceptable accuracy (Raymundo et al, 2014).

Figure 1. Potatoes production field at ARC Roodeplaat Pretoria, South Africa , 2013.

Crop models are also useful tools to assess impacts of climate change on crop production and explore adaption potential of crops. A study was carried out using DSSAT crop model to evaluate sensitivity of current potato production system to projected climate changes for a major potato production region in South Africa. DSSAT was calibrated using observed experimental data. Past potatoes productivity and yield variability was simulated for 90 farmers using historical weather data (1980-2009) at CO_2 of 360 ppm. Future potatoes productivity was simulated using CO_2 of 571 ppm for a period of 2040-2069 projected by 5 GCMs.

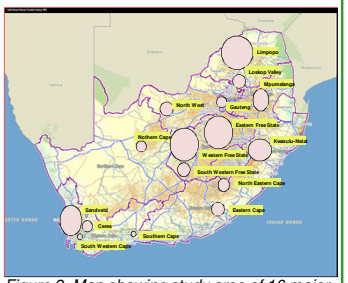
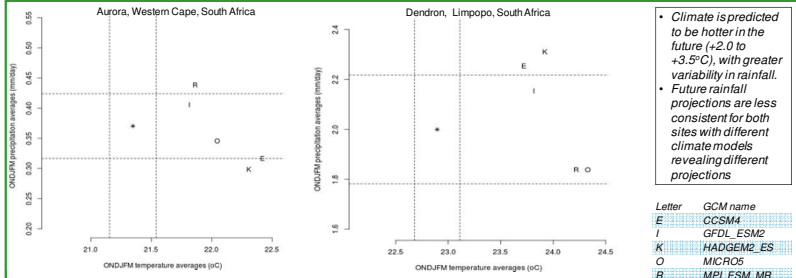


Figure 2. Map showing study area of 16 major potato producing regions in South Africa (Haverkort AJ et al. 2013)

2.Climate analysis



- *Climate is predicted to be hotter in the future (+2.0 to +3.5°C), with greater variability in rainfall.*
- *Future rainfall projections are less consistent for both sites with different climate models revealing different projections*

Letter	GCM name
E	CCSM4
I	GFDL_ESM2
K	HADGEM2_ES
O	MICRO5
R	MPI_ESM_MR

Figure 3. Mean temperature and precipitation projected by 5 CMIP5 climate models (denoted by letters E,I,K, O and R) Aurora, Western Cape and Dendron, Limpopo, South Africa in the 2040-2070 under the high-emissions RCP8.5 scenario. The Black star represents current conditions.

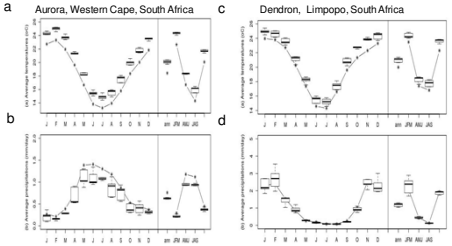


Figure 4. Current (black line and stars) and future (box-and-whiskers) monthly and seasonal mean temperature (Figure 4a and 4b) and precipitation (Figure 4c and Figure 4d), projected by 5 CMIP5 climate models for Aurora and Dendron, South Africa in the 2050s under RCP8.5.

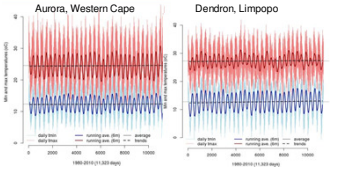


Figure 5. Both minimum and maximum baseline data show an increasing trend over 1980-2010 (approx. 0.02°C and 0.1 per decade)

- *Annual mean temperature showed consistent increase (Figure 4a and 4b)*
- *Mean annual precipitation vary across all GCMs but do not differ significantly from the baseline (+) for Limpopo whether on a monthly, seasonal or annual basis but varies significantly for Western Cape(Figure 4C and 4d)*

3. Crop analysis

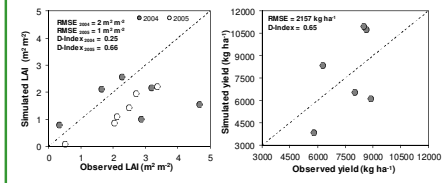


Figure 6 DSSAT crop model evaluation; observed versus simulated LAI and tuber yield. Dashed lines represent 1:1.

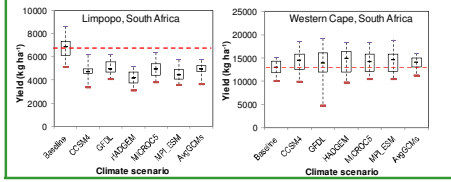


Figure 7. Box-and-whisker plot of climate effect (for the baseline and each of the 5 GCMs ((CCSM4),(GFDL_ESM2),(HADGEM2_ES), (MICRO5) and (MPI_ESM_MR) for DSSAT crop model. Simulations are for 90 farmers field in Western cape and Limpopo provinces, South Africa. Interannual (rather than spatial) variability is reflected in this graph. Red dash line indicates baseline.

4. Conclusion

Projections of future climate changes for potato producing regions in South Africa showed an increase in temperature and variability in rainfall (*Figures 3&4*), increasing the risk of crop failure in some provinces and increase in yield in the other provinces. Over all South Africa potato production under current agricultural system is projected to increase by 7%. However, GCMs produced differences in yield across all regions, for example, in Limpopo yield losses of 28-33% was estimated whereas for the Western Cape yield increase of 7-11% was projected. Further analysis on the crop model simulations is necessary to understand why the crop model produced such different simulations of the same crop across all the region.

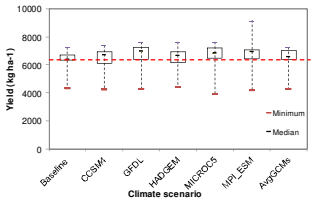


Figure 8. Climate change impacts on potato main production regions South Africa for each of the 5 GCMs (CCSM4),(GFDL_ESM2),(HADGEM2_ES), (MICRO5) and (MPI_ESM_MR). Tuber yield simulated using DSSAT. Red dash line indicates baseline.

Reference:

1. FAO, 2010.[Online].www.fao.org [Accessed 28 July 2014]
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4. Raymundo R, Asseng S, Cammarano D, Quiroz R, 2014. Potato, sweet potato, and yam models for climate change: A review. *Field Crops Research, Volume 166, pp. 173-185.*

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