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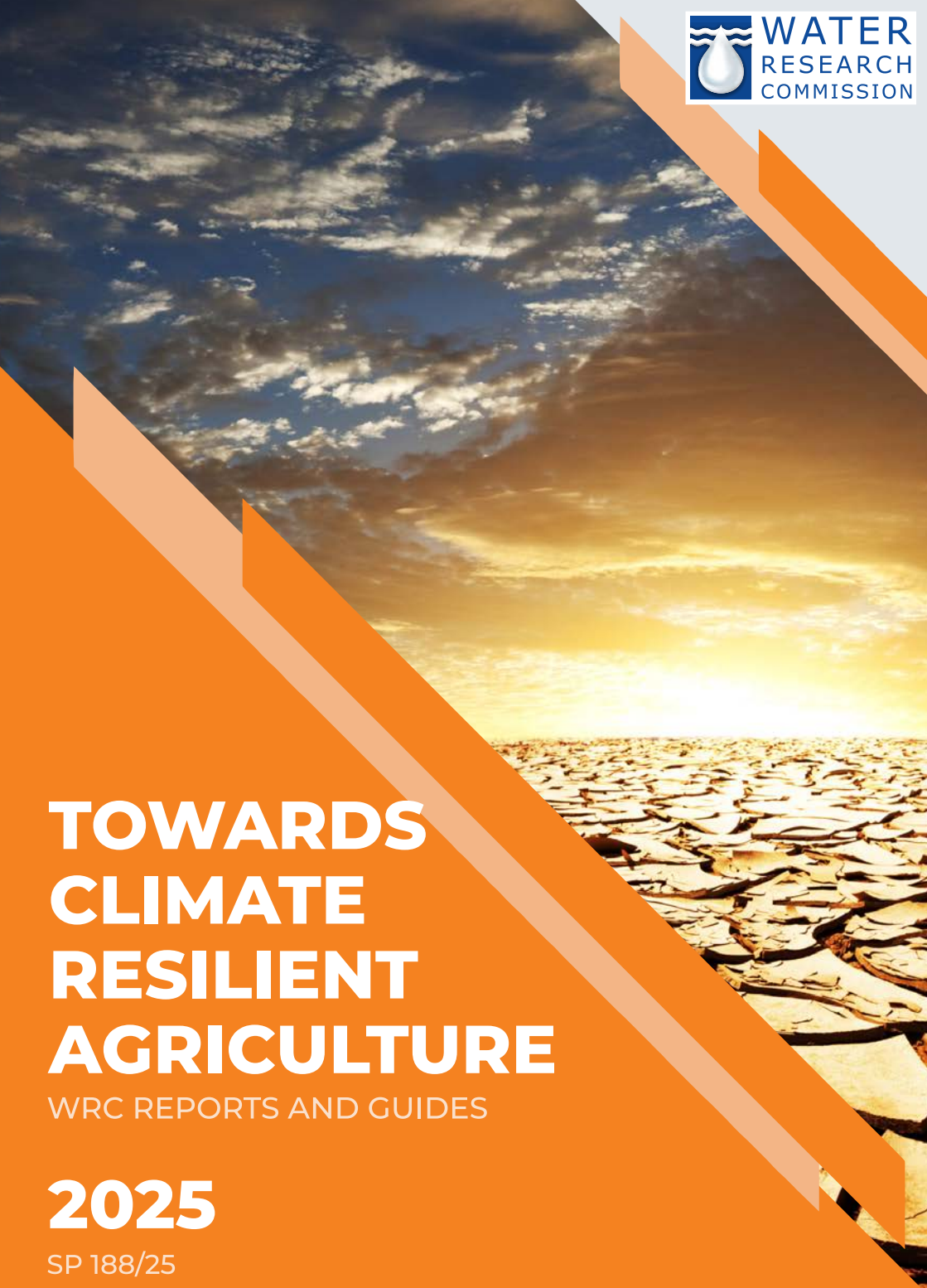

TOWARDS CLIMATE RESILIENT AGRICULTURE

WRC REPORTS AND GUIDES

2025

SP 188/25

Obtainable from:
Water Research Commission
Private Bag X03
Gezina
0031

SP 188/25

Printed in the Republic of South Africa

INTRODUCTION

South African farmers, whether commercial or smallholder, face increasing pressure from climate change, which is intensifying extreme weather events such as droughts, floods, heatwaves, and shifting rainfall patterns. These changes threaten food security, rural livelihoods, and the country's broader economy, as agriculture plays a vital role in providing jobs, supporting exports, and sustaining communities. For farmers, adapting to these unpredictable conditions is no longer optional; it is essential for survival and long-term resilience.

Research and development (R&D) play a critical role in helping agriculture navigate this uncertain future. Through innovation, science, and technology, researchers are developing drought-tolerant crops, water-efficient irrigation methods, improved soil management practices, and early-warning systems that allow farmers to plan ahead. R&D also supports the adoption of climate-smart farming techniques that reduce emissions while increasing productivity and sustainability. Importantly, localised research, such as that funded by the Water Research Commission (WRC), ensures that solutions are tailored to South Africa's diverse farming landscapes, from smallholder farms to large-scale commercial operations.

By investing in agricultural research and fostering strong partnerships between scientists, farmers, and policymakers, South Africa can strengthen its ability to withstand climate shocks while ensuring food security for future generations. Adaptation, guided by evidence-based solutions, is the bridge between climate risk and agricultural resilience. This brochure highlights the research undertaken between 2015 and 2025 under this topic by the WRC.

FROM DROUGHT RESPONSE TO DROUGHT PREPAREDNESS AND MITIGATION: DROUGHT MONITORING FOR EXTENSIVE LIVESTOCK FARMING IN THE NORTHERN CAPE

WRC report no. 3175/1/24

The primary achievement of this project is the establishment of a detailed indicator framework for drought monitoring, tailored specifically for reference farms in the extensive livestock sector. This framework not only enriches the National Drought Disaster Risk Reduction and Management Plan but also provides a model that can potentially be replicated across various agricultural sectors and provinces. Additionally, the project has introduced a computerised reporting and data capturing system that replaces outdated paper-driven methods, thereby streamlining and enhancing the efficiency of data collection and drought monitoring. This system is poised to be adopted nationwide, offering real-time monitoring capabilities that are crucial for timely and effective drought response. Furthermore, the development of contingency plans based on distinct drought categories provides a structured approach to managing drought impacts, specifically in the livestock sector. These plans are a critical resource for farmers, enabling them to implement strategic measures to mitigate the adverse effects of drought based on varying levels of severity. The research outputs from this project not only guide the development of similar contingency plans in other sectors but also underscore the necessity for a unified approach to drought management. This includes the integration of municipal reporting, which will further the reach and effectiveness of drought mitigation strategies.

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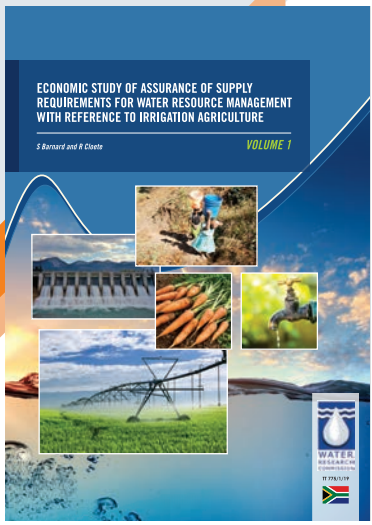

ECONOMIC STUDY OF ASSURANCE OF SUPPLY REQUIREMENTS FOR WATER RESOURCE MANAGEMENT WITH REFERENCE TO IRRIGATION AGRICULTURE

WRC report no. TT 775/1/18 (Volume 1) and TT 775/2/18 (Volume 2 – Guidelines)

The water demands within a hydrological system are dynamic and are based on population growth and economic development. The purpose of water resource planning is to determine the sustainability of the available water supply with current and growing demands imposed on the system. This study set out to develop a decision-support tool for managing water supply assurance by linking water resource models with an economic model. Its main objective was to determine how different levels of water supply reliability affect economic indicators such as GDP, employment, and household income, especially in irrigation-intensive regions. Case studies of the Orange, Groot Letaba, and Mhlathuze river systems showed that water restrictions can result in severe economic losses, up to R635 billion under extreme curtailments. Findings highlight that prioritising water allocation based on economic impact can guide more equitable and sustainable drought management.

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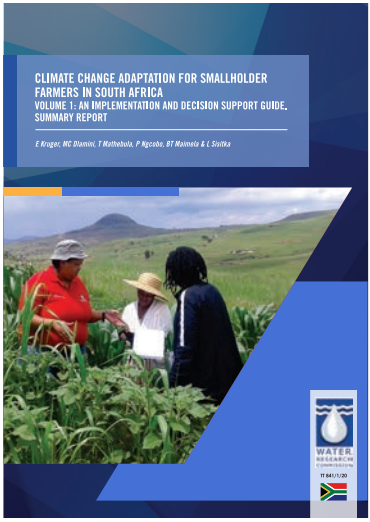

CLIMATE CHANGE ADAPTATION FOR SMALLHOLDER FARMERS IN SOUTH AFRICA. AN IMPLEMENTATION AND DECISION SUPPORT GUIDE

Report no. TT 841/20 (Multiple volumes)

This project had several objectives, namely to evaluate and identify best practice options for climate resilient agriculture (CRA) and Soil and Water Conservation (SWC) in smallholder farming systems, in two bioclimatic regions in South Africa; To amplify collaborative knowledge creation of CRA practices with smallholder farmers in South Africa; to test and adapt existing CRA decision support systems (DSS) for the South African smallholder context; and to evaluate the impact of CRA interventions identified through the DSS by piloting interventions in smallholder farmer systems, considering water productivity, social acceptability and farm-scale resilience. The project also tested visual and proxy indicators appropriate for a Payment for Ecosystems based model at community level for local assessment of progress and tested against field and laboratory analysis of soil physical and chemical properties, and water productivity. The project delivered nine reports:

*Volume 1: Climate change adaptation for smallholder farmers in South Africa. An implementation and decision support guide. Summary report. (**WRC report no. TT 841/1/20**).*
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*Volume 2 Part 1: Community climate change adaptation facilitation: A manual for facilitation of climate resilient agriculture for smallholder farmers (**WRC report no. TT 841/2/20**).*
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*Volume 2 Part 2: Climate resilient agriculture. An implementation and support guide: Intensive homestead food production practices (**WRC report no. TT 841/3/20**).*
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*Volume 2 Part 3: Climate resilient agriculture. An implementation and support guide: Local, group-based access to water for household food production (**WRC report no. TT 841/4/20**).*
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*Volume 2 Part 4: Climate resilient agriculture. An implementation and support guide: Field cropping and livestock integration practices (**WRC report no. TT 841/5/20**).*
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*Volume 2 Part 5: Climate resilient agriculture learning materials for smallholder farmers in English. (**WRC report no. TT 841/6/20**).*
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*Volume 2 Part 6: Climate resilient agriculture learning materials for smallholder farmers in isiXhosa. (**WRC report no. TT 841/7/20**).*
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*Volume 2 Part 7: Climate resilient agriculture learning materials for smallholder farmers in isiZulu. (**WRC Report No. TT 841/8/20**).*
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*Volume 2 Part 8: Climate resilient agriculture learning materials for smallholder farmers in Sepedi. (**WRC report no. TT 841/9/20**).*
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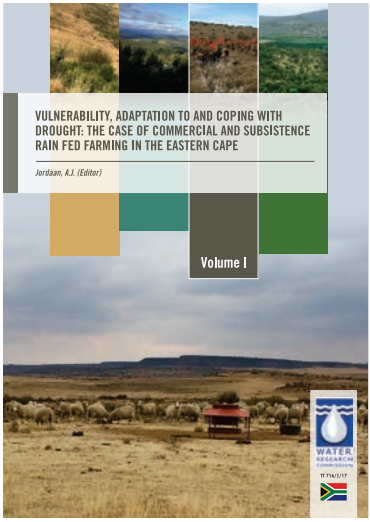

VULNERABILITY, ADAPTATION TO AND COPING WITH DROUGHT: THE CASE OF COMMERCIAL AND SUBSISTENCE RAINFED FARMING IN THE EASTERN CAPE

WRC report no. TT 716/1/17 (Volume 1) and TT 716/2/17 (Volume 2)

Dry periods and droughts remain the major meteorological factor with devastating impacts on the livelihoods of most rural people in Africa. The agricultural sector, specifically, incurs millions of Rand in losses every year. Economic growth in South Africa is severely hampered by every disastrous drought, even given the low contribution of agriculture to GDP in an industrialised economy. This research addressed a serious issue in agricultural risk and disaster management in South Africa. The results of the research provided the basis for a national drought management strategy and provided improved indicators for drought classification and declaration. Provinces currently manage drought disaster declaration and drought response and each province applies different guidelines, which are influenced by politicians and pressure groups. This research provides a set of quantitative measures for drought classification and disaster declaration. The difference in vulnerability and drought resilience between commercial and subsistence farmers is also highlighted, with recommendations made on the criteria indicators for drought declaration to each sector.

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COPING AND ADAPTATION STRATEGIES FOR AGRICULTURAL WATER USE DURING DROUGHT PERIODS

WRC report no. KV 363/17

This project was commissioned by the WRC in 2016. The main objective was to conduct a desktop review in the nine provinces of South Africa, with a view to identifying the current knowledge on drought and occurrence, how the government is managing the drought both at national and provincial level, including early warning systems, climate advisory services, and indigenous knowledge systems. The research was also aimed at reviewing drought coping and adaptation strategies in dryland cropping systems, irrigation, livestock and mixed systems. It was aimed at identifying potential strategies that can be adopted by South Africa, including strategies from Sub-Saharan Africa and other regions. Additionally, the review was to identify policy and research gaps, and make recommendations of what should be done in South Africa under current drought conditions, and future droughts, including the suggestion of a national drought response strategy for agricultural water use in South Africa.

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IRRIGATION EFFICIENCY TRAINING MATERIAL

WRC report no. KV 342/1/15

Making better use of our available water is now becoming imperative and not negotiable. As users within the biggest water sector (in terms of annual volumetric use) in South Africa, irrigation water managers are often called upon to 'improve efficiency'; however, when the question is asked what this request practically implies, answers are not as forthcoming. Major constraints include the lack of a common understanding of the term 'efficiency', inadequate information available for water effective management because of a lack of measurements, the perception that any efficiency initiative will cost the water user money, but the benefit goes to the authorities, and also the fear of reduced water use allocations if greater efficiency is achieved. In practice, it has been found that commercial farmers and irrigation scheme management are quite willing to invest in practices and technologies that make business sense. However, lack of knowledge on technologies and insufficient human capacity in agricultural water management often prevent this from happening. This material is therefore aimed at assisting both water users and authorities to obtain a better understanding of how irrigation water management can be improved, thereby building human capacity, so that targeted investments can be made with fewer social and environmental costs, by introducing the water balance approach to improved system performance. The material presented here is the result of more than 10 years of research funded by the WRC.

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OTHER REPORTS

Water use efficiency and soil carbon sequestration of selected indigenous and modern crop cultivars for sustainable agriculture intensification and climate change mitigation

Despite numerous studies on the water use efficiency (WUE) of staple cereal crops, there is yet little information on the extent of the variations in WUE or atmospheric C storage between the different cultivars and associated controlling mechanisms, which might allow the selection of drought-resilient varieties and guide breeding programmes. Among others, this project sought to In validate data on water use efficiency and soil carbon sequestration potential of selected cultivars of wheat, maize and sorghum under several environments in South Africa; and rank cultivars of each crop to advise farmers on which one to use for a given condition for sustained agricultural development.

WRC report no. 3127/1/24

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Infrastructure performance, water governance and climate change impacts on water resource management for smallholder farmers in the Western Cape, South Africa

In addition to climate change, ageing, inadequate water infrastructure, and governance inefficiencies have hindered smallholder farmers' access to reliable water supplies. This project aimed to examine the intersection of climate change, water governance, and infrastructure performance, with a specific focus on smallholder farmers in historical towns in the Western Cape, South Africa.

WRC report no. 3194/1/24

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Improving smallholder farmers' resilience to climate change through on-farm mycorrhizal production

The project aimed to create an on-farm mycorrhizal production system for smallholder farmers by using locally adapted mycorrhizae to create mycorrhizal inoculum. When these farmers inoculate their crops with mycorrhizae, they can achieve higher yields with lower inputs.

WRC report no. 3191/1/24

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Threats of extreme weather events – Improving the resilience of Qwaqwa to the multiple risks of climate change

The overarching aim of this project was to understand how the cumulative impacts of successive extreme weather events may affect the exposure and resilience of local communities in QwaQwa and how these impacts may be ameliorated through risk reduction planning.

WRC report no. 3091/1/23

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Development of an agricultural drought preparedness framework for South African croplands and grasslands

There is an increasing concern that the frequency, severity and duration of droughts might increase as a consequence of climate change and observed increases in extreme climate events. . In the 21st century, new techniques and algorithms are required to address food security challenges and provide solutions for agriculture. The use of model simulations, remote sensing and GIS technologies coupled with the collection of field samples for monitoring has yielded positive outcomes. The collection of field samples, although labour intensive, can give indications of available data for the upcoming season that can assist farmers to avoid practices that will exacerbate land degradation.

WRC report no. 2968/1/23

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Climate-smart irrigation: Development of a framework for conjunctive groundwater and surface water use for solar-driven smallholder irrigated agriculture

Africa is vulnerable to climate change due to its dependence on rain-fed agriculture and low adaptation capacity. Climate change will likely increase the frequency of droughts and flooding. Aquifer Storage and Recovery (ASR), the purposeful recharge of the aquifer when there is excess water during wet or flooding periods for subsequent abstraction during dry or drought periods has been used for a long time to bridge the gap in seasonal water availability.

WRC report no. 3085/1/23

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Feasibility assessment and sustainability evaluation of water supply options for implementation in drought

A comprehensive feasibility study on the use of local scale alternative water source interventions and associated technologies for water abstraction and supply has not been done at large scale. The project investigated the technical, socio-economic and environmental feasibility for the establishment of alternative water source (AWS) systems, different groundwater options and multiple use water schemes (MUS) in order to provide water services for domestic and agricultural purposes.

WRC report no. 3039/2/22

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Smallholder farmer drought coping and adaptation strategies in Limpopo and Western Cape provinces

Smallholder farmers are a generally heterogeneous grouping, but in South Africa, the diversity is especially pronounced due to a history of unequal distribution of resources. This project sought to characterise smallholder farmers and to identify the coping and adaptation strategies to which they resort during periods of drought.

WRC report no. 2716/1/20

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Modelling impacts of climate change on selected South African crop farming systems

The agricultural sector is physically and economically vulnerable to climate change. The authors identified a gap in research with regard to integrated economic modelling at farm level. This project addressed the knowledge gaps by making a contribution to integrated climate change modelling and this report documents the research work done as part of the project.

WRC report no. 1882/1/16

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Hydrological modelling of climate change impacts for development of adaptation strategies: The case of Luvuvhu river catchment, Limpopo, South Africa

The Limpopo basin is a semi-arid region of South Africa where rainfall patterns are highly variable, unpredictable and unreliable. One of the major challenges with climate change is its impact on water resources and extreme hydrological events. Extreme events such as droughts and floods, significantly affect important sectors such as agriculture, energy, water resources, among others. There is a need to determine the effects of climate change on water resources to predict the potential impacts on agriculture and domestic/municipal water use. Adaptive responses that reduce vulnerability to current, as well as future climate variability and change, are critical in the context of South Africa's urgent socio-economic developmental needs and threatened ecosystem services.

WRC report no. 2771/1/20

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Coping and adaptation strategies for agricultural water use during drought periods

The main objective of this project was to conduct a desktop review in the nine provinces of South Africa, with a view of identifying the current knowledge on drought and occurrence, the ways in which the government is managing the drought both at national and provincial level, including Early Warning Systems, Climate Advisory Services, and Indigenous Knowledge Systems. The research was also aimed at reviewing drought coping and adaptation strategies in dryland cropping systems, irrigation, livestock and mixed systems.

WRC report no. KV 363/17

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Insights into indigenous coping strategies to drought for adaptation in agriculture: A Karoo scenario

There is a gap in understanding and recognising the value of indigenous knowledge in reducing vulnerability of rural communities to impacts of hazards such as drought. Local people who are most vulnerable to these impacts are left out of the research in many studies. It has been proved by many recent studies that local or indigenous knowledge holds valid, meaningful and relevant answers for coping with current and future droughts.

WRC report no. 2084/1/15

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