WATER RESEARCH COMMISSION

GUIDES AND TOOLS FOR

SUSTAINABLE IRRIGATED AGRICULTURE

2024

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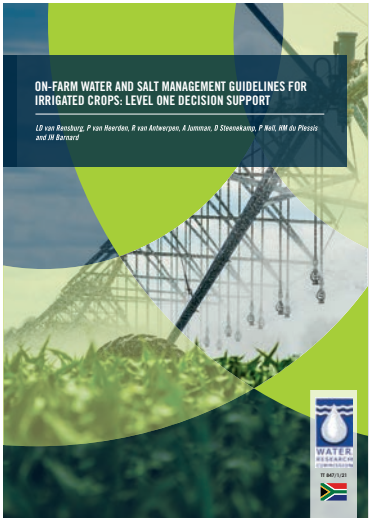
INTRODUCTION

The Republic of South Africa covers an area of 122 081 150 ha of which approximately 14 million ha (13%) is cultivated land. Irrigated agriculture plays a major role in the production of food in South Africa. Irrigation supports up to 30% of South Africa's national agricultural production. It is estimated that irrigation is responsible for up to 90% of the production of high-value crops (such as potatoes, vegetables and fruit) and up to 40% of the production of industrial crops (including sugarcane and cotton).

Water (and energy) efficient irrigation also provides a number of environmental and socio-economic benefits. High irrigation efficiency is becoming increasingly important due to the current decrease in available water resources and growing populations that drive expansion of agricultural activities. With irrigated agriculture being the largest user of runoff water in South Africa, there have been increased expectations from government that the sector should increase efficiency and reduce consumption in order to increase the amount of water available for other uses, in particular for human domestic consumption.

Increasing efficiency in irrigated agriculture has been a main theme of Water Research Commission (WRC)-directed research for more than 40 years. According to the WRC, water productivity can be increased by producing more with the same use of water or by producing the same with less use of water. This requires understanding of water dynamics in the soilwater-plant-atmosphere continuum, the equipment which is used and the method of production which is followed. Research on all these aspects can contribute to higher water use efficiency in agriculture. The following guidelines and tools are a product of the knowledge created by WRC research in this domain.

PUBLICATIONS ACCOMPANYING THIS BOOKLET



ON-FARM WATER AND SALT MANAGEMENT GUIDELINES FOR IRRIGATED CROPS

WRC report no. TT 847/1/21-TT 847/3/21

Intensification of agriculture poses risks to crops and soils that demand management. One of the major risks of irrigation is accumulation of salts in the soil. Soil salts originate mainly from dissolved salts in irrigation water, fertiliser application, as well as mobilisation of salts in soils and parent material. Uncontrolled build-up of salts carries two threats to farmers, i.e. salinity and sodicity. The goal of the current project was to develop a water and salt management guideline that can serve as a level one Decision Support System (DSS). Resourceful farmers have options to utilise private consultants and laboratories that render field services. Guidelines for conducting such services and expected outcomes are presented as a level two Decision Support System (Volume 2). Generally, level two DSS deals with high-income crops such as pecans, walnuts, blue berries and lucerne. The aim of such an investigation is to show distribution of salts in the field, determine their impact on hydro-physical properties, and to provide procedures for solving salt related problems. For a deeper understanding of salt-related problems and their medium to long-term management, a level three decision support system was introduced (Volume 3). This DSS is on a research level and is aimed at serving the science community, although mega-farmers, agricultural cooperatives and companies may also benefit from it. In this case, salinity models, such as SWAMP, are used to make medium to long-term estimations of salt impact on land productivity.

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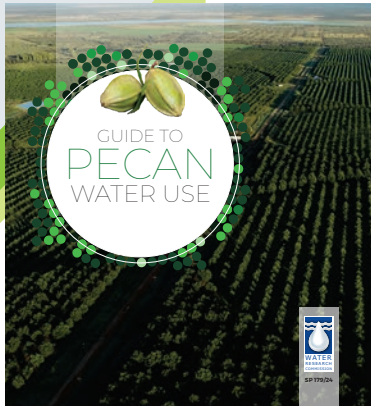

PECAN NUT WATER USE GUIDE

WRC report no. SP 179/24

Pecans are often viewed as a crop that uses a lot of water because of the large canopy, which means it is even more important to demonstrate good water management and productive use of the water applied. It is also important to make sure that fair water licenses are issued for pecan production. Good irrigation scheduling involves meeting the full evapotranspiration (ET) requirements of the crop, while minimising water lost from the system through evaporation, run-off and deep percolation. This guide aims to provide comprehensive information on irrigation management and scheduling in pecan orchards, in order to assist growers to use water more productively in pecan orchards. This guide covers the following aspects: the water balance of an orchard; pecan orchard water requirements and factors impacting water use; scheduling irrigation and monitoring applied water; and what to do when there is not enough water.

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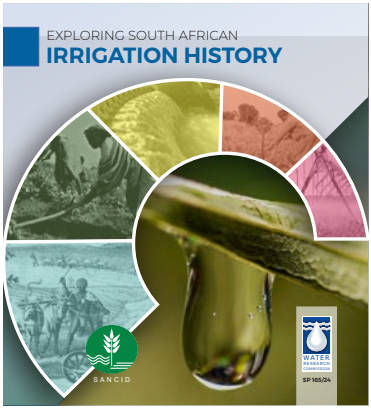

EXPLORING SOUTH AFRICAN IRRIGATION HISTORY

WRC report no. SP 165/24

South Africa cannot boast an ancient irrigation history such as Syria, Egypt, Iran and Turkey, yet irrigated agriculture forms an important part of the country's agricultural sector. The combination of influences varying from traditional African to European, combined with the country's unique agricultural challenges makes for an interesting history. The South African National Committee on Irrigation & Drainage (SANCID) with support from the Water Research Commission, created a platform to provide an account of South Africa's irrigation history, including the history of its own origin, some years ago. It was seen as especially pertinent to include the history of irrigation among smallholder farming communities which has hitherto been much neglected. The result is a detailed chronicle of how the irrigation sector developed in South Africa from initial private initiatives to the cooperative flood diversion schemes of the nineteenth century and the large, sophisticated public storage schemes which took shape after unionisation in the early 1900s. The book ends with a glimpse of the current and future challenges faced by both commercial and smallholder irrigation farmers in the country. The book will also be available in hard copy from end July.

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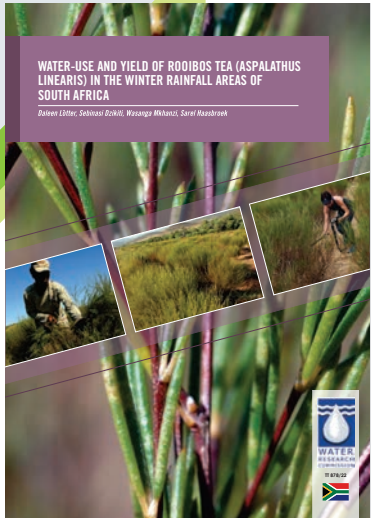

WATER USE AND YIELD OF ROOIBOS TEA (*ASPALATHUS LINEARIS*) IN THE WINTER RAINFALL AREAS OF SOUTH AFRICA

WRC report no. TT 878/22

More than 20 000 tons of rooibos are produced in the Cederberg region per year. About half is exported to more than 60 countries, meaning rooibos accounts for about 87% of South Africa's tea exports. Despite the plant being able to tolerate harsh climatic conditions, extreme droughts and increasing temperatures in recent years have placed pressure on the productivity of the rooibos crop. Many farmers have reported more erratic rainfall patterns, such as a shift in the onset of the rainy season, poor rainfall distribution throughout the growing season and more intense heat waves. The main objective of this study was to investigate how the water use and yield of rooibos tea vary under current growing conditions in the prime production areas in the winter rainfall areas of South Africa. The study also sought to provide insights on how the projected future climatic conditions will affect the water requirements of rooibos tea crops. The research outputs are intended to enable the formulation of policies and recommendations to facilitate the development of best management practices and appropriate climate change adaptation strategies for the sustainable production and growth of the rooibos tea industry.

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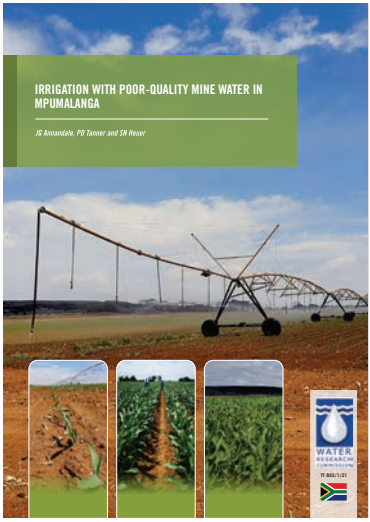

IRRIGATION WITH POOR QUALITY MINE-WATER IN MPUMALANGA

WRC report no. TT 855/1/21 (main report), TT 855/2/21 (technical guidelines)

The mining industry in South Africa produces large volumes of mine-impacted water and the agricultural industry requires large water inputs to improve and maximise crop yields. A noteworthy opportunity, therefore, arises for the use of mine water for irrigation, if monitored and correctly managed, to facilitate sustainable mine closure. It could also provide an alternative strategy for operating mines, and for the use of mine water, with or without treatment, depending on the quality. Success with mine water irrigation has been demonstrated in several previous WRC studies. This project evaluated and demonstrated successful irrigation with untreated mine water on a single unmined site, and evaluated issues associated with setting up irrigation on a rehabilitated site. In addition, factors that are likely to affect the success of using untreated acid mine drainage (AMD) and partially treated AMD for irrigation are investigated in depth. The economic viability of mine water irrigation projects was analysed, which lead to the development of a technical guideline to assist mines and regulators to establish irrigation projects using mine-water.

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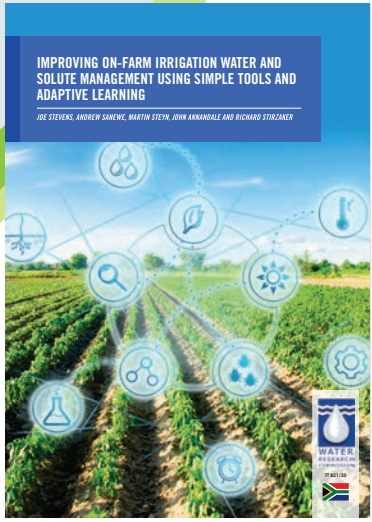

IMPROVING ON-FARM IRRIGATION WATER AND SOLUTE MANAGEMENT USING SIMPLE TOOLS AND ADAPTIVE LEARNING

WRC report no. TT 821/20

This report outlines the water situation in the country and the national plan to increase the area under irrigation. Improving agricultural land and water productivity is essential to solutions for sustainable water management and agriculture development. Achieving high irrigation water use efficiency and profitability in irrigated agriculture is to a large degree determined by the efficiency of irrigation water management. However, irrigation scheduling generally has left a lot to be desired, despite the fact that very useful research in this regard has been done in the country. This project followed a different approach to the traditional methods of research that have been conducted in irrigation water management. It attempted to include the users of the knowledge (farmers) in its generation and address real-world problems by using a combination of disciplines. It tried to encourage dialogue between academic research and the applicants of the knowledge, the farmers.

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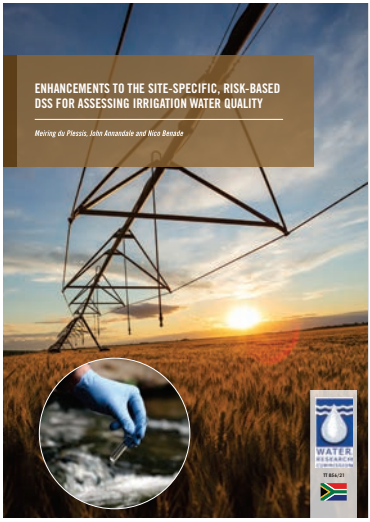

ENHANCEMENTS TO THE SITE-SPECIFIC, RISK-BASED DSS FOR ASSESSING IRRIGATION WATER QUALITY

WRC report no. TT 856/21

The South African Water Quality Guidelines, published in 1996, comprise one of the most widely used tools in water quality management. The water quality guidelines for irrigation were the first of the new generation guidelines to be started and completed. These guidelines are reported on in two volumes. The first being a high-level description of the DSS and the second a technical report with a detailed description of the DSS and the approaches and criteria used in its development. For a project of the magnitude and complexity of the software-based Decision Support System (DSS) with which to determine Water Quality Guidelines for Irrigation (SAWQI), it was only to be expected that further refinement and the need for additional features to improve utility and user-friendliness would be identified as more people start using it. The site-specific algorithms of the DSS are quite involved, and incorporate the use of the Soil Water Balance (SWB) model, that relies on several input parameters. The model simulates soil-plant-atmosphere interactions with irrigation water constituents for periods of up to forty-five consecutive years. Although the DSS has been tested under a range of conditions, it was foreseen that further 'debugging' would be required to ensure model validity. This would, however, only become apparent once SAWQI was adopted by a larger group of users.

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DEVELOPMENT AND TESTING OF A SMARTPHONE APPLICATION FOR PREDICTING CROP WATER REQUIREMENTS IN APPLE ORCHARDS 1 TO 7 DAYS IN ADVANCE

WRC report no. TT 836/20

Over the years, the WRC, in collaboration with fruit industry partners, has initiated and funded several research projects aimed at establishing the water requirements of orchards across South Africa. Many of the studies focused on apple orchards in the prime production regions in the Western Cape. The priority of the study was to develop a simple but scientifically credible online tool that operates on platforms that are easily accessible to end users, e.g. farmers, irrigation boards, etc. to assist them with irrigation planning in real-time. The project therefore investigated the possibility of developing a Smartphone Application (APP) for forecasting orchard water requirements a few days in advance using readily available data as inputs. Focus was on apple orchards which have some of the largest volume of measured water use data. This innovation comes at the right time when the fruit industry is grappling with water scarcity as a result of frequent droughts and the increasing demand for the limited water resources.

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RISK-BASED, SITE-SPECIFIC IRRIGATION WATER QUALITY GUIDELINES

WRC report no. TT 727/17 (Description of the decision support system)

The 1996 South African Water Quality Guidelines comprise one of the most widely-used tools in water quality management. However, they are now viewed as significantly out of date. A Phase 1 Department of Water Affairs and Forestry (now DWS) project was completed by a panel of experts in 2008. They performed a needs assessment, developed a general philosophy and described the general specifications of a decision support system (DSS) for revised water quality guidelines for South Africa. The new guidelines were envisaged to be different in a number of fundamental ways. Firstly, they would be risk-based – a fundamental change in philosophy from the 1996 guidelines. Secondly, they would allow for much greater site-specificity – a widely-recognised limitation of the generic 1996 guidelines. Thirdly, they would be made available primarily as a software-based DSS. The first project, which was initiated and mainly funded by the WRC, addresses guidelines for irrigation water use. The project saw the development of a software-based decision support system able to provide both generic and site-specific risk-based irrigation water quality guidelines for South Africa.

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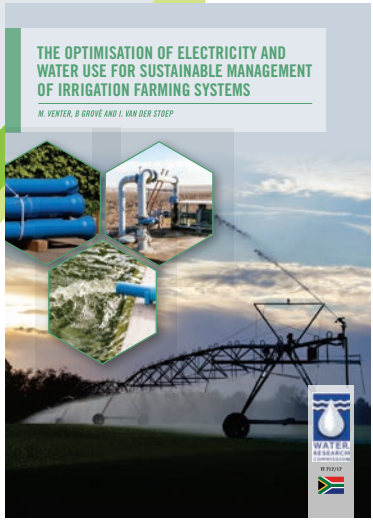

THE OPTIMISATION OF ELECTRICITY AND WATER USE FOR SUSTAINABLE MANAGEMENT OF IRRIGATION FARMING SYSTEMS

WRC report no. TT 717/17

The dependence of commercial agriculture on electricity as a source of energy to pump water will continue in future, even though electricity tariffs are increasing, as the cost associated with the use of renewable energy sources in South Africa makes the use of alternative energy sources financially infeasible. On the positive side, significant opportunities exist for irrigation farmers to reduce energy costs through irrigation system design and operating practices to improve profitability. The design of an irrigation system and the operating practices needs to be evaluated in order to reduce energy costs. Potential energy savings can be achieved by adopting new technologies (variable speed drives, high efficiency motors) while taking cognisance of the trade-off between investments and operating costs. The general objective of this research was to develop appropriate management approaches for reducing electricity cost, improving water use productivity and increasing profitability of irrigation farming for selected irrigation areas in South Africa. Among the outcomes was the development of a guideline for irrigation systems designers to optimise electricity and water efficiency of irrigation farming systems.

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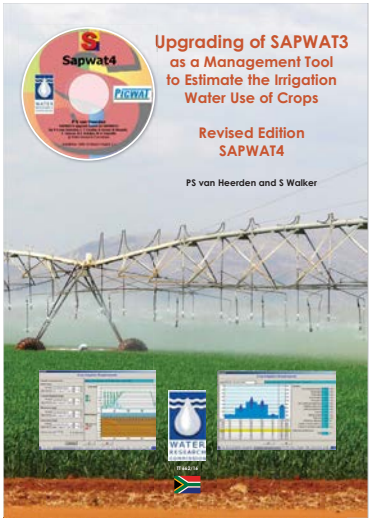

UPGRADING OF SAPWAT3 AS A MANAGEMENT TOOL TO ESTIMATE THE IRRIGATION WATER USE OF CROPS (REVISED EDITION) SAPWAT 4

WRC report no. TT 662/16

SAPWAT4 is an improved version of SAPWAT3, the program that is extensively applied in South Africa and internationally and was developed to establish a decision-making procedure for the estimation of crop irrigation requirements by irrigation engineers, planners, agriculturalists, administrators, teachers and students. The development of the current SAPWAT4 program, as in the case of SAPWAT3, is based on the FAO-published Irrigation and Drainage Report No. 56, Crop evapotranspiration. Guidelines for computing crop water requirements. The irrigation requirement of crops is dominated by climate, particularly in the yearly and seasonal variation in the evaporative demand of the atmosphere as well as precipitation. SAPWAT4 has included in its installed database comprehensive weather data that is immediately available to the user. SAPWAT4 also provides facilities for importing additional weather station data while the program has the built-in facility to export irrigation requirement data on crop, field or farm level, or on higher administrative levels to a variety of spreadsheets and similar facilities. Irrigation requirement output is provided in millimetres and cubic metres for the specified irrigated areas.

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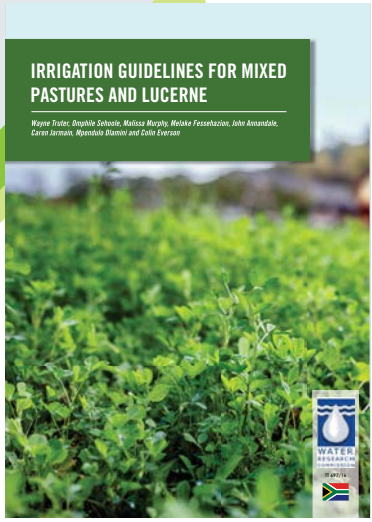

IRRIGATION GUIDELINES FOR MIXED PASTURES AND LUCERNE

WRC report no. TT 697/16

Ideal pasture management is the production of economically optimum forage yield and quality without compromising the environment. Accurate irrigation scheduling plays an important role in deciding the income of a dairy enterprise by affecting yield and quality; irrigation input and energy usage; and environmental pollution. Improved knowledge of irrigation timing and amount can also be of great value in scheduling other cultural operations. The objectives of this research were to determine water requirements of Lucerne and common grass/legumes mixtures through testing and evaluation of the model and develop generic guidelines for efficient irrigation management of grass/legume pastures. The most important aspects of irrigation management are: 1) proper functioning of the irrigation system, 2) knowledge of crop water use and its sensitivity to water stress, and 3) proper measurement of rainfall and irrigation. The farmer can manage the soil water balance to his advantage by minimising wasteful losses such as runoff, evaporation and deep drainage. This will leave more water in the soil for crop water uptake which is regarded as a useful loss. Atmospheric evaporative demand is the driving force for crop water use. Atmospheric demand depends on the prevailing weather conditions at any time in the growing season. Crop water requirements can, as a result of the weather, differ substantially between localities and different seasons for the same locality. Therefore, it should be clear that fixed recipes for irrigation management cannot be applied universally. Site specific irrigation management is necessary for each field, taking into account the factors mentioned above.

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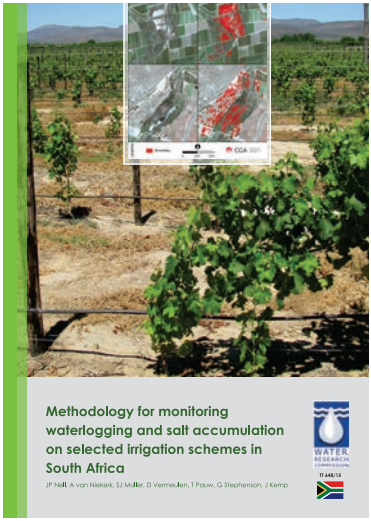

METHODOLOGY FOR MONITORING WATERLOGGING AND SALT ACCUMULATION ON SELECTED IRRIGATION SCHEMES IN SOUTH AFRICA

WRC report no. TT 648/15

The operation and management of irrigation water must include proper monitoring and reduction of seepage and other water losses in the system, particularly if there is a component of recharge by raising water tables and cause salt-affected soils. Management-related distribution losses (causing waterlogging that salinisation conditions) on irrigation schemes are, among others, caused by inaccurate dam releases, faulty sluice gate control, inaccurate lag time calculations, errors in water requisition calculations and insufficient monitoring of canal end points, and over-irrigation. In this project various data sources and methodologies for the identification of areas prone to salt accumulation and waterlogging were investigated. This includes land cover mapping, bare soil analysis (i.e. direct approach), multi-temporal crop condition monitoring (i.e. indirect approach), terrain analysis, within-field anomaly detection, and machine learning.

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TECHNICAL ASPECTS AND COST ESTIMATING PROCEDURES OF SURFACE AND SUBSURFACE DRIP IRRIGATION SYSTEMS

WRC report no. TT 524/12 (Volume 1), TT 525/12 (Volume 2), TT 526/12 (Volume 3)

Drip irrigation is considered to be the most efficient irrigation system if it is correctly selected, planned, designed, managed and properly maintained. Research funded by the WRC and projects completed by the Agricultural Research Council's Institute for Agricultural Engineering (ARC-IAE) on the performance of surface and sub-surface drip irrigation found that the emission uniformity as measured in the field declined over time for all dripper types. This indicates a decline in efficiency due to clogging or lack of maintenance. Correct planning, design, installation and maintenance is essential and it is recommended that regular water quality analysis be carried out to identify potential clogging problems. Through this project, a manual for designers and a manual for farmers have been developed, the former providing guidance for the selection, planning and design of drip systems for designers, and the latter enabling irrigators with sub-surface drip irrigation systems to apply good management and maintenance schedules to enable them to adhere to the objectives of the National Water Resources Strategy regarding the efficient and beneficial use of water. The work is presented in three volumes. Volume one is the main report. Volume two is a manual for irrigation designers while Volume three is a manual for irrigation farmers.

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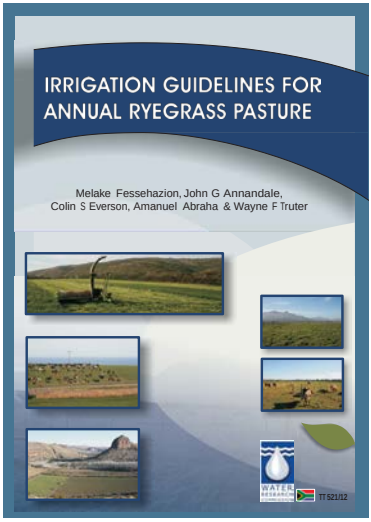

IRRIGATION GUIDELINES FOR ANNUAL RYEGRASS PASTURE

WRC report no. TT 521/12

Ideal pasture management is the production of economically optimum forage yield and quality without compromising the environment. Accurate irrigation scheduling plays an important role in deciding the income of a dairy enterprise by affecting yield and quality; irrigation input and energy usage; and environmental pollution. Improved knowledge of irrigation timing and amount can also be of great value in scheduling other cultural operations. Therefore, the objectives of this research were to determine water requirements of annual ryegrass through testing and evaluation of the model and develop generic guidelines for efficient irrigation management of grass pastures. The most important aspects of irrigation management are: 1) proper functioning of the irrigation system, 2) knowledge of crop water use and its sensitivity to water stress, and 3) proper measurement of rainfall and irrigation. The farmer can manage the soil water balance to his advantage by minimising wasteful losses such as runoff, evaporation and deep drainage. This will leave more water in the soil for crop water uptake which is regarded as a useful loss.

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GUIDANCE FOR SUSTAINABLE ON-FARM AND ON-SCHEME IRRIGATION WATER MEASUREMENT

WRC report no. TT 550/12

The National Water Act (NWA) (Act No. 36 of 1998) calls for efficient, sustainable and beneficial use of water in the public interest which implies that effective water management must be done. The management cycle of water consists, if presented in a simplified format, of a continuous process of planning, allocation, operation, monitoring, analysis, and feedback. For effective water management to take place, and to address the requirements of efficient, sustainable and beneficial use, it is imperative that firstly there is verification that every user receives their fair share of the water, as allocated. Secondly, water losses (non-beneficial use) should be limited to a minimum. Finally, accurate, reliable and appropriate data must be recorded and made readily available so that the right decisions can be made at any point in the continuous process of managing the water and related infrastructure. This project aimed to facilitate a process towards effective implementation of water measurement at river, irrigation scheme and farm level in South Africa. In order to achieve this, end users of water measurement technology were made aware of and encouraged to adopt the technology. Specific attention was given to technical constraints and the financial justification for implementing the technologies for water measurement.

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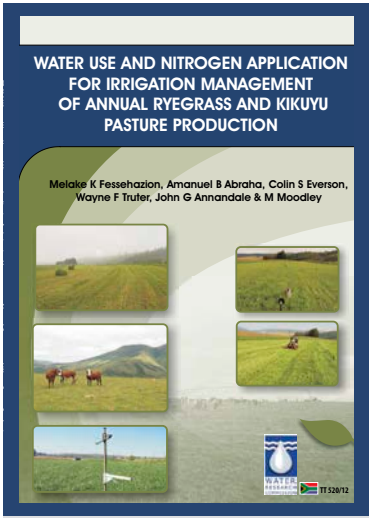

WATER USE AND NITROGEN APPLICATION FOR IRRIGATION MANAGEMENT OF ANNUAL RYEGRASS AND KIKUYU PASTURE PRODUCTION

WRC report no. TT 520/12

To meet the increasing demand for animal protein as human populations increase, there is a need to increase water (and land) productivity. Natural veld cannot fulfil this need alone and must be supplemented with irrigated and fertilised planted pastures. This requires intensive use of fertilisers and water, which leads to a higher cost of production and a greater risk of environmental pollution. Thus, farmers are under pressure to decrease their share of water and fertiliser usage, whilst at the same time, produce sufficient pasture to supply the protein (i.e. milk) demand of a growing population more efficiently. In South Africa, annual ryegrass (***Lolium multiflorum***) and kikuyu (***Pennisetum clandestinum***) are the most widely grown pasture species under irrigation. They are mainly used in dairy farming enterprises. Shortages of water and nitrogen can, however, be limiting factors for the production of these pastures. By using appropriate irrigation and nitrogen management tools, water and nitrogen productivity of the pasture species can be improved.

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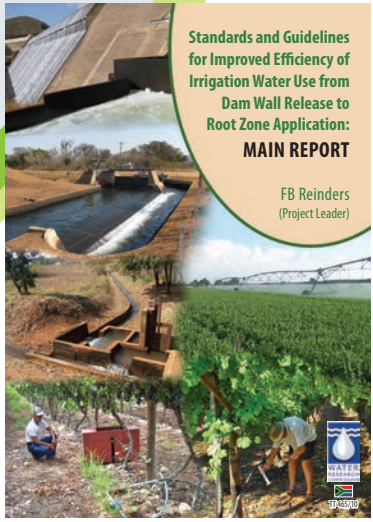

STANDARDS AND GUIDELINES FOR IMPROVED EFFICIENCY OF IRRIGATION WATER USE FROM DAM WALL RELEASE TO ROOT ZONE APPLICATION

WRC report no. TT 465/10 (Main report), TT 466/10 (Guidelines, TT 467/10 (Supplementary information)

The main output of the project was the compilation of guidelines for improved irrigation water management from dam wall release to root zone application. The guidelines are 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. Using lessons learnt during the WRC project, best practices and technologies are introduced and illustrated. The Guidelines (Volume 2) consist of four modules. Each module is a standalone unit with its own table of contents, introduction and conclusion. Module 1 provides an introduction to the fundamental concepts and should be used in conjunction with any of the other modules to introduce the fundamental concepts. Module 2 addresses the water balance approach at field level, and describes how each decision made during the planning, design and management of irrigation systems influences the amount of water required to irrigate the crop successfully. Module 3 addresses the water balance approach at farm level, and describes how the on-farm water distribution system should be planned, designed and managed to optimise water and energy requirements. Module 4 introduces the water balance approach at irrigation scheme level, and describes how technologies such as the Water Administration System (WAS), SAPWAT, iScheme and water measuring devices can be used to ensure greater reliability of supply to all water users on a scheme.

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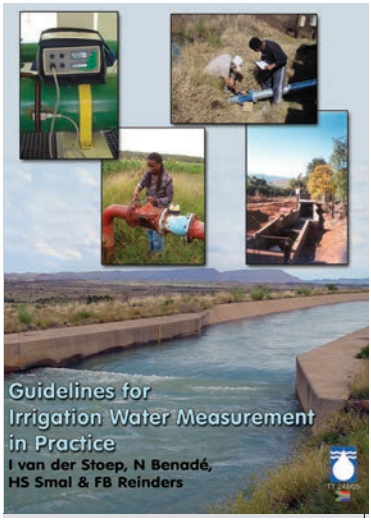

GUIDELINES FOR IRRIGATION WATER MEASUREMENT IN PRACTICE

WRC report no. TT 248/05

The WRC initiated a research project in 2000 in order to review the current situation and needs in the field of irrigation water measurement in South Africa. The main objective of the project was to develop guidelines for the correct choice, installation and management of water measuring devices by Water User Associations (WUAs) for canal, pipeline and river distribution systems. It was found that suitable measuring devices are available, but in order for them to be used successfully, they need be installed correctly, well maintained, and read accurately. In other words, a WUA's water measuring system has to be managed. This approach of managed implementation consists of at least the following components:

- A reason for measuring ("trigger")
- Acceptance and support by the water users
- Assessment of the current situation and planning the system
- Choosing appropriate technologies
- Correct installation by skilled technicians
- Sound operation and maintenance policies
- A system for data retrieval and management
- Comprehensive financial planning, and
- Procedures for handling disputes and tampering

The guidelines that were compiled were aimed at implementing this approach successfully in practice, and give a detail description of the actions that need to be taken under each component listed above.

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OTHER REPORTS

QUANTIFYING WATER USE OF MATURE PECAN NUT TREES AND ORCHARDS IN SELECTED IRRIGATION AREAS OF THE NORTHERN CAPE

Information and knowledge of the water use of pecan nut trees and orchards is essential for sustainable development, in particular because of scarce surface and groundwater resources and increasing competition for irrigation water use. Prior to this project there was no comprehensive knowledge available on water use of pecan nut trees and orchards in different production regions in South Africa.

Report no. 2814/1/24

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DEVELOPING A DECISION SUPPORT SYSTEM FOR WATER USE AND WATER-USE EFFICIENCY OF IRRIGATED CROPS IN THE INKOMATI-USUTHU WATER MANAGEMENT AREA (IUWMA)

This study first collected detailed data from irrigated crops (mango, grapefruit, banana and litchi) whose water use is not known thereby filling an important information gap. The data collected from this and from previous studies was used to develop a Decision Support System (DSS) for estimating the crop water requirements, yield and water use efficiency in all quaternary catchments thus adding another tool to the IUWMA toolbox.

Report no. 3129/1/24

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INVESTIGATING THE POTENTIAL OF FIXED AND DRAPED NETTING TECHNOLOGIES FOR INCREASING WATER PRODUCTIVITY AND WATER SAVINGS IN FULL BEARING APPLE ORCHARDS UNDER MICRO-IRRIGATION

Water insecurity has been identified as a major risk by the deciduous fruit industry where production is totally reliant on irrigation. The use of protective netting over apple orchards is one of the promising emerging technologies that can be implemented. The general aim of this study was to compare water use of a high producing open and netted (fixed and draped) full bearing apple orchards under optimal management and unstressed water use conditions, in order to determine water savings per hectare and per ton.

Report no. 2815/1/23

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AN ONLINE CROP COEFFICIENTS DATABASE USING FRACTIONAL VEGETATION COVER AND TREE HEIGHT FOR IRRIGATED FRUIT TREE CROPS

This study was initiated by the WRC with the aim of consolidating and updating existing crop coefficients generated in various studies into a national scale database that can be used to improve water resources management. The main aim of the study was to develop an online database of crop coefficients for irrigated fruit tree crops in South Africa for which water use data have been collected. This database is encapsulated in a Smartphone Application (APP) that can be used anywhere in the country on irrigated fruit tree crops that are included in the database.

WRC report no. 2963/1/23

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THE STATE OF IRRIGATION WATER LOSSES AND MEASURES TO IMPROVE WATER USE EFFICIENCY ON SELECTED IRRIGATION SCHEMES

Improved agricultural water security is important to meet rising demand for food, changing diet patterns of growing, wealthier and increasingly urbanised populations and for environmental protection. Moreover, water security underpins the future economic growth of the country. Among others, this project sought to assess the state of water losses and water use efficiency (WUE) in conveyance systems of representative irrigation schemes in South Africa through quantifying major water losses in the conveyance systems; to develop a framework for reporting the major water losses which the Department of Water and Sanitation (DWS) can use on all irrigation schemes in South Africa; and to suggest and put in place measures for improving water use efficiency in the irrigation schemes.

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ECONOMIC MANAGEMENT OF CONJUNCTIVE USE OF IRRIGATION WATER AND ROOT-ACCESSIBLE WATER TABLES

Integrated bio-economic models that include enough detail to provide decision support to improve conjunctive use management of surface water and root-accessible water tables do not exist in South Africa, which hampers the conjunctive management of surface water and root-accessible water tables. The main objective of this project was to develop and apply a bio-economic model to improve the conjunctive use and management of surface and shallow groundwater economically

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USE OF WINERY WASTEWATER AS A RESOURCE FOR IRRIGATION OF VINEYARDS IN DIFFERENT ENVIRONMENTS

The use of augmented winery wastewater was investigated in a previous WRC and Winetech-funded project. However, this project only addressed the suitability of using winery wastewater for grapevines in a sandy soil under one set of climatic conditions. . Therefore, a field study was necessary to investigate the use of winery wastewater for vineyard irrigation to determine the sustainability of such a practice in other environments. Three different regions were to be selected where grapevines would be irrigated with winery wastewater. In addition to climatic differences, there are also different soil types.

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WATER USE OF AVOCADO ORCHARDS

Accurate information on the water use of avocado orchards is important for water management in these orchards, to ensure that orchards are optimally irrigated, to develop water savings strategies to cope with water shortages caused by droughts and to know how to allocate water during different phenological phases with minimal impact on yield and quality. This project quantified water use of avocado in relation to yield at orchard scale.

Report no. 2552/1/21

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WATER USE OF MACADAMIA ORCHARDS

Accurate information on the water use of macadamia orchards is important for water management in these orchards, to ensure that orchards are optimally irrigated, to develop water savings strategies to cope with water shortages caused by droughts and to know how to allocate water during different phenological phases with minimal impact on yield and quality. This project quantified water use of macadamia in relation to yield at orchard scale.

Report no. 2552/2/21

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DEVELOPMENT OF SCENARIOS FOR FUTURE AGRICULTURAL WATER MANAGEMENT IN SOUTH AFRICA

Poor management of water resources threatens the resource base on which agriculture depends; therefore, there is a need to conserve water by creating and managing alternative water sources based on scenarios for future agricultural water use, and other benefits. This project aimed to suggest and develop scenarios for future agricultural water management, despite the natural and unnatural hazards that could unfold in the future. This was addressed through key objectives such as the identification of the forces that will drive scenarios, and the effects of those forces on scenario building for future agricultural water management.

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OPERATIONALISING THE INCREASE OF WATER-USE EFFICIENCY AND RESILIENCE IN IRRIGATION (OPERA)

Stellenbosch University Water Institute partnered with seven European partners in a Water-JPI project entitled 'Operationalising the increase of water-use efficiency and resilience in irrigation (OPERA)', aimed at better understanding farmers' use (or non-use) of irrigation technology, and investigating ways to practically improve water efficiency. South Africa's contribution to the project was collecting data for a survey on technology uptake, and – based on the outcome of this survey – investigate whether it would have been beneficial for farmers to use more than one technology available to them. Focusing on the technology already available to farmers, instead of developing a new model, was the chosen approach as South Africa has numerous crop models that have been developed (many funded by the WRC), and the Western Cape also has a free remote sensing service called FruitLook, which is funded by the Western Cape Government and developed by Dutch partners.

WRC report no. 2788/1/20

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SCOPING STUDY AND A BASELINE UNDERSTANDING OF POMEGRANATE ORCHARD WATER USE IN SELECTED PRODUCTION AREAS

Although the pomegranate industry in South Africa is small, it is growing. Research and development by the Pomegranate Producers' Association of South Africa (POMASA) is currently focused on the improvement of production practices. Although pomegranate trees are considered drought tolerant, irrigation is required during the dry summer months to optimise growth, yield and fruit quality for commercial production. The skilful management of limited water resources will be a necessity if optimal production and fruit quality are to be retained for a total farm unit.

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IRRIGATION EFFICIENCY TRAINING MANUAL

This material is 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 is the result of more than 10 years of research funded by the WRC.

WRC report no. KV 342/15

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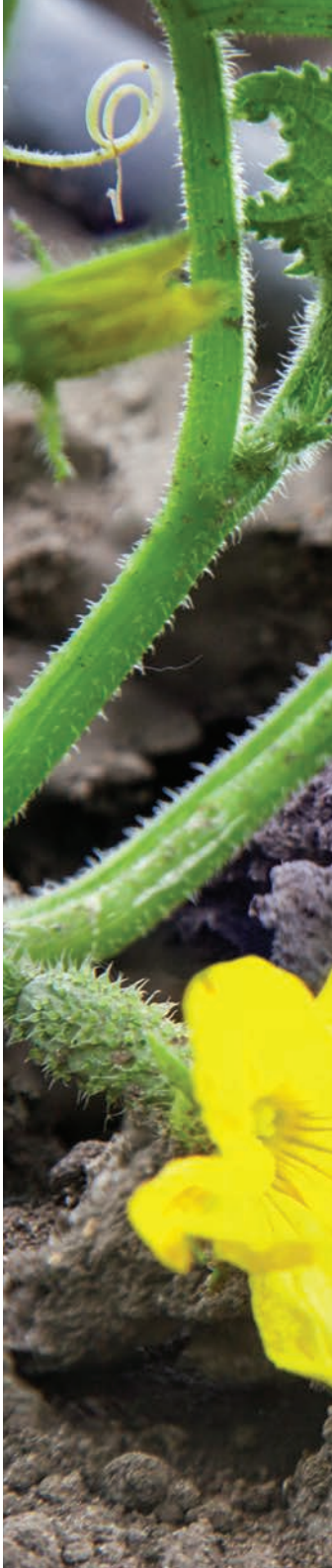

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