A Status Quo Review of Climate Change and the Agricultural Sector of the Western Cape Province

Brief for the Table Grape Sector
The SmartAgri project

Smart Agriculture for Climate Resilience (SmartAgri), a two-year project by the Western Cape Department of Agriculture and the Western Cape Department of Environmental Affairs & Development Planning, was launched in August 2014. SmartAgri responds to the need for a practical and relevant climate change response plan specifically for the agricultural sector of the Western Cape Province. By March 2016, the University of Cape Town’s African Climate and Development Initiative (ACDI) and a consortium will deliver a Framework and Implementation Plan which will guide and support the creation of greater resilience to climate change for farmers and agri-businesses across the province. The project will provide real and practical information and support, and inspire farmers in a manner which optimizes their decision making and ensures sustainability at a local level.

This brief was prepared for the table grape farming sector of the Western Cape. It summarises the findings of the Status Quo Review of Climate Change and Agriculture in the Western Cape Province. This study covers current climate risks and impacts across the sector and how risks and potential benefits are expected to shift under a changing climate. It also considers how climate risks and impacts can be reduced and managed. This is approached in the context of provincial economic and social development goals, and careful use of scarce and valuable natural resources.
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Climate change in the table grape production regions

As a result of global climatic changes, the Western Cape faces a warmer future. This poses serious threats to agricultural commodities in the province, including table grapes. Changes in annual rainfall as well as changes to the spatial distribution, seasonal cycles and extremes in rainfall are also likely, even if the extent and direction of these changes are still uncertain. The SmartAgri project is focusing on the planning and preparation needed in the agricultural sector in order to deal with this threat over the next 10–40 years.

Agricultural production is closely linked to climate and weather. These linkages are sometimes straightforward, for example seasonal total rainfall influencing crop yield. More commonly they involve far more specific influences such as dry spell duration during key reproductive phases, or rainfall during the harvesting period. Higher temperatures are often tolerated as long as rainfall and/or irrigation are sufficient. However, temperature sensitivities can be much more complex, for example the reduction in fertilisation brought about by a heat wave during flowering. Thus, a discussion of the impacts of climate change on agricultural production requires focused attention to specific threats to specific crops and at specific times in the seasonal cycle. In addition, local conditions such as production potential and microclimate influence the extent of the threat.

The table grape production potential of the Western Cape is influenced by local climate, ocean and mountain influences and soils. Table grape production is centred on the lower Olifants River catchment on the West Coast, the middle Berg River catchment, and the Hex River valley. Both the lower Olifants River region and the middle Berg River region have a hot and dry climate. Water for irrigation is provided by the large Clanwilliam Dam, the Olifants River, the large public dams connected to the Western Cape Water Supply System, the Berg River and its tributaries, and private farm dams. The Hex River valley has a unique production climate: winters are cold and rainy, and summers are hot and generally dry but can experience some rainfall.
The SmartAgri project is assessing four agro-climatic zones region, based on Relatively Homogeneous Farming Areas: Olifants Irrigation, Swartland, Hex and Breede (upper) (Figure 1).

Figure 1. Map of the Western Cape Province showing the 23 agro-climatic zones used in the SmartAgri project, and the table grape regions of the Western Cape (circles).
How will the climate of this area change into the future? Climate modeling studies show with a high degree of certainty (i.e. almost all the models agree) that the western parts of the province will experience continued warming and reductions in winter rainfall by mid-century and thereafter. An important change in the climate system involves the shifting of the rain-bringing frontal storm tracks further south during winter. However, the influence of the mountains and ocean will lead to more complex results at local level, particularly for rainfall. In the short term, these influences could lead to increased rainfall on the windward mountain slopes, for example, or rainfall shifting into autumn and spring. Future changes in total annual rainfall will depend strongly on the strength of various system responses to the changing global climate. Since the science is not yet able to provide absolute certainty, both increased and decreased rainfall should be considered by farming communities.

Already, the weather data shows that warming has occurred (on average approximately 1.0 °C over the last 50 years), particularly in mid- to late summer. The number of rain days in a year has decreased, particularly during summer–autumn (January to April) and early spring (August) but there has been some increasing trend in the western regions of the province in late spring-early summer (November-December). These trends are also perceived by the farming community according to information given during stakeholder workshops. This may indicate a progressively later start and end to the rainy seasons. As yet there are no detectable trends in total rainfall during the winter season or annually across the table grape production areas.

Future increased temperatures are almost a certainty. The greatest increases are likely to be inland and the lowest increases along the coast indicating a moderating effect from the Atlantic Ocean. Expected increases in mean annual temperature for mid-century are in the range of 1.5 °C to 3 °C. Both maximum and minimum temperatures will increase leading to increased heat stress for table grape crops, but also lower risks associated with low temperatures.

The Western Cape experiences regular flooding events, droughts and heat waves. These events have had significant impacts on farmers. Floods are the most common problem, causing the most damage and costs for response and recovery. An increase in extreme rainfall events is likely in the core of the winter season which could increase the risk of flooding.
Figure 2. Observed (grey) and projected additional (red) number of hot days (> 36°C) per month for Lutzville, Paarl and Worcester. Projections are for the 2040 – 2060 period and based on 11 different climate models. Height of the grey bars indicates median number of hot days from observed historical climate records. Red bars indicate the range of projected increases in number of hot days (10th to 90th percentile range) in addition to the observed (or current) values.
Heat waves are expected to become more frequent. Figure 2 shows the monthly count of days exceeding 36 °C for Lutzville, Paarl and Worcester, as well as projected changes in the same statistic for mid-century. This shows that under current climate, very hot days are frequent in the mid and late summer months, but also that under climate change such occurrences will increase dramatically.

Extreme events could occur more frequently in future. The very hot table grape production regions are most vulnerable. Cooler and moister areas such as the southern mountain slopes will likely be somewhat buffered.

**Climate change risks and impacts on table grape production**

Table grape production in this region is sensitive to very high temperatures and prolonged heat waves, reduced seasonal rainfall and longer dry spells, higher frequency of heavy rainfall and flooding, more frequent and heavier late spring and early summer rainfall, and rising CO₂ levels. Other possible high impact climate risks for table grape production include frost, hail and strong wind. Since these are often erratic, highly localised and poorly captured by climate models, their future risk and impact is not understood.

As for other perennial fruit crops, climate change is expected to reduce the amount of winter chilling which is required by the grapevine to induce dormancy. Insufficient chilling results in early and irregular bud break which leads to uneven berry size and quality, and challenges to timing of harvest and post-harvest shelf life. The longer-caned cultivars appear to be more sensitive. Warming also caused shifts in phenological stages. Worldwide, interval lengths between the main grapevine phenological stages have declined. These effects can also influence the developmental phases, yield and quality during the following season. Nevertheless, warmer spring temperatures could be beneficial to fruit set and early berry growth in some areas.

An hourly temperature dataset for every day for 50 years for each of 5838 quinary catchments in South Africa was used to model percentage days optimal for grapevine photosynthesis and colour/flavour. Relative to current conditions, climate change was predicted to reduce optimal conditions in the warm areas of the middle Berg River region and the lower Olifants River region.

As in the case of wine grapes, warming will affect the quality of the grapes in terms of skin colour and berry composition. Warming during the pre-harvest period reduces colour expression in some red cultivars, shifts the balance between sugars and acids (more rapid sugar accumulation, lower acids), and affects the flavour components, i.e. the ripening processes are altered.
On the basis of global climate modelling, it has been projected that increases in the frequency of extreme hot days (>35 °C) in the growing season would eliminate grape production in many areas of the United States. However, estimates of losses following a severe summer heatwave in Australia in 2009 were not always related to the amount of heat above a certain threshold but to the management practices employed in the lead-up and through the event, i.e. where current vineyard management already addresses regular exposure to high temperatures through canopy and water management.

Table grapevines require sufficient water during the growth season, provided by a combination of rainfall and irrigation. High temperatures increase grapevines’ transpiration and vineyard evapotranspiration, which could, in the long-term, lead to an increased demand for irrigation water at a time when agricultural use of water is coming under increased pressure and the resource could diminish. Table grape production is sensitive to water stress, with flowering and fruit-set periods being the most critical phases. It has been estimated that warming associated with climate change will increase the irrigation requirement of crops by around 8 % by mid-century. Shifts in rainfall seasonality have potentially significant impacts. Recent trends towards wetter spring/early summer have negatively affected berry growth and disease incidence (e.g. Botrytis), but if longer-term drying in spring, summer and harvest time is realised, then this could be beneficial for grape production.

Significant threats of climate change (warming, changes in humidity and changes in rainfall) to table grape production are likely to lie in changes to the distribution and intensity of pest species, the spread of diseases and growth of weeds. Very little is known about this. Higher pest pressure would increase the need for pesticides, thus raising the costs of plant protection and increasing the risk of pesticide resistance and negative impacts on natural predators. Additional sprays can also jeopardise the acceptability of fruit in the export market due to residues. The distribution and competitiveness of weeds changes with increasing temperatures, changing rainfall patterns and rising CO₂. Weed control could also become more difficult.

The impacts on rural communities need to be considered. Adverse impacts on the sector and its extensive value chain, and the employment it offers could heighten levels of poverty, drive urbanisation, and increase food insecurity. The well-being of agricultural workers is likely to be affected by increasing heat stress, diseases associated with floods and poor water quality, and physical danger associated with storms, floods and fires. Poor nutritional status and other health threats (stunting, obesity, HIV/AIDS) prevalent in the region render rural workers less resilient to the demands of agricultural labour under stressful conditions.

The following table summarises key sensitivities for each agro-climatic zone:
Table 1. Summary table of climate change sensitivities for each agro-climatic zone in the table grape production regions. The summary indicates overall agricultural sensitivities and is not specific to table grape production.

<table>
<thead>
<tr>
<th>Name</th>
<th>Main water resource features</th>
<th>Main climatic features</th>
<th>Climate change temperature projections¹</th>
<th>Main commodities</th>
<th>Future agricultural potential²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breede</td>
<td>Breede River, dams, farm dams, very large storage capacity</td>
<td>Winter rainfall; hot dry summers</td>
<td>Medium range warming</td>
<td>Wine and table grapes, wheat, stone fruit, pome fruit, olives Broilers, egg layers</td>
<td>Remains high as long as dams fill up</td>
</tr>
<tr>
<td>Hex</td>
<td>Farm dams, very low storage capacity</td>
<td>Unique production climate, cold winters with rain, and some summer rainfall, hot in summer</td>
<td>Medium range warming</td>
<td>Table grapes, citrus</td>
<td>Remains high as long as dams fill up</td>
</tr>
<tr>
<td>Olfants irrigation</td>
<td>Olfants River, dam, large storage capacity</td>
<td>Hot and dry summers, with occasional winter rainfall</td>
<td>Medium to high range warming</td>
<td>Citrus, wheat, wine and table grapes, rooibos, tomatoes</td>
<td>Remains viable as long as river flows and dams fill up, but constrained by heat</td>
</tr>
<tr>
<td>Swartland</td>
<td>WCWSS large dams, Berg River, farm dams, large storage capacity</td>
<td>More reliable dryland conditions than further north. Winter rains, with cool conditions, hot to very hot in summer</td>
<td>Low to medium range warming</td>
<td>Wheat, wine and table grapes, canola, olives Dairy, pigs, sheep, cattle</td>
<td>Remains high as long as dams fill up</td>
</tr>
</tbody>
</table>

¹ Due to model uncertainties both decreasing and increasing rainfall scenarios should be considered
² For the medium term future 2040-2060
Natural resource use and management

Many of the impacts of climate change on agriculture show strong linkages with the ecological system and the natural resources which provide the means for farming. In the table grape production areas, the most important factors and threats to consider are water supply and demand by numerous competing users, fire risk, invasive alien plant infestations, and biodiversity loss. All are expected to become worse under climate change.

Land and soils

Arable land in the core table grape production regions is also intensively utilised for the irrigated production of wine grapes, citrus and deciduous fruit and vegetable crops, as well as for winter grains and rooibos (Olifants River region). Shifting production to other areas in response to climate change will not be easy and the sector will mainly need to adapt to changing conditions on its existing land ‘footprint’.

Water resources

Water resources are already stressed with low level of assurance for agricultural use. Climate change is likely to increase this stress through increasing evapotranspiration, more variable and very likely reduced rainfall and increasing crop water demand. The current repair and raising of the Clanwilliam Dam wall will bring some relief to the Olifants River catchment.

Crop irrigation accounts for a very high proportion of water use in the Berg (42%), Breede (68%) and Olifants-Doorn (87%) Water Management Areas (WMAs). For this component of production, water storage and conveyancing capacity and maintenance of infrastructure are essential. For example, the failure of a canal from the Clanwilliam Dam in early 2015 caused massive losses to irrigation farmers. The protection and management of high-yielding catchments and flow-regulating wetlands and river banks upstream of farmlands is critical for the optimisation of water flows serving agriculture. Options to increase water supply, such as water conservation and demand management through improved irrigation efficiencies, will also need to be developed.

The highly developed and integrated water supply system for the greater Cape Town area (the Western Cape Water Supply System, WCWSS) provides a reasonable degree of resilience to potential climate change impacts for this main demand centre and the intensive agriculture practiced in the Berg River catchment. Future additional water sources and re-use of water are receiving high levels of attention from water planners. However, water quality in parts of the Berg and Olifants Rivers is negatively impacted by salinity, sub-standard effluent return flows and runoff from dense urban settlements. There is a risk that irrigation water not complying with the required standards by international export markets will have a very significant economic impact.
Compared to the WCWSS, the less well-integrated water supply systems of the Olifants and Breede regions will likely be more vulnerable to climate change impacts.

**Biodiversity and ecosystems**

Healthy ecosystems connected to working landscapes are the foundation for clean air and water, fertile soil and food production. They provide an immensely valuable role in buffering agriculture from the worst effects of climate variability and climate change, provide opportunities for adaptation, and provide sinks for the absorption of carbon dioxide.

The region contains ecosystems with exceptional biodiversity, some of which is under threat from extensive land transformation. Other threats to ecosystems within or surrounding farmlands include destruction of riverbanks and wetlands, which act as flow regulators and drought buffers. The regions suitable for table grape production contain some important wetlands, many threatened by agriculture. Invasive alien plants and wildfires are expected to become more problematic under climate change. High fire risk conditions are projected to increase by between 40% and 300% from the western to the eastern parts of the province with rising risks to crops, livestock and farming infrastructure. Future shifts in agricultural climatic potential could come up against restrictions on land conversion imposed by conservation requirements.
A climate resilient sector

Responding to climate-related risks involves decision-making in a changing but uncertain world. The agricultural sector of the Western Cape is adapting by responding to the demands posed by current climate variability and extremes in the context of other equally challenging socio-economic drivers and pressures. Irrespective of production system, location or resource status, if producers and their value chain have access to a wider choice of appropriate options, they are able to innovate and improve their practices tailored to their own situation and needs.

In the agricultural sector, technology plays an important part in productive potential and ability to adapt. It includes physical infrastructure, machinery and equipment (hardware), knowledge and skills (software), the capacity to organise and use all of these (orgware), as well as the biological technology with which farmers produce.

For table grape production in the Western Cape, it is expected that flexible adaptation approaches such as the use of heat-hardy cultivars and rootstocks, careful soil management, best practice Integrated Pest Management and new technologies such as shade netting, combined with the fertilising effects of rising atmospheric CO₂, could provide some resilience to warming.

The greatest threat may arise through malfunctioning water storage infrastructure and irrigation systems, as well as increasing competition from other water users such as growing settlements, particularly in times of drought, which could lead to reductions in water allocations to farms. Some of the greatest gains in water use efficiency can still be made in reducing losses from seepage and the conveyance system (i.e. from river or dam to the vineyard edge), but these have added challenges such as costs and ownership of infrastructure. Restoration of natural ecosystems including riparian buffers and wetlands is required. Innovative solutions such as those being implemented as part of the Berg River Improvement Plan should also be considered as this will reduce the current water quality risk as well as the potential increased water quality risk under future climates.

Table grape farmers are shifting to the use of more water efficient drip irrigation systems. These are being installed in new developments and where old vineyards are replaced. However, drip systems are not suited to some soil types and slopes, especially the more marginal sites. There are indications that further increases in water use efficiency are possible in the early season. Research has begun locally to improve water use efficiencies in this sector. Precision irrigation guided by satellite imaging (‘FruitLook’) has been proven to reduce water use and costs.

In all cases marketing and processing options should be re-evaluated on a continuous basis in order to optimise the opportunities presented by local shifts in production and shifting global markets.
Energy use and reducing greenhouse gas emissions from agriculture

The generation of electricity and the use of liquid fossil fuels such as diesel leads to greenhouse gas emissions which cause climate change, but energy is an essential input in agricultural production and processing. In the Western Cape the sector is responsible for 2% of energy use and 5% of greenhouse gas emissions. Estimates suggest that the livestock sub-sector is accountable for approximately 16% of provincial agricultural emissions (highest contribution from cattle), grains and field crops for 28% (highest contribution from wheat), fruit and wine for 55% (highest contributions from pome fruit and wine grapes) and other commodities for 1%.

The economic competitiveness of the agricultural sector must be maintained and increased. One component of this is to ensure international acceptability of agricultural products from the province by minimising the environmental impact of their production and complying with agreed standards for energy use and emissions.

The ‘carbon footprint’ of table grape production, packaging and cold storage in South Africa is being measured through the Confronting Climate Change (CCC) project. The results show that the largest sources of greenhouse gas emissions are electricity usage (especially for irrigation pumping, packhouse operations and cold storage), the use of nitrogen-based fertilisers, diesel usage, and packaging material. Measures to reduce emissions include the reduction of electricity consumption through improved efficiencies and switching to renewable (non-fossil) energy sources such as wind or solar, the use of variable speed drives in irrigation pumps, the more efficient and lower use of nitrogen-based fertilisers, or the use of alternative low-carbon packaging materials. Where organic waste is high, waste-to-energy technologies provide opportunities to generate energy and reduce emissions.
Key actions which farmers can implement

What are key actions table grape farmers can take to be able to respond effectively to existing climate risks and projected climatic changes? The following priorities were highlighted by the status quo assessment and by farmers attending the stakeholder workshops:

1. **Improved management of water resources** to optimise water use efficiency, reduce water losses in the system, and preserve and restore good water quality. Monitor soil moisture levels and depletion rates carefully and irrigate vineyards optimally according to best practice. Register with FruitLook in order to obtain free advice on irrigation scheduling which can increase water use efficiency. Aim to maintain an organic soil cover at all times to retain moisture. Water infrastructure must be well maintained to prevent losses and crises. Catchments and wetlands require conservation and good management – maintain the necessary buffer of unfarmed and undisturbed land between riverbanks / wetlands and the cultivated lands. Manage water quality as best as possible.

2. **Manage the lack of sufficient winter chilling** by using technologies which can overcome the problem to ensure even budbreak and good berry quality. This could include the application of safe chemical dormancy breakers or the use of cultivars with a lower chilling requirement.

3. Natural hazards and pest and disease outbreaks pose a high risk in some parts of the region and **pro-active risk management** should be practiced by farmers. These should include learning from established long-term experience of dealing with droughts, better holistic flood and drought planning by all role players (farmers and government in partnership), greater attention to firebreak management, and accessing the best available weather forecasts for decision making purposes. In the future, the development of early warning systems and responses relating to pests and diseases will be critical.

4. The energy crisis and climate change are both driving the need for **increased efficiencies of energy use** and the **greater use of renewable energy** on-farm where this is feasible. Farmers who need energy for irrigation pumping and maintenance of the cold chain for perishable produce are particularly vulnerable. The use of variable speed pumps and strategic irrigation scheduling can reduce pumping costs (and water use) significantly. In addition, **reduce the synthetic nitrogen fertiliser usage**, which can be achieved through more precise application as and when the plant needs it, and utilize small scale **waste-to-energy technology** which could provide an opportunity to both reduce waste-related emissions and reduce the reliance on grid electricity.
5. Monitor shifts in phenological stages and in particularly harvest dates. Use this information to **enhance market opportunities** and strengthen the trade position against foreign competitors in the export market.

Further information on all these responses and opportunities, and others, can be found on the GreenAgri information portal: [http://www.greenagri.org.za](http://www.greenagri.org.za)
Conclusion and way forward

The Western Cape agriculture sector is faced with numerous difficulties and climate change will exert its influence in the context of multiple interacting drivers and pressure points. It can thus be regarded as a stress multiplier. Agriculture is highly dependent on effective risk management covering economic, environmental and social sustainability.

All farms in the table grape production areas can experience exposure to variable and extreme weather, but some are able to draw on resources and skills to ‘bounce back’ relatively unscathed, whereas others never fully recover and become morbid or fail. Economies of scale and diversification across commodities and agro-climatic zones renders larger farming groups with greater resources much more resilient than small, undiversified and resource-poor farming operations. A shift to more resilient crop types, cultivars and farming systems (climate smart agriculture) can buffer agriculture against some aridification without negatively impacting profitability or jobs.

Nevertheless, there will be ‘winners’ and ‘losers’ and the sector together with government needs to identify the latter and jointly provide support. The SmartAgri project is currently developing the Climate Change Response Framework and Implementation Plan for the province, which will provide the mechanisms for such support. We warmly invite comment on the issues summarised in this brief, and the needs of farmers and other role players in responding to climate change.

Contact us:

To find out more or send comments or questions please visit www.greenagri.org.za.
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