Climate Change – Both sides of the coin:

How will agriculture in South Africa cope in the future?

The impact of climate change on South African agriculture can depend on the location and type of crop. Investigating how climate change will affect maize, wheat, soya and fruits (grapes, citrus and mangoes) helps to identify viable adaptive techniques that can be used to mitigate potentially negative effects of the future climate. Article by Julio Araujo and Peter Johnston.

One of the biggest concerns about climate change is how agriculture will be affected in the future. Many projections have suggested that future climate change will cause fluctuations in crop yield and quality in grains (maize, wheat and soya) and fruit (mangoes, citrus, avocados and grapes). Will the expected changes favour or inhibit crop yields in South Africa? Can we do anything to adapt to the changes?

Hot topics like this have sparked interest in the response of agriculture to climate change, especially since South Africa benefits so much from the agriculture industry. Interest in this respect has resulted in the undertaking of this project, as commissioned by the Water Research Commission (WRC) and headed by Dr Peter Johnston (UCT), Prof Daan Louw (US) and Prof Roland Schulze (UKZN). The project (no **K5/1882/14**) is entitled 'Adaptive interventions in agriculture to reduce vulnerability of different farming systems to climate change in South Africa.'

The general objective of the project is to investigate the impact of climate change on agriculture, assess the vulnerability of crops, rangelands and farming households and enterprises, identify and suggest appropriate adaptive techniques and practices in selected catchments and farming areas. In short, if we know how and where a crop is affected by climate change, it is possible to adjust farming practices and ensure that the relevant people can cope with the negative impacts or benefit from the positive.

The project spans over 4 years, from its start in 2011 and focuses on maize, wheat, soya, grapes, mangoes, citrus and avocadoes. The areas of interest include Vredendal, Moorreesburg (in the winter rainfall region), Carolina and Hoedspruit (in the summer rainfall region) and include within each region rainfed and irrigated farming systems (Figure 1).

Making use of the advances in crop/climate/financial models and interactions with farmers/experts in the field has allowed this project to address issues while limiting the bias of any one approach. A representation of the approach is shown in Figure 2, where information from all four modules is incorporated into creating the final assessment.

A large aspect of the project lies in interacting with farmers, gathering the necessary information to analyse case study data that can be used to assess the success and failure of the suggested adaptations. It in some way gives purpose to the project, as the results are being used and tested by the people who really need it.

Part of the farmer interaction was through a simple questionnaire, which asks how they feel their farming practices are affected by climate change, if at all. Next they are asked how they currently deal with it, as well as how they plan to deal with it in the future.

In providing sensitive climate change information to the farmers it is important to note our confidence in the results and the variation amongst model outputs. Through the process of downscaling (translating the global information into a regional perspective) the climate projections hold an envelope of uncertainty.

In this respect, we can suggest the conditions of the climate in a specific area (based on climate projections without giving specific changes to rainfall, for example for a specific area for a date in the future, (which is sometimes expected by farmers). Other uncertainty lies within the crop modelling and financial modelling as some processes can't be modelled and thus need to be approximated. This makes the testing of the results with the farmers even more important to validate our results.

CLIMATE CHANGE AND FRUIT

Climate change is generally regarded as negatively impacting agriculture in South Africa and for some fruits such as mangoes and citrus this may well be the case. Predicted shifts in temperature and rainfall patterns could cause yield and quality loss unless adaptive strategies are successfully implemented. Fruit farming is already affected by climate variability and the predicted future change could make the conditions even worse.

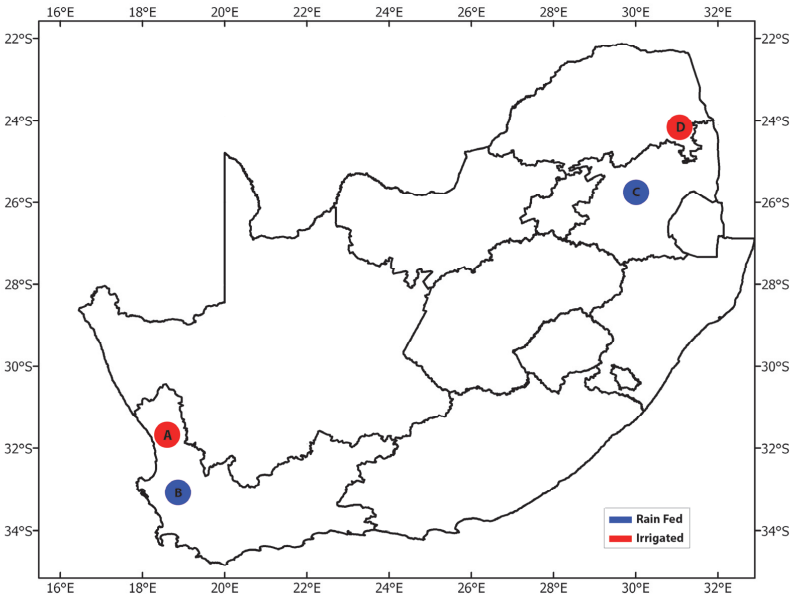
"Over the past 20 years it has become cooler in summer and hotter in winter, with heavy rains in January," says a Lowveld fruit farmer. When asked how the climate negatively influences the fruit harvest, a variety of answers were agreed on including: fungal diseases and rotting fruit from too much rainfall close to and during the harvest, sunburn from daytime temperatures above 36°C and poor fruit set from temperatures below 3°C.

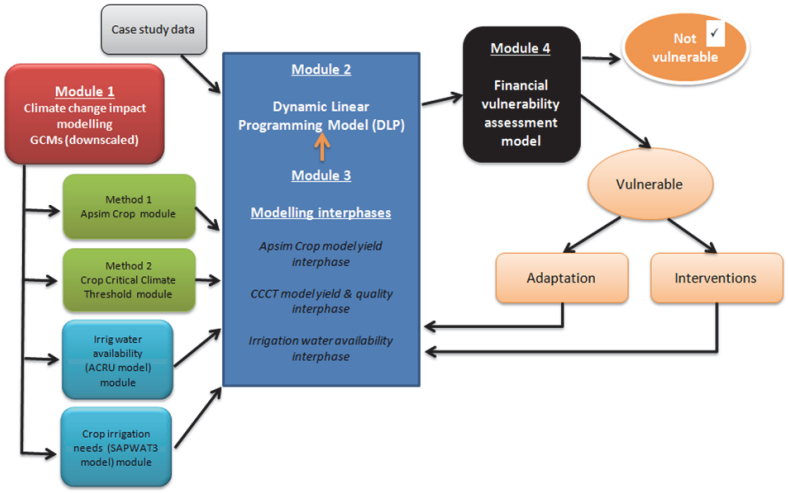
But, it is not all bad for fruit production as applying adaptive strategies helps to mitigate the negative impacts of climate change. Relocating the citrus orchards to cooler (lower) locations, while planting mangoes in warmer (higher) areas, appear to be a good way of addressing the low temperature issues.

"The use of shade netting or sun cups over the fruit is also a good way of reducing the effect of high daytime temperatures," notes another fruit farmer. Similarly using mulch will keep the soil temperature

Figure 1 (below): The case study locations for: Winter rainfall: Vredendal (A) and Moorreesburg (B) & Summer rainfall: Carolina (C) and Hoedspruit (D).

Figure 2 (bottom): Integrating climate, hydrological and economic models.





Irrigated citrus fruit in Hoedspruit is affected by the climate

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down and ensure that less water is lost through evaporation. This will reduce the need for irrigation and ensure that water is used more efficiently. Given that these adaptive strategies are suggested to have been successful, it is important to determine how they will address the issues of future climate change.

Although mangoes and citrus can be produced in the future under these adaptive strategies, there will still be some impact from future climate change as shade netting and mulch are not only an extra input cost, affecting profitability, but they are also not 100% effective. The models may suggest that the adaptive strategies are a viable option for mitigating future climate change, but it is still necessary to observe the test results on actual farms before the strategies are shown to be effective.

Interviews with the farmers shed light on climate issues

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After a second round of interviews with mango and citrus farmers, it was clear that some adaptive strategies had been implemented and were considered to be successful. When asked how they plan to change their farming practices based on the knowledge they now have, some farmers said, "we will change from mangoes to citrus because of the cooler temperatures" while others said, "we will plant more fruits under shade cloth and use more effective irrigation methods like drip irrigation".. The success of these strategies from the modelling helps to provide more information and allow the farmers to make more informed decisions regarding their farming practices in the future.

CLIMATE CHANGE AND GRAINS

Maize farmers believe that rainfall is the biggest driver for variations in their crop yield and quality. "The seasons have shifted, maybe starting slightly earlier. Rainfall has also dropped by about 50 mm", says a Carolina maize farmer. Farmers are adamant that the climate is changing and affecting their crop, but they feel that it is not a big concern at present. So how exactly does the climate affect maize? The farmers in this area suggest that abnormal weather, rainfall below the threshold of 510 mm and temperatures below 0°C will reduce the quality and yield of their harvests. This is caused by additional stressors affecting the crop such as increased diseases and poor growth and flowering.

Since the future predictions suggest that the temperature and rainfall patterns will change, maize farmers will have to adapt in order to maintain their current harvests. They felt that increased spraying (diseases), planting shorter growing crops will be a good way to mitigate the negative effects of climate change. Similarly they feel that crop rotation and conservation agriculture will help to ensure that their harvests are not reduced.

Conservation agriculture is a system that replaces conventional tillage with reduced or no-tillage, conserving soil moisture by applying mulch and steering away from mono-cropping by diversifying planted crops (rotations). One of the main reasons for adopting this system is for conserving water, which should allow the farmers to adjust to potentially harsh conditions in the future.

Once these adaptation options are run through the models, we get a clearer picture of how the future

climate change will affect the crops and what will be the best way of dealing with any negative impacts.

The intermediate climate scenarios will likely pose little threat to maize production. In fact, if the farmers make use of conservation agriculture and crop rotations, there is a possibility that their production will increase. Successful implementation of these adaptation strategies will reduce production risk and likely eliminate the negative effects of climate change on the maize value chain in some areas.

Although the models suggest that adaptation will mitigate climate change impacts, it is important to test this in the real world on working farms. Over the past two years, maize farmers have tested some of the adaptation strategies that they feel will work for them, with some promising results. When asked how they plan on changing their farming activities in the future, one farmer said "plant shorter growing cultivars" while others said, "use more conservation tillage". The use of these practices, as suggested by the farmers for the future, stems from the successful application in the past.

PROJECT DEVELOPMENT

In light of the current climate change research regarding agriculture, it seems that the news is not all bad for all crops. There are cases (such as for maize) where understanding the impact of climate change may help to increase production and help to maintain food security. Therefore changing their practices in the future would exploit climate change and not be too costly. On the other hand, mango and citrus production is expected to decline as a result of climate change.

Although there are some adaptation options, which could mitigate the negative effects of climate change, they can be costly. Relocating the mango trees to warmer areas as well as citrus to cooler areas is a viable option although it is still costly and time consuming. Overall, the use of crop rotations as well as conservation tillage seems to be the best option to either mitigate climate change impacts or exploit them.

The project is reaching its final year and another set of interviews with the farmers and relevant experts is in envisaged. This is helping to provide lessons on effective knowledge dissemination in this field as well as provide reliable and useful recommendations that can be applied by the farmers to mitigate the impacts of climate change as well as manage water resources better in the future.

It is also important to remember that this research is based on climate scenarios and models that are being updated with new data and models, which means that further research will always be required. ❑

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Cool temperatures in the low lying citrus farms are ideal for growth.