CLIMATE CHANGE AND **THE AGRICULTURE SECTOR**

Climate and Impacts Factsheet Series, Factsheet 4 of 7

THE LONG-TERM ADAPTATION SCENARIOS FLAGSHIP RESEARCH PROGRAMME (LTAS) FOR SOUTH AFRICA

The LTAS aims to respond to the South African National Climate Change Response White Paper (NCCRP, para 8.8) by developing national and sub-national adaptation scenarios for South Africa under plausible future climate conditions and development pathways. This will be used to inform key decisions in future development and adaptation planning so as to build climate resilience.

The first phase, completed in June 2013, developed a consensus view of climate change trends and projections for South Africa. It summarised key climate change impacts and potential response options identified for primary sectors, namely water, agriculture and forestry, human health, marine fisheries, and biodiversity.

The second phase will use an integrated assessment approach and model to develop adaptation scenarios for future climate conditions using the information, data and models from Phase 1 and inputs from a range of stakeholder consultations and task-team workshops.

The Climate and Impacts Factsheet Series has been developed to communicate key messages emerging from LTAS Phase 1; and to complement the LTAS Phase 1 technical reports and the summary for policy-makers.

This factsheet has been developed specifically to provide policy- and decision-makers, researchers, practitioners and civil society with up-to-date information on the climate change impacts, adaptation responses and future research needs for the agriculture and forestry sectors in South Africa.

The information is built upon past and current research, including the Climate Change Adaptation and Mitigation Plan for the South African Agriculture and Forestry Sectors currently under development, and new impact modelling for crop yields (maize, wheat, sunflower and sugarcane) and irrigation demand using updated scenarios and the latest downscaled models produced during LTAS Phase 1. For further details, see the LTAS Phase 1 full technical report entitled *Climate Change Implications for the Agriculture and Forestry Sector in South Africa.*

1. Background

The South African agricultural sector is highly diverse in terms of its activities and socio-economic context. This sector can be described as two-tiered (commercial vs. small-holder and subsistence farmers), with activities across a wide variety of climatic conditions (especially of rainfall). Roughly 90% of the country is sub-arid, semi-arid, or sub-humid, and about 10% is considered hyper-arid. Only 14% of the country is potentially arable, with one fifth of this land having high agricultural potential. Climate is important in determining potential agricultural activities and suitability across the country, especially in smallholding and homestead settings. Irrigation and conservation tillage practices can overcome rainfall constraints, especially in the high-value commercial agricultural sector. Irrigation currently consumes roughly 60% of the country's surface water resources, with important implications for agricultural exports, and food and water security in the context of climate change.

2. Climate change impacts on the agriculture sector

Projected climate change impacts under an unconstrained emissions scenario are generally adverse for a wide range of agricultural activities over the next few decades, but with some exceptions. Adverse impacts are projected for key cereal crop production, high value export agricultural production and intensive animal husbandry practices, but positive impacts are projected for some tropical crops. Deleterious impacts would also be felt through increases in irrigation demand and in the effects of agricultural pests and diseases. With strong international mitigation responses (i.e. under a constrained/mitigated emissions scenario) and with the implementation of appropriate adaptation responses these adverse impacts could be reduced – with large avoided damages. (see Box 1)

BOX 1. UNCONSTRAINED/UNMITIGATED VERSUS CONSTRAINED/MITIGATED EMISSIONS SCENARIOS

- Different emissions scenarios, climate models and downscaling techniques complicate the projection of climate change impacts on agriculture in South Africa.

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Conservation Agriculture approaches aim to achieve resource-saving agricultural production with acceptable profits, and high and sustained production levels while conserving the environment. The three core principles are: minimum mechanical soil disturbance to maintain minerals within the soil, stop erosion and prevent water loss; maintaining permanent organic soil cover for growth of organisms within the soil structure; and crop rotation with more than two species (FAO, 2007[1]).

Ecosystem-based Adaptation approaches use biodiversity and ecosystem services in an overall adaptation strategy and includes the sustainable management, conservation and restoration of ecosystems to maintain and increase their resilience, and reduce the vulnerability of ecosystems and people in the face of adverse effects of climate change (CBD, 2009[2]).

Community-based Adaptation approaches empower people to plan for and cope with climate change impacts by focusing on community led processes grounded in the priorities, needs, knowledge and capacities of communities (Chesterman and Hope 2011, in Midgley *et al*; 2012[3]).

Agroecology approaches include recycling nutrients and energy on the farm rather than introducing external inputs; integrating crop and livestock management practices; diversifying species and genetic resources in agroecosystems over time and space; and focusing on interactions between production components and productivity across the agricultural system.

4. Future research needs

It is critical for the agriculture sector to conduct a holistic assessment of future research needs relating to climate change impacts and adaptation. Such an assessment could usefully include:

- distinguishing between needs at different scales of implementation
- identifying adaptation needs for specific agricultural activities at local level
- exploring an approach for assessing activity-specific adaptation options
- defining appropriate levels of intervention and prioritising agricultural sub-sectors for implementation.

The latest scientific insights combined with indigenous knowledge and experiences would provide valuable guidance on when, where, and how to adapt to climate change including:

- greater rainfall variability and its impacts on crop production
- multiple-year droughts and crops with long plant cycles of 10–30 years (such as commercial timber species or deciduous fruit trees) where long droughts are critical to the survival of crops
- persistence of rain days in wet/wet, wet/dry, dry/dry or dry/wet sequences or fewer, long duration gentle rains that are being observed in the winter rainfall region
- number of rain days and future changes thereof in the growing season
- onset and duration of the rainy season and whether it is projected to set in earlier or later.

5. Conclusion and linkages

The impacts of climate change on food production, agricultural livelihoods and food security in South Africa are significant national policy concerns, and are also likely to have implications beyond South Africa's borders. Potential adaptation responses in the agriculture sector range from national level strategies that include capacity building in key research areas, extension, and consideration of water resource allocation, all the way to the local level where responses may be specific to agriculture production methods and local conditions.

Irrigated agriculture is the largest single surface water user in the country and dependence on water is a significant vulnerability for almost all agricultural activities. Adaptation plans could usefully consider how to allocate water optimally to irrigators and competing uses in times of drought, especially taking account of food security needs, and conditionalities relating to efficient water use. Water pricing incentives have a role to play in the context of national food security, export value and potential foreign earnings. The latter is particularly pertinent to the deciduous fruit industry of the Western Cape, an area projected to experience reduced runoff under plausible future climate scenarios. The socio-economic implications of resource allocation trade-off scenarios under plausible future climates require investigation to inform key decisions in development and adaptation planning to reduce impacts on the most vulnerable communities and groups.

FACTSHEET SERIES PRODUCED BY

SANBI, DEA and GIZ in consultations with relevant sector stakeholders

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- LTAS Phase 1 Methodology
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- Climate Change and the Water Sector
- Climate Change and Human Health
- Climate Change and Marine Fisheries
- Climate Change and Biodiversity

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2. Secretariat of the Convention on Biological Diversity (CBD). 2009. Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change. Montreal, Technical Series No. 41.
3. Midgley G, Marais S, Barnett M and Waagsaether K. 2011. Biodiversity, climate change and sustainable development. Summary of technical report. SANBI.

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- Projections have often focused on relatively unconstrained emissions scenarios such as the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (SRES) A2 scenario which represents CO_2e levels higher than 500 ppm by mid-century.
- Only recently have climate change impacts on agriculture been assessed comparatively under both unconstrained and constrained pathways.
- Constrained pathways represent effective international mitigation responses equivalent to CO_2e levels stabilising between 450 ppm and 500ppm. This would reduce the likelihood of adverse impacts projected under an unconstrained emissions scenario.

Irrigation demand in South Africa is projected to increase over the next few decades under both unconstrained and constrained emissions scenarios, as a result of increases in temperature and evaporation.

- Under a warmer and wetter climate scenario, a modest increase of 4–6 % in irrigation demand is projected, with limited implications for the agriculture sector. For catchments along the eastern seaboard, an increase in evaporation is projected to be offset by the increase in precipitation, with no change in irrigation demand.
- Increases of about 15–30% in irrigation demand are plausible under a hotter and drier scenario presenting substantial risk for the sector, and with important cross-sectoral implications due to the high proportion of surface water allocated to agriculture in South Africa.

Mapping areas suitable for crops and forestry and potential spatial shifts in optimum growing regions is a useful approach to assessing potential impacts on agricultural activities, and site-specific modelling of yield changes provides valuable additional information. Some spatial shifts in optimal growing regions as well as impacts on yields are likely by mid-century for field crops such as wheat, barley, maize, sorghum, soybeans and sugarcane; pasture/rangeland grasses such as *Eragrostis curvula* and Kikuyu (*Pennisetum clandestinum*); horticultural crops such as apples and pears; viticulture crops and major commercial forestry trees such as eucalyptus, pine, and acacia. Projected climate change-induced effects on plant and animal diseases and insect distributions could also adversely affect both crop and livestock production, and animal health (see Box 2 and Figure 1).

BOX 2. CLIMATE CHANGE AGRICULTURAL IMPACTS BY MID-CENTURY, WITHOUT ADAPTATION RESPONSES

- A range of possible impacts on yields of rain-fed crops including a -25% to +10% change in maize yield. Mitigation to stabilise CO_2e at 450 ppm would reduce this to a -10% to +5% change in yields with similar results for crops such as wheat and sunflowers.
- Areas towards the west are likely to become less suitable for maize production.
- Areas suitable for viticulture in the western and southern Cape could be substantially reduced or shift to higher altitudes and currently cooler, more southerly locations.
- Projected reduced runoff in areas important for the deciduous fruit industry in the Western Cape will negatively affect the production of horticultural crops.
- The total area suitable for commercial plantations in KwaZulu-Natal, Mpumalanga and the Eastern Cape provinces would increase along the eastern seaboard and adjacent areas.
- Yields of tropical crops, such as sugarcane, may increase given the warmer/wetter projections in the tropical north-east. However, exposure to eldana – a serious sugarcane pest – would increase throughout the area climatically suitable for sugarcane by ~10% to > 30%.
- The area subject to damage by chilo – a key pest of major tropical crops and sugarcane – and codling moth – a key pest of several high value temperate fruits, including apples, pears, walnuts and quince – would increase substantially.

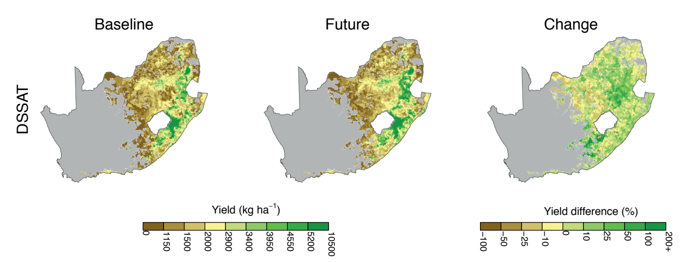

Figure 1. Median change in crop yields for rain fed maize by mid-century.

Climate change impacts on livestock have been less intensively studied than those on key crops and forestry species. However, estimates of heat stress and humidity indices for certain livestock types have been developed, including the thermally comfortable zone per livestock type and upper critical temperatures needed to ensure optimum development and productivity. Heat stress has known effects such as reducing milk yields in dairy cattle, and influencing conception rates across virtually all breeds of livestock. Furthermore, projected decreases in rainfall and hence herbage yields would result in negative health impacts for livestock.

Increases in the number of days humans experience thermal discomfort have been projected over South Africa under future climate scenarios with serious implications for the productivity of agricultural labour, especially in summer and with multi-year crops.

3. Adaptation responses

Adapting agricultural and forestry practices in South Africa requires an integrated approach that addresses multiple stressors, and combines indigenous knowledge and experience with the latest scientific insights. For large-scale commercial farmers, adaptation needs to focus on maximising output in a sustainable manner and maintaining a competitive edge in changing climatic conditions. For rural livelihoods, adaptation needs to focus on vulnerable groups and areas and include promoting climate-resilient agricultural practices and livelihoods. Promoting alternative, sustainable sources of income will be important for subsistence households that are unable to continue farming.

As an overall adaptation strategy, benefits would come from practices based on best management and climate-resilient principles (see Box 3), characteristic of concepts such as climate smart agriculture, conservation agriculture, ecosystem- and community-based adaptation, and agro-ecology (see Box 4). Such practices include restoring and rehabilitating ecosystems to optimise them for future climatic conditions, minimising soil disturbance, maintaining soil cover, maximising water storage, multi-cropping and integrating crop and livestock production to optimise yields, sequestering carbon, and minimising methane and nitrous oxide emissions. Both risks and opportunities of climate change should be considered when planning adaptation options.

BOX 3. ADAPTATION INTERVENTIONS IMPORTANT TO THE SOUTH AFRICAN AGRICULTURE SECTOR INCLUDE:

- Sustainable water resource use and management including catchment management.
- Maintenance and climate-resilient restoration of ecosystem services.
- Sustainable farming systems including integrated crop and livestock management.
- Community-based forestry and diversification of livelihood skills.
- Climate resilient forestry options.
- Climate advisory services and early warning systems for extreme weather events.
- Fire mitigation including burning fire breaks and reactive fire fighting.
- Climate change integrated into agricultural curricula.
- Integrated water use planning.
- Integrated, simplified and unambiguous policy and effective governance systems.
- Sustainable urban expansion including, where possible, ecosystem-based solutions.
- Awareness, knowledge and communication on climate change and adaptation.

Diversification in the agriculture sector is especially important in areas of projected decreases in rainfall and/or shifting rainfall conditions. This includes in-field and off-field water harvesting and storage to assist with increased irrigation requirements (without compromising water availability), finding new, climatically suitable locations for crops and commercial forests, growing indigenous species and farming indigenous and locally adapted breeds which are heat and drought tolerant (e.g. Bonsmara, Nguni, Huguenot, and Boergoats), harvesting less often to prevent nutrient depletion, using local techniques to decrease wind erosion (such as mulch strips for shelter belts of natural vegetation), and planting climate-resilient crop varieties, such as drought-resistant maize varieties, alternative crops or late-maturing fruit trees.

Climate advisory services could usefully communicate key messages from the latest available science in an appropriate format to government, agri-business (e.g. seed companies), extension services and farmers. This should relate to the onset of rains, number of rain days, persistence of rain days, enhanced rainfall variability, droughts and long and short cycle crops. Communication and trust should be increased between authorities and all farming sectors (commercial, small-holder and subsistence) to disseminate relevant knowledge on climate change and promote adaptation. Such communication should be augmented with processes that support vulnerable communities to interpret and respond to such messages.

BOX 4. CONCEPTS WHICH INCORPORATE BEST MANAGEMENT AND CLIMATE-RESILIENT PRINCIPLES

Climate Smart Agriculture approaches are designed to identify and implement sustainable agricultural development for climate change. They integrate the economic, social and environmental dimensions of sustainable development by jointly addressing food security and climate challenges based on three main pillars: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions (FAO, 2013).