Climate change adaptation: How will we feed people in 2050?

While the latest report from the Intergovernmental Panel on Climate Change (IPCC) indicates that the effects of global warming are already occurring on all continents, few sectors are prepared for the risks that this change brings. Yacob Beletse, Senior Researcher in modelling crop water relations at the Agricultural Research Council (ARC)-Roodeplaat reports on local efforts to help southern African farmers prosper despite a shifting climate.

Most scientists agree that the climate change and concomitant rising temperatures we are currently experiencing is a result of anthropogenic activities, notably the release of greenhouse gases, which include carbon dioxide, nitrous oxide, methane and water vapour. While actions to reduce global greenhouse gas emissions are critical, communities also need to prepare or adapt to unavoidable climate change impacts. Adaptation can take the form of changes in policy, management, technology and behaviour that reduces negative impacts or exploits opportunities.

The ability of society to adapt to the challenges (and opportunities) presented by climate change is, however, limited by several factors. Education levels, access to information and access to capital depend on the economic pathway (i.e. government policy) followed to get to that point. Climate change is therefore expected to affect different communities in different ways depending on location, terrain, land use patterns, social networks, infrastructure, planning capacity, institutional, political and financial realities when they select their own adaptation measures.

DETERMINING THE IMPACT OF CLIMATE CHANGE ON FOOD PRODUCTION IN SOUTHERN AFRICA

The potential impacts of climate change on southern Africa's agricultural sector are well researched and documented. Evidence shows that annual rainfall trends in the southern regions of South Africa are likely to decrease moderately, resulting in increased inter-annual rainfall variability and more intense and widespread drought. On the other hand, rainfall projections over the rest of southern Africa remain uncertain. Farmers will be required to adapt to these extreme conditions.

Temperatures over South Africa are increasing. An analysis of minimum and maximum temperature trends indicate that the region is getting warmer by about 2-3°C. This concurs with those IPCC headlines and scale of changes. We can now say with more confidence that this is expected to lead to decreased water availability in rivers due to increased evaporation, coupled with shifts in the timing and volumes of rainfall. Thus, water scarcity is highly likely in some areas. The impact on the agricultural sector could be exacerbated further by changes in land use, poor land-use management and political imperatives of improving households' access to water, which places more pressure on available water resources.

It is clear, therefore, that climate change potentially has serious repercussions for the agricultural sector, particularly food crops and livestock production, both spatially and temporally. The questions South African authorities now wish to answer is 'how seriously will climate change affect our food production?' and 'what can be done about it?'

THE CHALLENGE OF UNCERTAINTY

A number of scientists in the region have already unveiled methodologies for assessing climate change impacts on agriculture towards the development of adaptation strategies. One of the key challenges, however, is the uncertainty of future impacts, as the conclusion is derived from the complex interaction of various factors, such as biological, economic, policy and social interactions that determine farmers' production each season.

Crop, climate and economic models coupled together are usually used to project future food production and assess the potential impact of climate change. In the last three decades, global climate circulation models (GCMs), crop models and economic models have been used to assess the impacts of climate change on the production and prices of food crops.

Weaknesses identified from previous climate change impact assessments include limited model inter-comparison and multi-model assessment. Furthermore, methods used to date are neither well suited to assess socio-economic impacts of climate change nor adaptation potential. Previous assessments failed to represent the heterogeneity and technological detail essential to the analysis of adaptation while others examined the impacts of climate change on crop yield linking to economic models but not to risk of hunger.

"If the agricultural sector continues with 'business as usual' sufficient food production for the region will remain a pipe dream."

Courtesy ARC

Crop modellers interact during a training workshop on crop multi-models in India earlier this year.

MULTI-INSTITUTIONAL PROJECT

This has raised the need in southern Africa to capture these complex biophysical and socio-economic heterogeneities and so improve our understanding of agricultural impacts of climate change at national and regional scales using consistent methods and protocols of multi model comparison. A diverse team of climate, crop, economic and information technology research scientists are answering this need through a global network called AgMIP (Agricultural Model Inter Comparison and Improvement Project). Its aim is to evaluate the impacts of climate change on food production and economic status of farmers.

A current project under this network is titled the Southern Africa Agricultural Model Intercomparison and Improvement Project (SAAMIIPP). This project involves 10 institutions, 12 researchers and six post-graduate students. The southern African institutions involved in the project include the ARC (who is coordinating the project), the universities of Cape Town and Free State, South African Sugar Research Institute, Human Sciences Research Council, Polytechnic of Namibia, National University of Lesotho, Botswana College of Agriculture, and Swaziland Meteorological Services.

The project is being supported by researchers at the University of Florida, National Aeronautics and Space Administration (NASA), Columbia University as well as Oregon State University in the United States.

The ultimate objective of the project is to estimate regional-scale food production for different future periods and development scenarios, identify field-level adaptation strategies and evaluate economic impacts of climate change on commercial and small-scale farming systems. In addition, the project is aiming to build capacity across the disciplines of climate, crop and economic modelling in the region.

To date, the project has organised six workshops across southern Africa and engaged in several international workshops and training to develop methodologies on integrated climate change impact assessment. The concepts developed during the workshops and training sessions have been applied to predict meaningful climate change impact assessments as a case study in southern Africa.

As maize is the main staple crop in southern Africa, SAAMIIP has assessed the impacts of expected climate change at district level on maize production. In this first attempt, the team focused on the Free State province and, more specifically, on the Bethlehem district of South Africa. The project investigated questions around the sensitivity of commercial-scale maize production to climate change; the impact of climate change on future maize production; and benefits of adaptation to climate change in the district.

A new approach that was considered in this case study was to separate the biophysical and socio-economic components of climate change. This means similar key economic drivers were considered, but the factors were assembled in a manner that allows more flexibility and easier cross-disciplinary research. For example, the future agricultural pathway for South Africa was envisaged as positive and with low adaptation challenges. It was further assumed that South Africa would follow a more positive economic development pathway in line with the National Development Plan, Vision 2030 (National Planning Commission, 2012) characterised by higher rates of economic growth, increased agricultural technology development and use; and increased access to productive commercial agricultural land.

In addition, increased investments in implementing agricultural and land reform policies provide a positive environment for increased agricultural productivity and production for commodities such as maize. Improved economic performance and associated reductions in poverty enhances social cohesion and facilitates investments in commercial agricultural production.

Courtesy ARC

The southern African crop, livestock, climate and economic modelling team.

SHOULD WE CONTINUE WITH BUSINESS AS USUAL?

The term 'business as usual' refers here to socio-economic and agro-climatic conditions of the recent past. Formally, there will not be significant change of socio-economic growth and agro-climatic conditions in the future, and it is expected that it will remain similar to conditions experienced from 1980 to 2010.

The study into the sensitivity of the Bethlehem maize industry to projected changes in climate is

indicative of just how severe these changes could affect the southern African agricultural sector. Analyses indicate that maize yield in this region will decrease by 9% to 28% as a result of changes in climate. Furthermore, about 60% of farmers will be negatively affected as a result of climate change by 2050. At the same time farmers' per capita income is expected to decrease by 27% to 61% as a result of climate change.

The predicted impact on climate change on poverty indicates small increases in poverty levels ranging from 0.25% to 3.79%. Thus, the overall results of the analysis, which used five different climate scenarios, show that maize production will substantially affected by climate change should there be no adaptation. Business as usual is therefore not an option.

WHAT ARE THE BENEFITS OF ADAPTATION?

Project future changes in climate may mean that farmers will need to modify their maize production in order to either maintain current yield or exploit future conditions in order to increase production. These so-called adaptation methods may include changes in field management planting/harvest dates, choice of cultivars, row-spacing, planting depth, application of fertilisers and pesticides, and irrigation schedules, among others.

Thus, if the Bethlehem farmers manage to change the way they grow their maize through adaptation, then only 33-48% of farmers be negatively affected as a result of climate changes. So adaptation will help reduce the negative impacts of future climate change.

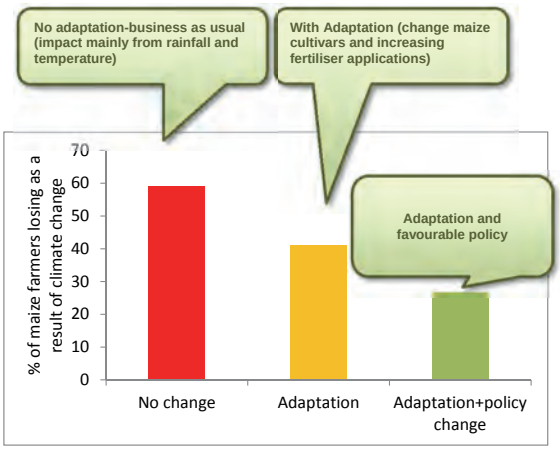
CLIMATE CHANGE WITH ADAPTATION AND FAVOURABLE POLICY

With the introduction of favourable policy together with adaptation, the agricultural sector's vulnerability to climate change can be further reduced. This particular study showed that implementing both will result in only 24-32% of growers being impacted negatively by climate change. Thus policy and social changes reduce the number of those impacted by 54%.

In short, if the agricultural sector continues with 'business as usual' sufficient food production for the region will remain a pipe dream. If, on the other hand, we adapt to new varieties, new technology, socio-economic conditions and policies change favourably towards farming conditions, food security challenges may reduce amid changing climatic conditions.

The question now is how can we introduce farming system changes to the region and so reduce climate change's potentially disastrous impact on food production, and how can we ensure favourable policies and socio-economic conditions and so improve the agricultural sector's resilience to the effects of climate change.

In conclusion, climate change is predicted to have serious implications on food production if appropriate adaptation measures, favourable policy and mitigation is not implemented. The SAAMIIP has a further vision to bring scientists in the region together to work with stakeholders in affecting these changes.



Projections of percentage of maize farmers losing due to climate change.

The project's current work has enhanced southern African capability to response to climate change by building scientific and technical capacity, advancing scientific knowledge, and linking scientific community and stakeholders. The team plans to expand such investigations in different main food producing districts to investigate the inclusion of other adaptations strategies, such as early and late maturing crops, diversification of farming systems (including alternative crops), ecosystem-based adaptation, sustainable land management (such as rainwater harvesting), organic and inorganic fertilisation.

- To find out more about SAAMIIP contact Yacob Beletse at
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Courtesy ARC

The SAAMIIP project involves 10 institutions, 12 researchers and six post-graduate students, all geared towards stealing the southern African agricultural sector to the impacts of climate change.