DROUGHT RESILIENCE

Study explores the impact of multi-year drought on apple and wheat farmers in the Western Cape

Climate change is likely to impact all apple and wheat production regions in the Western Cape, albeit to varying extents. A new study explores how drought affects resilience building for crop production in the winter rainfall region of the province. Article by Jorisna Bonthuys.

For key wheat and apple production regions, the recent multi-year drought was the most severe one experienced in 30 years. This may be an early sign of the effects of climate change on agriculture in the winter rainfall area of the Western Cape. This is evident from Dr Simone Theron's PhD study. She received her doctoral degree from Stellenbosch University's Department of Horticultural Science (part of the Faculty of AgriSciences) in April. Theron's' dissertation, titled ***Improving resilience in rainfed and irrigated agriculture under the future climate in the winter rainfall region of the Western Cape: Lessons from the 2015-2018 drought***, underlines the urgent need for adaptation in agriculture. Her study sheds light on factors affecting resilience-building in crop production, adaptation approaches, and barriers to adaptation.

Theron's research focused on how producers may be impacted from a climate perspective from now until 2065. She zoomed in on two agricultural commodities, wheat, and apples, across five production regions: the Swartland, the Rûens, Ceres and Elgin-Grabouw-Vyeboom-Villiersdorp. Theron, who completed her study in 2021, worked for the Agricultural Research Council's (ARC) business unit focusing on soil, climate and water issues until recently.

The overall aim of her research was to capture the lessons learned from the drought. "The drought provides a case study

for climate resilience and can offer lessons for adaptation under climate change," she says. "In that regard, several questions arise. How severe was the drought, and how did it manifest spatially?

"What responses were taken by farmers for both rainfed and irrigated crops? Can drought forecasting be improved in the province? What lessons can be identified for crop production in terms of drought response and adaptation?"

The apple industry was chosen to represent irrigated horticulture because it is the second-largest deciduous fruit crop grown in the province, and some key production regions share water resources with the City of Cape Town. Wheat was chosen to represent rainfed crops. It is the most profitable and widespread of the rainfed crops and covers the largest area of any crop grown in the province.

Agriculture laid bare by drought

Drought has been identified as a key vulnerability for agriculture under climate change — most notably in Southern Africa. There is evidence that inter-annual rainfall variability over southern Africa has increased since the late 1960s. Droughts have also become more intense and widespread in the region. As a result, it is considered a priority area for adaptation.

"Improving the resilience of the agriculture sector to rising shocks and stresses under climate change is vital," Theron says. "Resilience is dynamic, nuanced, socially contingent, and context-specific."

"As with all natural disasters, drought has both a natural and a social dimension," she adds. While drought is a natural and normal occurrence, it can still have damaging effects on human lives and the environment." For example, this particular drought caused devastation to agriculture in the province, resulting in approximately 30 000 agricultural job losses.

The Western Cape has been identified as a highly vulnerable region to the effects of climate change due, in part, to its reliance on winter rainfall and water storage schemes. Projections indicate that the province is likely to become hotter and drier, with more frequent drought. Such conditions may be experienced as early as 2030 to 2040.

Recent studies have shown that climate change also increases the severity of extreme events (including droughts) in the province. Researchers have found that, because of human-induced climate change, the recent multi-year drought was three times more likely to occur than it would have been otherwise.

"Without appropriate adaptation actions, climate change is likely to constrain agricultural activities in the Western Cape," Theron emphasises. "It is becoming clear that climate change will create new risk management challenges for farm-level adaptation and decision-making."

She used observed climate datasets and production data to understand the impacts of the drought on producers. Theron also investigated actual drought-related adaptations at the farm level and the factors that appear to be driving and supporting these actions. Theron analysed the physical and spatial characteristics of the drought using both agricultural and hydrological drought indices. She performed a trend analysis to investigate whether these observations form part of a long-term trend and indicate potential future conditions.

The apple regions emerged as more vulnerable to climate change than wheat. This is because apple orchards operate on considerably longer timescales than annual wheat crops, typically surpassing 25 years.

She used a questionnaire to collect data and did interviews with farmers and industry stakeholders on how the drought affected production, strategies (relating to water resources) taken to alleviate the effects of the drought, and perspectives on adaptation and resilience.

Theron also employed drought indices to determine whether they could be used to improve seasonal drought forecasts. Furthermore, she considered the differences between retrospective and prospective drought-related adaptation and how this translates to building climate resilience to drought for crop production.

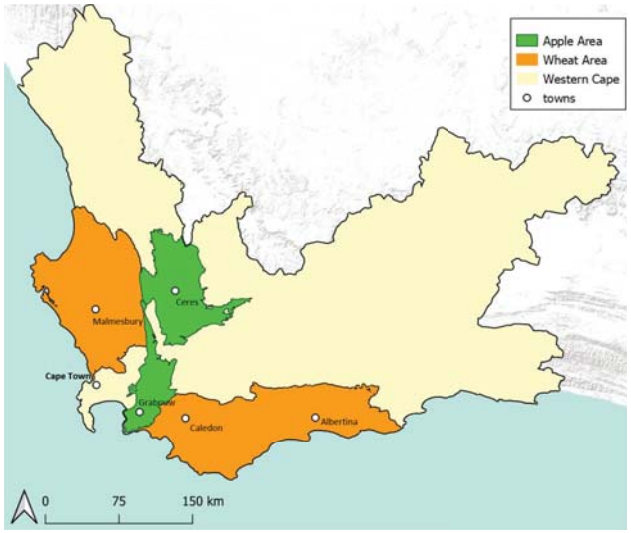
Adapting to a changing climate

Drought manifests through four main stages. "It begins as a meteorological drought, brought about through below-normal rainfall over a period of one to three months. If drought conditions continue beyond a few months, it results in poor soil and subsoil moisture, affecting crop growth; this becomes the second stage, namely an agricultural drought.

"The third stage is referred to as a hydrological drought, which develops when persistent drought conditions for longer than 36 months and affect runoff, which manifests through reduced streamflow and reservoir storage. Finally, a socioeconomic drought arises when the physical water shortage affects people."

Theron says it is crucial to understand and learn from past drought events to build resilience in agricultural systems and society. This particular drought was characterised by very low rainfall amounts received, particularly in autumn and spring. Theron says the length of drought periods and their persistence is highly variable in the province, with drought return periods varying from one to four years for an agricultural drought, and up to ten years for a hydrological drought.

Both rainfed and irrigated crops will be affected by climate change; however, the risks and impacts between the two farming types will differ.



This map shows two wheat-producing areas and two apple producing areas studied. These areas are visualised according to the SmartAgri agro-climatic zones.

"The results suggest that climate change is likely to impact all crop production regions in the province, albeit to varying extents," Theron says. "Increases in minimum and maximum temperature and drought intensity were significant, with significant changes likely to occur between 2040 and 2050.

"Climate change is a 'wicked problem' or 'crisis multiplier', likely to pose the greatest threat to agriculture," Theron says. "It threatens many sectors with impacts on food security, natural resources, rural security and stability, and urban-rural migration."

Climate change will, for instance, affect rainfall and water resources and lead to higher temperatures in key apple production areas. In addition, higher temperatures will affect accumulated chill units, affecting dormancy and rest breaking of fruit trees. Increased temperatures can also lead to more sunburn damage and reduced fruit quality.

Research shows that climate change could also cause a significant decrease in the area suitable for apple production before 2050. In addition, projected decreases in rainfall and increases in drought events may heighten the risk of dams not filling adequately, which may lead to more frequent water restrictions, putting apple orchards under stress and reducing yields and fruit quality.

A reduction in winter rainfall will lead to lower storage in irrigation dams at the end of the rainy season and lower streamflow. In addition, higher summer temperatures will also lead to higher evaporation from the soils and higher transpiration from the trees. Thus, irrigation water demand to sustain existing production quantities is estimated to rise by approximately 10% by 2050.

"This means agriculture will need to produce more food for a growing population, but under more challenging conditions with likely less available resources," Theron says. "It also means there will be added pressure on infrastructure and shared resources, notably in the water sector.

"Adaptation needs to happen at all levels of the value chain, and the onus cannot be placed squarely on farmers to meet these challenges."

Competition with urban users for water resources may become a source of vulnerability for irrigated agriculture over the next few decades. "This kind of competition was highlighted in some production regions during the recent drought," Theron says. "It emphasises the interconnectivity and delicate balance of urban and agricultural water use in this region."

According to Theron's research, apple regions emerge as more vulnerable to climate change than wheat. This is because apple orchards operate on considerably longer timescales than annual wheat crops, typically surpassing 25 years. New orchards only become productive after four to five years. As a result, apple growers need to prepare for significant climate changes sooner than wheat farmers.

Mature apple orchards also use more water than young ones. As trees mature, their water requirements will increase, which will increase their vulnerability to drought and irrigation water restrictions. This suggests that the average projected age of orchards, particularly after 2040, should be considered in climate vulnerability assessments of the apple regions.

Nonetheless, to some extent, irrigated farms are less sensitive to climate change since irrigation has a mediating effect. "Importantly, irrigation reduces a farm's dependency on rainfall and reduces interannual variability of production," Theron explains. "However, this is dependent on the availability of water for irrigation."

Future-proofing agriculture

Most farmers who participated in this study are actively preparing for climate change or intend to start preparing within the next five years. The majority of participants (53%) said they are already experiencing the effects of climate change. Most farmers (72%) felt that they had learnt from the 2015-2018 drought and had changed some of their farming practices since then. Furthermore, producers who said they learned from the drought were also more likely to prepare for climate risks.

The majority of farmers employed crop management practices to respond to the drought. These practices included the use of quality seeds and planting materials, integrated pest management, nutrient cycling, and soil protection (particularly increasing the carbon content).

The adoption and expansion of conservation agriculture and the use of short-season wheat cultivars were also highly cited as drought management strategies. Adaptation options available to farmers with rainfed crops include using cover crops and mulch to retain soil moisture, switching to short-season cultivars, changing crop types, and diversifying their business both within and outside the agricultural sector.

Farmers are encouraged to adopt more efficient irrigation systems and precise irrigation scheduling to adapt to climate change and increased pressure on resources. Another option is for farmers to use other sources of water such as groundwater where the quality of water allows and rainwater harvesting. Theron says farmers using irrigation on their farms can also adapt

by switching to more heat-tolerant crops or cultivars and using shade nets.

In response to climate change, apple farmers view on-farm water management (such as irrigation management and water recycling) as the most important strategy. On the other hand, wheat farmers' strategies are focused on crop management (including conservation agriculture). However, how these strategies will apply at the farm level and their success will vary between the two farm types and by location. For example, changing cultivars and crop types is relatively easy for an annual crop such as grain. Farmers can use seasonal forecasts to decide which varieties to plant that season.

According to Theron's results, producers' adaptation strategies did not differ too much from their drought response. "This suggests that most farmers are still focused on short term coping or recovery mechanisms rather than long-term resilience building," she says. "It may also suggest the strength of information networks in driving farmer decisions. Farmers may be more likely to adopt the practices of their peers in the fear that they may get left behind."

Theron says the results also suggest that decisions regarding climate change or drought response strategies may be attributed to other influences such as farmer information networks. "Importantly, it was found that farmers who rely a great deal on weather forecasts were more likely to feel that their farm's response to the drought was effective. This illustrates the importance of seasonal or weather forecasts in strengthening resilience."

"Guiding farmers on whether and which inputs to purchase is critical during droughts as farmers need to ensure they do not overspend," Theron says. "Considering seasonal cycles in drought forecasts can provide a considerable source of drought predictability."

She considers drought forecasting critical for providing early warning and resilience-building programmes in the region. In addition, research shows drought indices may be a valuable component of future drought early warning systems.

Most farmers cited financial barriers to adaptation. Institutional barriers were cited as the second biggest barrier to adaptation. In terms of support, farmers cited industry bodies as giving the most support to farmers, with research institutes cited as the second.

The most significant change is expected to be in drought intensity in Ceres (an apple farming area) and the Swartland (a rainfed winter wheat area). Moreover, Ceres and the Swartland are likely to experience the largest temperature increases, possibly as high as 4°C.

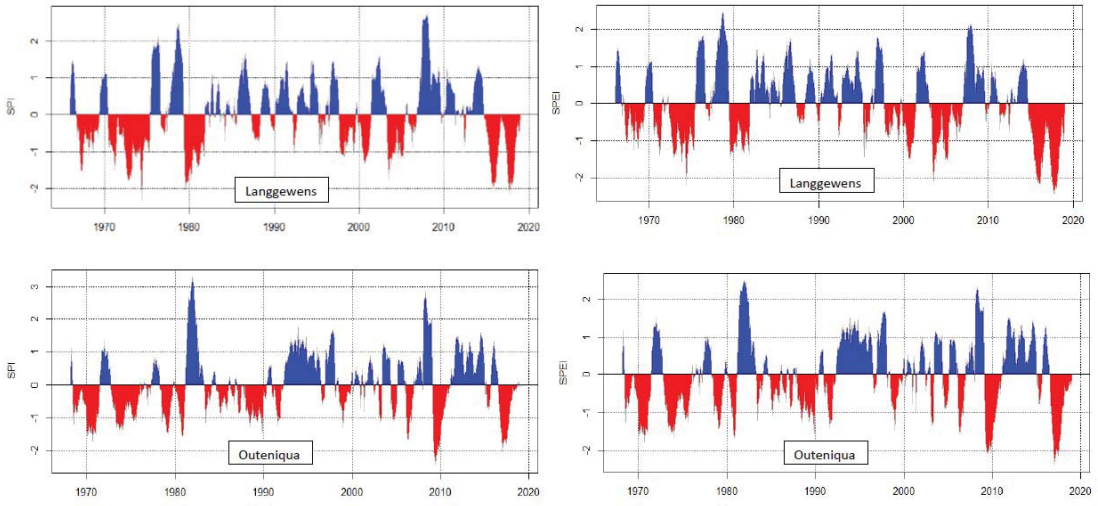
From the results, five key lessons were identified: drought is a reoccurring phenomenon in this region; forecasts are an essential tool for building resilience; drought indices can be a valuable tool for seasonal drought prediction; farmers have high autonomous adaptative capacity; and improving the various types of capitals available to farmers (including social capital).

She recommends that investments into adaptation focus on research and development, particularly with regard to cultivar development, irrigation management, tailored weather forecasting, and risk assessments.

"Although the results presented suggest a daunting outlook for agriculture in the Western Cape, the sector has already adjusted and is continuously adapting to changes in the natural resource base, including those brought on by climate variability and climate extremes.

"While some of these adjustments may be transformative or prospective such as the widescale adoption of conservation agriculture, most are more incremental, retrospective responses. Responses to the drought provide a recent example of the capacity and ability of the sector to respond to sudden and extreme climatic change."

Theron was based at the ARC's division for natural resources and engineering (ARC-NRE). Her research was supported through the ARC's Professional Development Programme.



This data reflects the drought index accumulated over 12 months for Langgewens (top) and Outeniqua (bottom) from 1965 to 2018.