KSA 4: WATER UTILISATION IN AGRICULTURE

SCOPE

The strategic focus of KSA 4 is on increasing the system of knowledge for efficient use of water for production of food, forage, fibre, and fuel crops; improving food security, reducing poverty and increasing the wealth of people dependent on water-based agriculture; and ensuring sustainable water resource use. The requirements of present and future generations of subsistence, emergent and commercial farmers are addressed through creation and application of water-efficient production technologies, practices, models and information systems within the following five interrelated sub-sectors of agriculture:

- Irrigated agriculture
- Rain-fed agriculture
- Woodlands and forestry
- Grasslands and livestock watering
- Aquaculture and fisheries

The challenge for applied research is contributing to finding sustainable solutions for water use in agriculture, with priority given to innovative new products which support economic development and inform decision-making for private business and public policies. In the process of undertaking these research projects, the composition of research teams endeavours to increase representivity of Black and female researchers; post-graduate students are trained to improve the expertise of human capital and encourage young scientists to choose a career in water research, while on-farm and participatory action research leads to empowerment of individuals and groups in rural communities.

This KSA strives to achieve a balance between projects in irrigated and rain-fed agriculture, agro-forestry and aquaculture, to promote farmer involvement in poor rural communities through participatory action research, and to take research projects further toward practical application of results with technology transfer activities.

OBJECTIVES

The strategic objectives of KSA 4 are as follows:

- To increase the biological, technical and economic efficiency and productivity of water use
- To reduce poverty through water-based agricultural activities
- To increase profitability of water-based farming systems
- To ensure sustainable water resource use through protection, restoration and reclamation activities

THRUST 1:
WATER UTILISATION FOR FOOD, FORAGE AND FIBRE PRODUCTION

Scope: The direction and driving force for research activities and outputs are determined by the strategic focus to improve the knowledge of the processes of production of field, horticultural and industrial crops.

Programme 1: Water-efficient production methods in relation to soils, crops and technology in rain-fed and irrigated agriculture	**Scope:** 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 soil-water-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.
Programme 2: Fitness-for-use of water for crop production, livestock watering and aquaculture	**Scope:** Various processes and factors, which are site-specific, have an influence on the quality of water for crop, livestock and fish production. Significant shortcomings exist in assessment of the fitness-for-use of surface and underground water sources and identifying water-related production problems. The emphasis in this programme is on the efficient use of water and management of water quality for irrigation of crops, livestock watering and aquaculture in rivers, ponds and dams.

THRUST 2:
WATER UTILISATION FOR FOOD, FORAGE AND FIBRE PRODUCTION

Scope: The direction and driving force for research activities and outputs are determined by the strategic focus to improve the knowledge of the processes of production of trees in woodlands, plantation forestry and trees planted in combination with food and forage crops.

Programme 1: Water-efficient production methods and systems in agro-forestry, woodlands and forestry plantations	**Scope:** In catchment areas where trees are a prominent feature of land use, runoff and deep percolation of water can be reduced. Management of these so-called streamflow reduction activities necessitates an understanding of the water use by trees and the competitive or complementary relationship of water use by trees and water use by staple food and forage crops. Due to research specialisation, separate attention is given in this programme to increase the efficiency of water use by trees in woodlands and plantations for fuel-wood and timber production.

THRUST 3:
WATER UTILISATION FOR POVERTY REDUCTION AND WEALTH CREATION IN AGRICULTURE

Scope: The direction and driving force for research activities and outputs are determined by the strategic focus to improve the knowledge of the management processes undertaken by people who are using water.

Programme 1: Sustainable water-based agricultural activities in rural communities	**Scope:** Poverty, hunger and malnutrition amongst rural people are widely recognised as major problems. These members of rural communities, consisting mainly of women, children and the elderly, are also disadvantaged or marginalised for various social, economic and political reasons. A wide-ranging programme is required to support the sustainable development of rangeland livestock, rain-fed and irrigated crop production. Efficient use of water through a combination of agricultural activities can contribute to improving living conditions. Empowerment of rural people can further be promoted through participatory action research which improves knowledge, farming skills and leadership capabilities.
Programme 2: Integrated water management for profitable farming systems	**Scope:** Commercial farming is a major user of water resources and faces a particular challenge to ensure that this share of water is used effectively and efficiently. There is invariably a close link between efficient use and allocation of water and whole-farming profitability. Water management on farms is also time-dependent and based on incomplete knowledge of changes in the weather, prices and technology. Under these circumstances modelling is a powerful tool to provide decision-support and management advice. The focus in this programme is therefore on developing procedures, methods and models to provide advice to farmers on best management practices and the optimal combination of crop and livestock enterprises within the constraints of water, land and capital resources.

THRUST 4:
WATER RESOURCE PROTECTION, RESTORATION AND RECLAMATION IN AGRICULTURE

Scope: The direction and driving force for research activities and outputs are determined by the strategic focus to improve the knowledge of the natural processes and people-induced impacts of resource use.

Programme 1: Sustainable water resource use on irrigation schemes and within river catchments	**Scope:** With cultivation and irrigation, larger quantities of salts present in the soil and lower strata could be mobilised. Increasing salinity levels and higher water tables threaten the sustainable use of soil and water. Knowledge and tools to manage the quantity and quality of water resources for agricultural production are therefore required. The focus of research is on developing methods and models to manage water distribution and prevent water resource degradation.
Programme 2: Impact assessment and environmental management of agricultural production	**Scope:** Agricultural decisions to use land and to conserve rainfall, or to withdraw water from rivers, dams and boreholes, have wide-ranging impacts on the natural environment. Intensification of crop and livestock production processes can potentially contribute to higher levels of chemical residues of fertilisers, pesticides and herbicides in surface and groundwater. Precautions must be taken as part of the agricultural production process to protect the terrestrial and aquatic ecosystems. This requires an understanding of the negative impacts of agriculture and guidelines for an assessment and mitigation of those impacts.

RESEARCH PORTFOLIO FOR 2016/17

COMPLETED PROJECTS

THRUST 1:
WATER UTILISATION FOR FOOD, FORAGE AND FIBRE PRODUCTION

Programme 1:
Water-efficient production methods in relation to soils, crops and technology in rain-fed and irrigated agriculture

Nutritional water productivity of indigenous food crops

ARC Roodeplaat Vegetable and Ornamental Plant Institute; ARC Institute for Soil, Climate & Water; Medical Research Council

2171

Sub-Saharan African (sSA) countries are facing three interrelated challenges, namely, water scarcity, population growth, and food and nutritional insecurity of essential micronutrients (Fe and Zn) and Vitamin A. Agricultural production needs to increase and has to be achieved against a backdrop of issues such as climate change (extreme weather, flooding, and droughts), soil fertility depletion, and land degradation. Micronutrient (Fe and Zn) and Vitamin A deficiencies affect resource-poor households (RPHs) who are located in less favourable areas characterized by poor soil fertility and low yield, as well as lack of capital and agricultural inputs (specifically water and fertilizer). Therefore, agriculture needs to re-think agro-biodiversity solutions when planning a food-based approach in curbing micronutrient deficiency. Traditional vegetable crops (TVCs) are highly nutritious in terms of Fe, Zn, and β-carotene and are drought tolerant (can withstand adverse environmental conditions), when compared to exotic vegetables. However, this assumption has been based on the fact that some TVCs grow naturally in marginal environments that are characterized by poor soil fertility, while depending solely on sporadic rainfall. In 2012, the WRC funded a project (TT/535/12) titled 'Nutritional value and water use of African leafy vegetables for improved livelihoods'. Key findings of the project were that these TVCs have the potential of providing more than 50% of the recommended daily allowance for Fe, Zn, and Vitamin A. However, these findings were based on plant samples taken from locations where soil fertility and actual evapotranspiration, or crop water use, were unknown. As such, further research was needed to better understand the link between management practices, water, soil nutrients, biomass, and nutritional content of TVCs. *Beta vulgaris* (Swiss chard) was used as a reference crop because it is a leafy vegetable, highly nutritious (contains

Fe, Zn and β-carotene), commercialized in South Africa and mostly utilized by RPHs who eat it as a relish with maize porridge.

Cost: R1 950 000
Term: 2012 – 2016

Current rain-fed and irrigated production of food crops and its potential to meet year-round nutritional requirements of rural poor people in North West, Limpopo, KwaZulu-Natal and Eastern Cape Provinces
University of Pretoria
2172

While there is not much evidence of widespread starvation and extreme undernutrition in South Africa, national surveys provide evidence of multiple forms of deprivation related to the experience of hunger, widespread manifestation of hidden hunger or micronutrient deficiencies and increasing rates of 'overweight' and obesity. Moreover, the co-existence of adult (especially female) 'overweight' and obesity with hidden hunger and child malnutrition raises serious concerns over household food security. Despite a multitude of state, private sector and non-governmental agency (NGO) funded food security programmes, South Africa is one of only 12 countries in the world where stunting has increased over the Millennium Development Goal (MDG) period. It is also the only country in the Southern African Development Community (SADC) region where child stunting has not decreased. The increasing incidence of 'overweight' among women and children raises alarm. This indicates severe inadequacies related to the diets of South Africans and highlights the importance of understanding the constraints faced by households in achieving food security to ensure health, productivity and development. A baseline and scoping study commissioned by the WRC (K5/1954/4) has revealed numerous knowledge gaps with regard to smallholder production and food security in South Africa. The study highlighted that there is limited current and generalisable food security and nutrition research in South Africa. Very few studies have investigated the year-round source(s) of food for the rural poor. In particular, agricultural interventions to improve human nutrition and the (indirect) eventual outcomes of health, education and economics are practically non-existent. The study identified two specific knowledge gaps. Firstly, it identified that the contribution of home- or smallholder-grown foods to total dietary intake and nutritional requirements (in the context of an in-depth description of the food environment and its links to water) is not known. Secondly, the effect of seasonality on home or smallholder production is not documented. This project set out to address this significant and longstanding gap in knowledge and to propose a set of options for strengthening rain-fed and irrigated crop production in the rural areas investigated, and to identify the research focus areas related to efficient water use that could directly overcome dietary inadequacies and lead to better nutrition of rural household members. This unique study drew on a transdisciplinary research approach to investigate the consumption and production patterns of rural households in communities in four selected sites in the poorest local municipalities in South Africa.

Cost: R3 650 000
Term: 2012 – 2016

Water use and crop parameters of pastures for livestock grazing management

University of Pretoria; University of KwaZulu-Natal (Howard College); ARC Livestock Business Division; Department of Agriculture, Western Cape

2173

Irrigated agriculture is facing fierce competition for a substantial share of water as the water demand for industrial, domestic, municipal and other activities is increasing rapidly. The increasing shortage of irrigation water in addition to the increasing cost of fertiliser creates a great need to improve the practices of irrigation through better understanding of crop water requirements and ultimately better irrigation scheduling. Cultivated pastures form the base of feed for many livestock production enterprises in South Africa, comprising more than one sixth of the country's total irrigated land, making it one of South Africa's highest value crops. To ensure sustainable pasture production to produce sufficient pasture to supply the protein demand more efficiently for a growing population, innovations will be required to increase the efficiency of water and nitrogen use in such pasture production systems used in the livestock industry. To save on nitrogen fertilizer costs, much attention has been given to self–nitrogen fixing legume hay crops and mixed grass-legume pastures. These pasture management practices are not always very economical from both a quantitative and qualitative perspective, but are becoming more economical, especially in the light of sustainability. Lucerne. which is regarded as the most important legume hay crop, has for many years been the pasture crop most frequently irrigated. Lucerne, however, is known for its high water usage compared to other pastures. The current irrigation guideline for lucerne is a very rigid and for mixed legume-grass pastures non-existent.

Cost: R2 750 000
Term: 2012 – 2016

Programme 1:
Programme 2: Fitness-for-use of water for crop production, livestock watering and aquaculture

Scoping study on different on-farm treatment options to reduce the high microbial contaminant loads of irrigation water to reduce the related food safety risk

Stellenbosch University; Winelands UV Technology; Cape Peninsula University of Technology

2174

The aim of this project was to conduct a scoping study of different on-farm treatment options to reduce or remove the high levels of potentially pathogenic micro-organisms from irrigation water. This was achieved by conducting a comprehensive literature study and survey of potential on-farm treatment options for irrigated water contaminated with high levels of micro-organisms to enable a treatment option to be selected for the trials in an exploratory study; conducting an exploratory study of an on-farm treatment option (in this case, ultraviolet (UV) light) by monitoring the water quality throughout the irrigation water cycle; determining the efficacy of different treatment options (including hydrogen peroxide, chlorine, peracetic acid, hydrogen peroxide/UV, peracetic acid/UV and chlorine/

UV and UV as single treatment) on different *E. coli* strains (reference strains, environmental strains and mixed environmental strains) at laboratory-scale and using river water in a custom pilot-scale irrigation water test unit; and proposing the most appropriate treatment options and requirements for further research.

Cost: R2 250 000
Term: 2012 – 2016

THRUST 2:
WATER UTILISATION FOR FUEL-WOOD AND TIMBER PRODUCTION

Programme 1:
Water-efficient production methods and systems in agro-forestry, woodlands and forestry plantations

Rehabilitation of alien-invaded riparian zones and catchments using indigenous trees: an assessment of indigenous tree water use

University of Pretoria; University of KwaZulu-Natal (Pietermaritzburg); Forestlore Consulting

2081

There is a lack of information on riparian tree water use for indigenous trees in South Africa. This study provided long-term water use for three different forest types, each at differing levels of rehabilitation. The techniques used were heat pulse velocity, stem steady state and thermal dissipation. A modelling component was used to upscale the data from individual trees to stands and catchment scales. The results showed that indigenous trees in an established riparian stand in a Western Cape Afro-temperate forest can use high volumes of water throughout the year (little seasonal rainfall change in this region). The variability of water use between species and tree size was large as this variable is largely dependent on location, tree condition and light dynamics. This further highlights the need for measurement replication. The comparison between individual trees indicated that the largest trees (*Celtis* and *Vepris*) used the most water. However, when extrapolated by stem density, the alien species (*Acacia mearnsii*) used significantly more water per unit area (up to five times more water in certain stand locations). The modelling results revealed that a significant amount of water can be conserved if alien-invaded forest stands are rehabilitated. Of particular importance, during the wetter season (May to August), the deciduous trees in the winter rainfall region were not using any water. This is in contrast to the deciduous species in the Eastern Mistbelt region and the Maputaland coastal belt that are dormant during the dry season when water is most scarce. In the Western Cape area, it is recommended that evergreen species be used for forest rehabilitation as they use less water than the deciduous trees during the drier months when water is needed the most.

Cost: R5 900 000
Term: 2011 – 2016

THRUST 3:
WATER UTILISATION FOR POVERTY REDUCTION AND WEALTH CREATION IN AGRICULTURE

Programme 1:
Sustainable water-based agricultural activities in rural communities

Empowerment of women in rural areas through water use security and agricultural skills training for gender equity and poverty reduction in KwaZulu-Natal and North West Province

North-West University (Mafikeng); University of KwaZulu-Natal (Howard College)

2176

Close to half of South Africa's population (45%) resides in rural areas. In KwaZulu-Natal, 56.7% of the total population and 54% of women reside in rural areas. In South Africa, an estimated four million people engage in smallholder agriculture and the majority of these people are in rural areas. The most common reason given for engaging in agriculture is to procure 'an extra source of food'. More than half of the rural households in South Africa are headed by women and are among the poorest. Women make up a substantial majority of the agricultural workforce and produce most of the food that is consumed locally. In developing countries, about 43% of women are working in agriculture. The large proportion of agricultural production that is attributable to woman makes them the principal agents of food security and household welfare in rural areas. However, lack of skills, especially agricultural, among rural women results in poor performance and negatively affects their livelihoods and that of their households. The New Growth Path for South Africa identified employment creation as possible, both within economic sectors as conventionally defined and in cross-cutting activities, and analysed the policies and institutional developments required to take advantage of these opportunities. The agricultural value chains were identified as job drivers through the restructuring of land reform to support smallholder schemes with comprehensive support around infrastructure, marketing and extension, to upgrade employment in commercial agriculture, especially through improved worker voice and supporting growth in commercial farming, while addressing price fluctuations in maize and wheat. This will target 300 000 households in smallholder schemes by 2020; agro-processing anticipates creation of 145 000 jobs by 2020 and upgrading employment on commercial farms will create a total of around 660 000 jobs. It is expected that these projections will adequately cover women farmers, since they form the bulk of the smallholder farmers. Gender issues are now mentioned in most national and regional agricultural and food-security policy plans, but they are usually relegated to separate chapters on women, rather than treated as an integral part of policy and programming. Many agricultural policy and project documents still fail to consider basic questions about the differences in the resources available to men and women, their roles and the constraints they face, and how these differences might be relevant to proposed interventions. As a result, it is often assumed that interventions in areas such as technology, infrastructure and market access have the same impacts on men and women, when in fact they might not.

Women's access to productive resources, such as land, modern inputs, technology, education and financial services, is a critical determinant of agricultural productivity. Agriculture is important to women, but female farmers have less access to the productive resources and services required for agricultural production. Women are less likely than men to own land or livestock, adopt new technologies, use credit or other financial services, or receive education or agricultural extension advice. In some cases, women do not even control the use of their own time. While the size of the gender gap differs by resource and location, the underlying causes for the gender asset gap are repeated across regions, and social norms systematically limit the options available to women. Regardless of cause or magnitude, however, the gender asset gap reduces the agricultural productivity of women and thus involves broader economic and social costs.

Cost: R3 000 000
Term: 2012 – 2016

Action-oriented strategy for knowledge dissemination and training for skills development of water use in homestead gardening and rainwater harvesting for cropland food production
Rhodes University; Umhlaba Consulting Group (Pty) Ltd
2277

The report provides insight into the actual knowledge mediation and dissemination processes that were pilot tested during the project. Key amongst these was the establishment of a learning network structure that was inclusive of all stakeholders in the agricultural learning system. Within this, a Training of Trainers (ToT) programme was established to mediate the WRC knowledge and to support the stakeholders in the agricultural learning system to take up and use the WRC knowledge. In the agricultural colleges, lecturers were supported to develop curriculum innovation programmes which included shared demonstration site development. Other stakeholders (extension officers, LED officers, researchers, farmers and farmers association members) were also included in the training of trainers where they too were supported to develop learning support innovation projects and to participate in the shared demonstration site development process. This brought the value of working in learning networks to the fore, as different stakeholders were able to mobilise their prior knowledge, experience and expertise in a local context, where the end results were contributions to improved farming practice amongst farmers, knowledge exchange between farmers, improved curriculum options for college students and better support to smallholder farmers to use RWH&C knowledge in a local context. However, it was only possible to implement one such learning network in some depth over a period of 18 months, but shorter ToT programmes were run, and other learning networks were emerging at the time of the project's end. A key extension to the above was the development of a media component for facilitating the expansion of access to, and use of, the WRC materials. This involved development of project branding which re-named the initiative 'Amanzi for Food', allowing quick access and association with the key message of the project, an associated and dedicated website (www.amanziforfood.co.za) which allowed multi-levelled access to the materials via various access tools. This included a 'navigation tool' which proved to be critical to the whole knowledge access and dissemination process, links to other social media, including a Facebook page, blogs

and news items, and links to other websites where the WRC knowledge is being shared. Posters and YouTube videos were also developed and pilot tested to assist with visualisation of the RWH&C practices. Additionally, a community radio programme was established with a radio handbook produced out of the experience of designing and hosting the radio programmes. A significant finding of the media component is that the various forms of media operate in relationship, requiring an integrated approach to media development for enhancing knowledge dissemination.

Cost: R1 950 000
Term: 2013 – 2017

Programme 2:
Integrated water management for profitable farming systems

Water use productivity associated with appropriate entrepreneurial development paths in the transition from homestead food gardening to smallholder irrigation crop farming in Limpopo Province

Umhlaba Consulting Group (Pty) Ltd; Tshwane University of Technology; University of Pretoria
2179

The research project resulted from a directed call for proposals. The general aim was to review and evaluate appropriate development paths for expansion from homestead food gardening to smallholder irrigation farming, increased water use productivity of crop production and improved livelihoods on selected smallholder irrigation schemes in South Africa. The findings show that irrigation is strongly associated with improved livelihood outcomes and a strengthened human, physical and financial capital base. The incomes of irrigator households were significantly higher with all irrigator households above the upper-bound poverty line, whilst home gardeners were on or below this line. Irrigator households were also more food secure with greater food diversity than home gardener households. Entrepreneurial farmers with varied characteristics, but sharing a business outlook, were identified in similar numbers to classical peasant-farming categories, with true capitalist farmers a rarity. Constraints were severe and were dominated by institutional disincentives in the acquisition of secure land and in obtaining secure water supply. The wholly inadequate, even chaotic, communal land-tenure arrangements, combined with high risks related to inadequate irrigation water supply, turn development pathways into somewhat treacherous endeavours. Relocation of promising farmers onto well-established (medium or large-scale) schemes, fundamental reforms in communal land-tenure systems on smallholder schemes, investment in water management institutions, marketing support, and water management interventions are all strategies that would have to be pursued in parallel to achieve results. Irrigation can, it seems, provide the much sought-after development outcomes. However, it will demand political will of iron to totally re-institutionalise the smallholder sector and allocate large budgets for the parallel essential investments that are needed to launch and drive smallholder irrigation development trajectories into the future.

Cost: R2 144 000
Term: 2012 – 2016

THRUST 4:
WATER RESOURCE PROTECTION AND RECLAMATION IN AGRICULTURE

Programme 2:
Impact assessment and environmental management of agricultural production

Adaptive interventions in agriculture to reduce vulnerability of different farming systems to climate change in South Africa

University of Cape Town; University of KwaZulu-Natal (Durban); Stellenbosch University; OABS (Pty) Ltd
1882

Based on the results from this study, increasing temperatures and changes in precipitation are very likely to reduce cereal crop productivity. This will have strong adverse effects on food security. The fact that the majority of the arable land in the country is rain-fed, with increasing variability projected under climate change conditions, suggests that the livelihoods of farmers who depend on rain-fed agriculture will be threatened and the percentage of the population experiencing hunger and under-nourishment may increase. It is important to determine the possible impacts on different agricultural systems under projected future climates and evaluate suggested climate change adaptation strategies. The results from this study show that more than 70% of smallholder farmers across the study sites have low adaptive capacity. This group of farmers are vulnerable due to lack of financial resources, limited access to technology and also insufficient climate change adaption strategies, especially for table grape farmers. Climate change is expected to exacerbate existing climate-related problems in the country where more than 60% of the population are found in rural areas and are dependent on agriculture for their basic livelihood. Several climate change projections show that temperature and rainfall patterns in Southern Africa by 2050 indicate a significant decline in the production of major staple crops such as maize, wheat and sorghum. Climate change is expected to not only impact on crop and livestock production, but also alter the agriculturally-related socio-economic environment and general livelihood of the majority of poor households. This study proposes several coping and climate change adaptation strategies based on agricultural commodities and also agro-ecological zones (AEZ).

Cost: R4 300 000
Term: 2009 – 2016

THRUST 1: WATER UTILISATION FOR FOOD AND FIBRE PRODUCTION

Programme 1:
Water-efficient production methods in relation to soils, crops and technology in rain-fed and irrigated agriculture

Investigating the possibility to improve water use efficiency and reduce canopy management inputs of wine grapes through deficit irrigation

ARC (Infruitec-Nietvoorbij)
2080

At present, wine grape farmers are advised by viticulturists to follow certain canopy management practices, such as suckering, tucking in and topping of shoots. This is done to ensure that the grapes fall within a prescribed quality class. Under current economic circumstances, as well as with the rising cost of labour and fuel prices, these practices are becoming increasingly expensive to maintain, as farmers are not necessarily compensated for the additional expenses. Knowledge of how different canopy management practices at different deficit irrigation strategies will influence the combination of vegetative growth, production and wine quality is limited. A completed Winetech project investigated the effect of different deficit irrigation strategies on the water usage, production, growth, plant water potentials and overall wine quality, and crop factors were determined for a range of irrigations at different soil water depletion levels. The same canopy management was applied to the grapevines of all the treatments (two-spur winter pruning, suckering twice during spring and the tucking in of shoots into trellis wires). The cost of these different management practice inputs has not been investigated. In previous irrigation trials conducted on wine grapes, a blanket standard canopy management was done on all the treatments as the object of these trials was to investigate the effect of the different irrigation strategies on the grapevines' yield and wine quality. In previous canopy management research, the same irrigation volumes were applied to the various treatments while their canopies were manipulated. The effect of different canopy management inputs in combination with different irrigation strategies, and the water requirements of these different canopies, has thus not previously been investigated. Depending on the outcome of the trial, the results could be used as subroutines in future economic models to calculate the profitability of wine grape vineyards.

Cost: R2 072 000
Term: 2011 – 2016

Water footprint of selected vegetable and fruit crops produced in South Africa

University of Pretoria (Plant Production and Soil Science)
2273

The vegetable and fruit industries are highly dependent on the availability of irrigation water and are clearly responsible for significant freshwater consumption. Numerous studies have evaluated irrigation practices and water use by horticultural crops in the country. Information is lacking on the long-term production and water consumption patterns at regional and industry scales over the entire agri-food production chain from field to fork. Standard methodology to calculate water footprints was recently published by Hoekstra et al. (2011). According to this methodology, water footprint assessments consider both the direct and indirect water consumption and pollution of a consumer or of a product. Blue-, green- and grey-water footprints make up the total water footprint, and temporal and geographic components are included. Blue water refers to surface and groundwater available to multiple users, green water is water originating from rainfall that is stored in the soil and available for vegetation growth only, and grey water refers to the volume of water required to dilute emitted pollutants to ambient levels. Generally, blue water is scarcer and has higher opportunity costs, meaning that irrigated crops with lower ratios of blue to green water consumption are viewed more favourably. Detailed water footprint assessments using standardized, state-of-the-art methodology for important vegetable and fruit crops is essential to: (i) enable regional-scale integrated water resource management and drive policy formulation, (ii) better understand the water-related risks to the production of vegetables and fruit in the country, and (iii) facilitate the identification of opportunities for reducing water use within the production chain to ensure the sustainability of these industries.

Cost: R2 750 000
Term: 2013 – 2017

Determining water use of indigenous grain and legume food crops

University of KwaZulu-Natal (Crop Science)
2274

Completed and ongoing WRC-funded research work (Projects K5/1579//4 and K5/1771//4) to determine water use has mainly focused on African indigenous vegetable crops. There is, however, recent evidence of knowledge gaps on water use, agronomic practices, etc., of indigenous legume and grain crops. The indigenous grain and legume crops include grain sorghum, maize landraces, cowpeas and Bambara groundnuts. Furthermore, limited research results on water use are available and little crop water use modelling has been done on these crops. There is clearly a need for research-based knowledge on water use which will contribute to higher production, water use productivity and food security. More research is required on these neglected crops to better inform farmers and extension officers of appropriate management practices. Quantifying water use should therefore be done for combinations of indigenous crops (such as grain sorghum, maize

landraces, cowpeas and Bambara groundnuts) by means of intercropping or crop rotations in comparison with intercropping or crop rotations of conventional crops (such as hybrid maize, dry beans, green peas and groundnuts). This will make it possible to broaden the crops and products in the food basket for consumption in a more balanced diet of starch and protein for rural household members. In addition, this knowledge of water use will provide opportunities to prepare for the challenge of climate change by adapting agronomic practices and cropping systems, thereby preventing detrimental livelihood impacts. Higher production and supply of indigenous grain and legume food crops will enable storage and inter-seasonal transfers, to specifically bridge the gap in nutrition during late winter and early spring. From a perspective of rural development there is also the potential of processing and value-adding in the food value chain of these crops. As a whole, it is therefore imperative to better understand the water use of indigenous grain and legume crops in the context of intercropping, to improve the fertility of the soil, and of producing food crops which combine staple grains with legumes as protein sources.

Cost: R2 750 000
Term: 2013 – 2017

Quantifying citrus water use and water stress at tree and orchard scale

Citrus Research International

2275

Citrus is the largest exporter in terms of volume and one of the largest in terms of the earning of foreign exchange, with more than 100 million 15 kg cartons exported annually. The 58 000 hectare citrus industry provides more than 100 000 jobs that support more than 600 000 people, but the whole industry is dependent on irrigation. Citrus is a perennial crop which requires a constant supply of water in order not to limit yields and returns on investment. Due to climate change, established production areas are likely to become drier, which will place increasing pressure on water resources and irrigation management to maintain productivity. An ongoing WRC research project (K5/1770//4) is using a sap-flow technique to quantify water use of mature citrus, deciduous fruit and nut tree cultivars under best management practices. Initial findings indicate results that are contrary to expectations, specifically for citrus. In addition, an external international review recommended more in-depth research to first validate measuring techniques; and secondly to quantify water use for different growth stages for different cultivars. The more detailed research must investigate water use over seasonal growth stages, from planting to mature canopy size, and water stress in relation to fruit yield and quality. In order to provide effective advice to both established and emerging commercial farmers on irrigation methods and scheduling, accurate knowledge is required on water use. The emerging commercial farmers, who comprise approximately 300 of the 2 700 citrus growers and who are supported by the industry through bursaries, mentoring and extension, are especially in need of this information. All citrus fruit producers are faced with a major challenge in maintaining high yields per hectare

and fruit quality whilst simultaneously achieving viable returns and ensuring sustainability. Given the increase in competition for water between irrigation agriculture, secondary industry and domestic water use, more knowledge is required on citrus water use for growers to remain competitive and justify future production.

Cost: R2 750 000
Term: 2013 – 2017

Determining the water footprints of selected field and forage crops towards the sustainable use of fresh water

University of the Free State (Agricultural Economics)
2397

Significant amounts of water are used in the agricultural sector to produce food, forage and fibre to meet the ever-increasing world-wide demands. According to the Department of Water and Sanitation, 60% of fresh surface water is used by irrigated agriculture, making it the largest single user of water in South Africa. While being the largest user of fresh water, irrigated agriculture is also expected to contribute significantly towards poverty alleviation in South Africa through job creation and increased economic activity in rural areas. The allocation of fresh water to irrigated agriculture thus holds substantial social and economic benefits for South Africa. The establishment of standardised procedures for calculating blue and green water footprints for irrigated field and forage crops in South Africa will contribute towards the setting of accurate benchmarks for fresh water use along the life cycle of the crops. By linking the water footprint applications to economic and social analytical tools, the social and economic impact of proposed changes in water use behaviour will be understood. The analysis of consumer awareness, preference and willingness to pay for water footprint information on product labels will give insight into the scope for incentivising water users through price premiums to use fresh water efficiently. This project will report on standardised procedures for calculating green- and blue-water footprints of irrigated field and forage crops, which will ensure that water footprints can be compared and will allow for benchmarks to be derived for water use along the life cycle of the crops.

Cost: R3 000 000
Term: 2014 – 2019

Quantifying water use of high-performing commercial apple orchards in the winter rainfall area of South Africa

CSIR (Natural Resources and Environment)
2398

Within the deciduous tree fruit industry, pome fruit (apples and pears) is the biggest fruit group in terms of area, volume, contribution to GDP and earning of foreign exchange. South Africa is the 7th biggest exporter of apples in the world and the main Southern Hemisphere competitor is Chile, which is third in terms of export. South Africa is also the 6th biggest exporter of fresh pears, with Argentina the biggest fresh pear

exporter in the world and the main Southern Hemisphere competitor. The deciduous fruit industry (including table grapes) employs 106 000 people with 424 000 dependents. Employment in apple farming consists of 27 800 labourers with 111 200 dependents. Currently there is limited knowledge of water use of young apple orchards up to full-bearing age in South Africa. The focus of water use research should be on Golden Delicious and Cripps' Pink cultivars on M793 rootstock, which is the industry standard. Golden Delicious is the major mid-season cultivar, with 24% of the area planted. Cripps' Pink is a late season highest value cultivar, with 9% of the area planted and experiencing growth potential. Within the winter rainfall area, 28% of apples are produced in the Ceres region, primarily in the Koue Bokkeveld climatic zone, and 42% in the Elgin/Grabouw/Vyeboom/Villiersdorp region and climatic zone. Within these regions soils vary considerably and will influence site selections. Soils should therefore be selected to effectively quantify the water balance of the orchard and for comparison between climatic zones. Based on results of completed research it is clear that there is still an existing knowledge gap on water use of apple orchards as well as water use efficiency under local conditions. Increase in efficiency of water use will enable expansion of the area under apple production, or alternatively allow water savings that can be transferred to other sectors or improve the resilience to drought. Research is therefore required to quantify the water use and model water use for future extrapolation for different apple cultivars to wider production regions. This research project should provide a baseline for expansion of this type of research to other deciduous fruit types. The research output will inform strategic decisions by the deciduous fruit industry and relevant government departments.

Cost: R3 000 000
Term: 2014 – 2018

Water use of strategic biofuel crops

University of KwaZulu-Natal (Pietermaritzburg)
2491

The biofuel-related policy of the Department of Energy is encouraging biofuel manufacturers to source approximately 10–30% of feedstock grown by emerging farmers (and smallholder farmers). Hence, research is required to determine the expected water use and yields of grain sorghum and soybean produced in rural areas as well as to determine best agronomic practices for maximising attainable yield. To assist with agricultural extension services, information on which cultivars or hybrids are best suited to biofuel production in particular areas, as well as advice on how to manage fertility, weeds and pests/diseases is required. It is also important to develop enterprise budgets (on a per hectare basis) to determine the feasibility of feedstock cultivation in rural farming areas. It is generally accepted that water (and not land) is South Africa's scarcest natural resource. Given that South Africa is classified as a 'water-stressed' country, there is an urgent need to quantify the water use of feedstock required to meet the expected feedstock demand for biofuel production. The DWS are particularly interested in the impacts of water use associated with farming of communal land as well as knowing which

feedstocks may need to be declared as Stream Flow Reduction Activities (SFRAs). The current biofuels research project (WRC Project K5/1874) has highlighted the need to use crop coefficients, derived for biofuel feedstocks grown under local conditions, for modelling purposes. Research on feedstock water use under dryland conditions is required to assess the impact of communal farming on the availability of water resources for other downstream users.

Cost: R4 000 000
Term: 2015 – 2020

Programme 2:
Fitness-for-use of water for crop production, livestock watering and aquaculture

Evaluation of the risks associated with the use of rain-water, harvested from roof tops, for domestic use and homestead food gardens; and groundwater for domestic use and livestock watering

University of Pretoria (Microbiology and Plant Pathology)
2175

Harvesting rainwater from rooftops is an ecologically-friendly alternative approach to addressing the country's critical water shortages. Water collected in this manner can address domestic water shortage and provide irrigation water for home gardens. Prior to promoting rooftop water harvesting, it is essential to determine the potential level of microbiological and chemical risks associated with such water collection systems. Water collected in this manner is also commonly stored in large plastic containers using well-known brands such as Jo Jo. The ability of microorganisms to proliferate in such water storage systems has been well documented. The quality of such harvested and stored water is however, not well known. In general, dust, bird droppings, chemical leachates from the roof material, adhesives and coatings, etc., may be washed down from the roofs after heavy rain storms with the result that this water will be collected in the storage water unit posing a potential risk for the consumer. Water quality may thus be compromised by the water collection approach. In addition, biofilms may develop in the storage unit and may further compromise the water quality. This is of particular importance since it is known that waterborne pathogens may survive, proliferate and shed into the waterways thereby contributing to the contamination risk. While the quality of groundwater varies significantly from one area to another, available research results (WRC Report 1175/1/06) to assess the risk of groundwater for use in domestic consumption as well as livestock watering has to be refined and updated. By understanding the risks associated with roof-top harvested rainwater and groundwater, improved usage of these valuable resources can be made. Through improved intervention strategies, guidelines and regulations, basic public health issues can be managed and exposure to contamination prevented.

Cost: R2 750 000 (incl. leverage)
Term: 2012 – 2016

Knowledge transfer on water quality management for improved integrated aquaculture and agriculture systems

Stellenbosch University (Aquaculture)

2276

South Africa has a large number of irrigation dams and networks that can potentially be used for integrated aquaculture–agriculture practices. Many of these water resources have not realised their potential. The challenge remains how Government can provide support to develop the aquaculture sector, particularly in rural and peri-urban areas. The perception is that farmers are not effectively engaged or strategically supported. Research-based knowledge is available on water quality management in farm irrigation dams and extension manuals have been developed. However, it is not fully understood how much of the knowledge is sufficiently interpreted and successfully applied. Access to technology is one of the major constraints for small businesses development in South Africa. It is further elaborated that much of the available knowledge does not reach household and producer level. In order to determine the development agenda, technology transfer from the source to the receiver needs attention. Technology transfer was most successful when conducted at a time when people had a specific need for it in their projects. During this process, engagement with the farmers is a crucial element for success. To achieve successful technology transfer, the following elements must be understood:

- What information is available to aquaculture and agriculture and how it is disseminated
- What media/modes are used by the farmers to access information
- In what ways is accessed information utilised
- What are the constraints to information routes at farmer/producer level
- What thinking/rational processes drive information prioritising
- How much of successful farming practice is based on existing and new knowledge
- What are the cost implications of information dissemination

Cost: R1 950 000
Term: 2013 – 2017

Revision of the 1996 South African Water Quality Guidelines: Development of risk-based approach using irrigation water use as a case study

University of Pretoria (Plant Production and Soil Science)

2399

The SA Water Quality Guidelines of 1996 comprise one of the most widely-used tools in water quality management. However, they are now significantly out of date. A Phase 1 Department of Water Affairs (now Department of Water and Sanitation – DWS) project was completed in 2008 that 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. An initiative within DWS is

under way to secure approval and funding for Phase 2 to revise these guidelines. The new guidelines will be different in a number of fundamental ways. Firstly, they will be risk-based – a fundamental change in philosophy from the 1996 guidelines. Secondly, they will allow for much greater site-specificity – a widely-recognised limitation of the generic 1996 guidelines. Thirdly, they will be made available primarily in a software-based decision support system. The overall DWS initiative aims to develop a DSS for all significant water users. With this project, a start is made to revise the guidelines for irrigation water use.

Cost: R2 000 000
Term: 2014 – 2016

THRUST 2: WATER UTILISATION FOR FUEL-WOOD AND TIMBER PRODUCTION

Programme 1:
Water-efficient production methods and systems in agro-forestry, woodlands and forestry plantations

Rehabilitation of grasslands after eradication of alien invasive trees

Rhodes University (Institute for Water Research)
2400

Invasive alien plants (IAPs) remain a serious threat to the water supply and to storage reservoirs throughout South Africa. IAPs are known to use a large quantity of water through evapotranspiration (ET), and the clearing and control of IAPs has been a major activity of the Working for Water (WfW) programme. Water saving has been the primary motivation for the programme. Successful clearing of these often aggressive woody trees and shrubs requires careful regeneration of effective indigenous vegetation cover after the physical clear-felling and removal of the IAPs. Application of effective post-clearing management regimes is required in order to improve the grass cover within catchments and this can ensure that there is controlled run-off and groundwater recharge. The research project will address issues in the following areas:

- Sustainable development solutions: applicability of Payment for Ecosystem Services (PES) to sustainable management of grasslands and IAPs on land under communal tenure; improved models that provide better estimates for ET, water use productivity (WUP) and livestock water productivity (LWP)
- Empowerment of communities: sustainable management by rural communities where livestock farming plays a crucial role in livelihood strategies; optimizing the land-use options available to graziers using WUE and LWP concepts
- Informing policy and decision making: providing

evidence-based scientific input into the policies of WfW, DWS and the DAFF

- Human capital development in the water sector with training for post-graduate students in ET modelling and hydrology. Improved models for ET estimations in South Africa using earth observation will be a significant contribution to further understanding of the impact of changes in land-use on water supply and encourage sustainable land-use practices.

Cost: R4 300 000
Term: 2014 – 2019

Water use of agro-forestry systems for food, forage and/or biofuel production

Institute of Natural Resources NPC; University of Zululand; SRK Consulting (SA) (Pty) Ltd; University of KwaZulu-Natal (Pietermaritzburg); IRD

2492

Agroforestry has been defined as a land-use system where woody perennial trees are integrated into the same land management unit as agricultural crops and/or animals. Agroforestry systems normally have two or more species, one of which is a perennial woody species and has two or more outputs (e.g. food, fuel and fodder). Furthermore, such systems are ecologically and economically more complex than a mono-cropping system. Silvo-pasture is a system that integrates livestock farming with trees and crops and may involve planting of pastures. There is a need to improve food production and make more efficient use of available resources, especially land and water. With increasing populations and more pressure on land, increasing outputs per hectare and per unit of water is key to improving rural livelihoods. The integration of trees and shrubs into cropping systems has the potential to improve the use of available water by intercepting water that has percolated through the root zone of the agronomic crop. Furthermore, trees and shrubs create microclimates, reducing evaporative losses through shading and canopy interception which reduces soil moisture fluctuations in the upper soil layer. Trees and shrubs can also increase the water-holding capacity of the soil through increased organic matter content. Leaf drop can also contribute to soil improvement and certain trees have the capacity to increase soil nutrient status through nitrogen fixation. In a situation where financial resources for investment in fertilizer are very limited, such interventions have the potential to improve crop yields. This research on agro-forestry systems therefore intends to develop environmentally sustainable solutions to improve rural livelihoods.

Cost: R5 000 000
Term: 2015 – 2020

THRUST 3:
WATER UTILISATION FOR POVERTY REDUCTION AND WEALTH CREATION IN AGRICULTURE

Programme 1:
Sustainable water-based agricultural activities in rural communities

Up-scaling of rainwater harvesting and conservation on communal crop- and rangeland through integrated crop and livestock production for increased water use productivity

Institute of Natural Resources (Sustainable Agriculture and Food Security)
2177

Sustainable crop-livestock systems can support the majority of poor members of rural communities. Rainwater harvesting techniques and practices in these systems have the potential to improve the livelihoods of these communities. Many rainwater-harvesting techniques have been tested and are proven to be effective, but their successful application in rural areas for crop-livestock systems is limited. Clearly, correctly designed institutions and organisations are required to support the application of rainwater harvesting techniques by individuals and groups in communities. Conflict that often exists between livestock owners and crop farmers usually leads to low or no production. By clarifying the production potential and rules that determine access to resources, solutions can be found to resolve conflicts. Production systems should be geared towards optimising both crop and livestock production and exploiting the synergies between the two. By up-scaling from the homestead food garden to the croplands and rangelands, opportunities are created to increase production and move from subsistence to profitable levels of farming. In an uncertain environment, interventions such as rainwater harvesting for crop-livestock water use productivity can bring resilience to the system. However, the integrated functioning of the crop- and rangeland system is not well understood. There is also a lack of knowledge of livestock water use productivity in rural areas since livestock have mainly been kept for cultural reasons, whilst demand for livestock products has increased. The challenge for research is therefore to adapt or develop technologies and practices which will improve land productivity whilst enabling water conservation in rain-fed agricultural production on dry-lands and rangelands. Participatory action research should be undertaken to demonstrate that higher crop and livestock water use productivity at lower risks is achievable.

Cost: R3 070 465 (incl. leverage)
Term: 2012 – 2016

Action-oriented development of a strategy for knowledge dissemination and training for skills development of water use in homestead gardening and rainwater harvesting for cropland food production

Rhodes University (Environmental Learning Research Centre)
2277

Household food security in South Africa remains a national challenge with an estimated 59% of 13.7 million households being food insecure, with hunger and chronic malnutrition being widespread within this group. Yet, present utilisation of available land and water resources for smallholders (0.5-10 ha), both in home-gardens and fields remain low. As it is women who are responsible in the majority of cases for farming decisions, they are a key group to target in initiatives aiming for increased crop-production and food-security. There is a substantial body of training information in the public domain which responds to the multi-faceted crop-production challenges faced by small growers. Two recent WRC research products are prioritised; one targeting homestead food production and the second water-harvesting and conservation techniques. In addition, there are other potentially useful publications for use in knowledge mediation processes. These include, for example, WRC grey-water re-use guidelines and in-field rainwater harvesting manuals. The challenge of achieving impact from research outputs is a global one; and is related to what is now recognised as inadequate Research-Develop-Disseminate-Adopt (RDDA) assumptions of how knowledge is/ought to be mediated in society. Contemporary theories of learning and change indicate that for knowledge or information to become meaningful, there is a need for the information to be related to the situation and experience of the user; and also to provide new knowledge or information that can expand existing knowledge and/or practice. The choice of strategic approach to achieve effective knowledge dissemination and uptake to transform available knowledge into productive practices will be determined by those opportunities that unfold during the project, including consultations with both learning organisations and mass-media organisations (TV, radio etc.), and feedback with homestead gardeners and smallholder farmers.

Cost: R1 950 000
Term: 2013 – 2017

Water use of crops and nutritional water productivity for food production, nutrition and health in poor rural communities

University of KwaZulu-Natal (Crop Science)
2493

Reports indicate that food insecurity exists in South Africa at the household level, with about 14 million people residing in rural and peri-urban areas facing malnutrition. There is a need to improve agriculture in these areas so that people are empowered to produce enough food, broaden their existing food basket and improve diversity of nutrition. A WRC scoping study (2012) made significant progress in establishing a baseline for future studies on nutritional water productivity of crops. It noted that inability to make generalisations about food intake by rural people was due to insufficient data. It was also reported that home gardens in rural areas were currently underutilised owing to lack of sound agronomic

practices. The report suggested improving home gardens through (i) proper crop selection, and (ii) use of best management practices. In short, it found that there was a gap in agronomic information on the range of crops that can be utilised in home gardens as food security crops. To this end, it recommended that such strategies should be aimed at improving the nutritional water productivity of these crops in rural areas. Such strategies should be multidisciplinary, because it is not just about increasing productivity of crops but also the impact on food intake trends and nutritional status of the rural poor. In this project such a multidisciplinary team would include agronomists, dieticians and sociologists working together through participatory research. This study will address challenges with food insecurity through empowering rural communities to grow their own crops based on their preference and using best practice management for improved nutritional water productivity.

Cost: R4 000 000
Term: 2015 – 2020

Enhancing food security and nutrition of selected rural communities in Limpopo Province using high-yielding and water use efficient grain legume varieties

University of Limpopo (Plant Breeding and Insect Pest Management)
2494

One of the ways to enhance sustainable food production, thereby enhancing food security and nutrition in drought-prone communities in Limpopo Province, is through the introduction and cultivation of high-yielding, disease and insect pest resistant, early maturing and water use efficient grain legumes such as cowpea, pigeon pea, Bambara groundnut, etc. Cowpea and early maturing pigeon peas are versatile crops which are known to thrive under low and erratic rainfall conditions where cereal crops cannot. Cowpea (*Vigna unguiculata* L. Walp) and pigeon pea (*Cajanus cajan*) are nutritious multipurpose grain legumes with tremendous potential, especially in rural areas of South Africa. These legumes are drought-tolerant and can thrive under low water stress and soil fertility. Cowpea is an important grain legume with very high potential for production and improving dietary intake in South Africa. The seeds are rich in protein (24.8%), carbohydrate (63.6%), vitamins and other essential nutrients. Cowpea snacks and their derivatives are important traditional protein-rich products prepared and sold as foods and this can help improve the dietary intake of impoverished communities in South Africa. Cowpea can be easily intercropped with many crop species and contributes to soil improvement through nitrogen fixation. This project intends to show that introduction and cultivation of water use efficient and low-input grain legumes in rural communities where erratic rainfall is a major contributory factor to low yield will ameliorate the problem of food insecurity and malnutrition.

Cost: R2 600 000
Term: 2015 – 2020

Up-scaling of rainwater harvesting and conservation to croplands and rangelands for food and renewable fuel (biogas) production

Agricultural Research Council (Institute for Soil, Climate and Water)

2495

The application of appropriate rainwater harvesting and conservation (RWH&C) techniques on homestead gardens, croplands and rangelands in selected rural villages in South Africa could empower community members to produce their own crops using the arable land more productively and enhance livestock production using rangeland, hence contributing towards the reduction of household food insecurity. Since livestock production is already an important component of many smallholder farming systems, livestock manure can be used to produce biogas, which is a cost-effective, environmentally-friendly energy source. The biogas can be used for cooking, heating and lighting and is less harmful to environment than the smoke from open wood fires. However, for biogas generation, a sustainable water and manure supply is essential for the successful implementation and meaningful impact of this technology. Adequate water for the biogas digester can be collected from rooftops into tanks. The advantages of collecting water from roofs are that the roofs are physically in place and runoff is immediately accessible, the water collected from roofs is much cleaner than from land runoff and that most of the rainwater falling on the roof can be collected. Various rainwater harvesting technologies and biogas digesters are used at sites scattered around the country; however, there is no single rural village where an integrated approach to economic development based on fodder, food, energy and water security is used. This emphasizes the importance of conducting a research and development project on the up-scaling of rainwater and conservation on croplands and rangelands for food and renewable fuel (biogas) production.

Cost: R4 000 000
Term: 2015 – 2020

Towards enhancing contributions of inland fisheries to rural livelihoods: An empirical assessment of freshwater fish stocks, fisheries potential, market value chains, governance and co-management arrangements

University of the Western Cape (Institute for Poverty Land and Agrarian Studies – PLAAS); University of Cape Town; Rhodes University; South African Institute for Aquatic Biodiversity; University of Limpopo

2497

A recently-completed baseline and scoping study published by the WRC found that inland fisheries contribute to the livelihoods, food security and employment of many rural women and men in South African informal economies. Recreational angling is by far the most developed, but access rights to the social and economic benefits from this sub-sector largely remain unequal. By contrast, commercial and subsistence inland fisheries are poorly developed despite several attempts dating back to the 1970s. This raises questions about the potential of inland fisheries to contribute to

enhancing rural livelihoods. The management of the fishery to ensure sustainable utilisation of fish stocks over time, to promote the economic and social well-being of fisheries, should therefore be a top priority for provincial administrations. Although it has been suggested that stock enhancement may improve the productivity of small reservoirs, there is a paucity of information on fish stocks and fisheries potential for most dams. This knowledge gap critically hinders the capacity to determine appropriate stocking and harvesting levels for various dams. Objectives of the research project will also be to improve understanding about the nature of existing formal and informal market value chains (MVCs) associated with inland fisheries as well as the multiple user groups that access water and fisheries resources in dams; the economic value of inland fisheries in selected South African dams; factors affecting entry by rural women and men into lucrative MVCs associated with specific dams; and requisite institutional interventions for ensuring that MVCs associated with inland fisheries are sufficiently pro-poor.

Cost: R4 000 000
Term: 2015 – 2020

Programme 2:
Integrated water management for profitable farming systems

Water use productivity associated with appropriate entrepreneurial development paths in the transition from homestead food gardening to smallholder irrigation crop farming in the Eastern Cape Province

University of Fort Hare (Agricultural Economics and Extension)
2178

In the programme of action of the Presidency announced during 2010, Outcome 7 envisages vibrant, equitable and sustainable rural communities with food security for all. It is expected that Output 4 will deliver improved employment opportunities and economic livelihoods. This includes a rising percentage of small-scale farmers producing for market sales and an increased number of jobs in agro-processing. Furthermore, it has been argued (Sunter, 2011) that, for a balanced economy, both an outward and inward focus is required. The last mentioned involves support for establishment of new small businesses and related additional job creation. In this regard priority attention should therefore be given to encouraging existing and new small farming businesses to be undertaken on smallholder irrigation schemes. The millennium development goals also require reduction in poverty levels and empowerment of women. The available evidence indicates that natural and human resources on most if not all smallholder irrigation schemes in South Africa are utilised far below potential. Given the semi-arid circumstances and potential impact of climate change, increasing emphasis must be placed on higher productivity of water use under irrigation. It will involve higher crop production and better product quality, which allows for negotiating higher prices and improving operating margins. For this purpose, ways must be found to enable more productive farming practices, and more competitive and profitable farming on irrigation schemes. This in turn requires that an assessment is made of the goals and

aspirations of current and potential farmers, in particular women, to improve the economic performance of farming enterprises. In order to show the way forward, research should be done which is based on real situations on existing irrigation schemes where solutions are practically achievable. This can be done by involving farmers and potential beneficiaries on irrigation schemes in the research effort.

Cost: R1 950 000
Term: 2012 – 2016

Water use productivity associated with appropriate entrepreneurial development paths in the transition from homestead food gardening to smallholder irrigation crop farming in KwaZulu-Natal and North West Provinces

University of KwaZulu-Natal (Agriculture Sciences and Agribusiness); African Centre for Food Security
2278

In the programme of action of the Presidency announced during 2010, Outcome 7 envisages vibrant, equitable and sustainable rural communities with food security for all. It is expected that Output 4 will deliver improved employment opportunities and economic livelihoods. This includes a rising percentage of small-scale farmers producing for market sales and an increased number of jobs in agro-processing. Furthermore, it has been argued that, for a balanced economy, both an outward and inward focus is required. The last-mentioned involves support for establishment of new small businesses and related additional job creation. In this regard priority attention should therefore be given to encouraging existing and new small farming businesses to be undertaken on smallholder irrigation schemes. The available evidence indicates that natural and human resources on most if not all smallholder irrigation schemes in South Africa are utilised far below potential. Given the semi-arid circumstances and potential impact of climate change, increasing emphasis must be placed on higher productivity of water use under irrigation. It will involve higher crop production and better product quality, which allows negotiating higher prices and improve operating margins. For this purpose, ways must be found to enable more productive farming practices, more competitive and profitable farming on irrigation schemes. This in turn requires that an assessment is made of the goals and aspirations of current and potential farmers, in particular women, to improve the economic performance of farming enterprises. In order to show the way forward, research should be done which is based on real situations on existing irrigation schemes, where solutions are practically achievable. This can be done by involving farmers and potential beneficiaries on irrigation schemes in the research effort.

Cost: R1 950 000
Term: 2013 – 2017

The optimisation of electricity and water use for sustainable management of irrigation farming systems

University of the Free State (Agricultural Economics)
2279

Electricity tariff structures have changed over the years, while electricity rates have recently escalated considerably and are expected to continue increasing in future. This requires a change in design norms and standards as well as a shift in emphasis to life-cycle cost evaluation. This subject was last formally researched more than 10 years ago, with publication of a report in 2002 (WRC Report No 894/1-4/02), followed by technology transfer activities (WRC Report No 274/05). This research output clearly needs to be revised and guidelines must be updated. Over the intervening years, new technologies have become available, such as variable speed drive (VSD) and energy-efficient motors (with a new classification system). Better engineering practices for pumps, including auto-restart and remote control, have led to increased accuracy and energy efficiency. It is therefore essential to evaluate and compare different technologies on the basis of efficient energy/power use and operating cost over the life cycle of the irrigation system. In addition, better automatic weather stations are accessible and convenient irrigation scheduling techniques, such as continuous logging probes with telemetry, can be applied. This enables more efficient use of water, reduced electricity consumption and higher food production. At the same time, there are pressures to reduce the carbon and water footprint, especially for export food markets. In so doing, costs must be lowered, profitability and competitiveness increased and water use productivity improved. However, farmers need advice and extension based on user-friendly guidelines, in order to respond to these pressures and incentives by changing irrigation practices. These practices that influence electricity power use include determining water use of crops, soil water monitoring, application rates of water, pumping water from the river or storage dam to the field, installing energy-efficient motors, selecting correct pipe sizes, and regular maintenance of equipment, etc. Measurement and verification therefore requires determining the baseline and implementing an information system for management of reduced energy/ electricity consumption and optimisation of water use on irrigation farms.

Cost: R1 950 000
Term: 2013 – 2017

Wide-scale modelling of water use and water availability with earth observation/ satellite imagery

Stellenbosch University (Environmental and Geographical Studies)

2401

It is clear that both the land area and water resources available for irrigated crop production is very limited in South Africa. With the added pressures of climate change, population growth and the impact of a decline in water quality, the need for improved assessments of the current water resource uses and land uses is critical. Actions related to improved water use productivity and irrigation expansion or water reallocation can only follow once this information is available. Use of remote-sensing data, together with algorithms developed over the past 20 years to estimate actual evapotranspiration (ET), is an internationally accepted alternative and improves the

traditional methods used to estimate or measure actual ET. Remote sensing data is routinely and frequently captured across the world. It is frequently used in deriving land cover–land use maps and hence suitable for estimating the area under irrigated agriculture. Remote-sensing data utilised in energy balance modelling has the potential to provide recent estimates of ET. Combining these remote-sensing based datasets will provide estimates of crop ET and total amount of water utilised by irrigated agriculture. Using remotely-sensed data within a framework for water accounting will be invaluable for water resources planning. A water accounting framework can provide an overview on water resources (per selected area) and facilitate decision making. The consumptive use by various land uses need to be understood prior to new water allocations. Various international initiatives have been developing water accounting systems to support water managers and decision makers. The usefulness of such a framework will be tested and illustrated in this project.

Cost: R5 010 940 (incl. leverage)
Term: 2014 – 2018

Long-run hydrologic and economic risk simulation and optimisation of water curtailments

University of the Free State (Agricultural Economics); DHI (SA); Technical University of Dresden
2498

Currently the Mhlathuze catchment is undergoing compulsory licensing to reconcile imbalances in the catchment through a proposed curtailment of irrigators' water rights by 40%. If the assurance of supply to the irrigation sector in the Mhlathuze is to remain the same, the extent of the curtailment may have a devastating impact on the financial feasibility of the farming operations with a direct impact on the local economy. A clear need exists to assist irrigation farmers with on-farm water use optimisation to cope with these water curtailments. Furthermore, the NWRS-2 highlights the need for a more sophisticated approach through decentralisation and stakeholder participation to optimise operational management of infrastructure to address sometimes conflicting water requirements. Such a more sophisticated and general approach to water management will necessarily require some form of hydro-economic modelling. The research project will address the following knowledge gaps in order to model the impact of dynamic responses by irrigation farmers to curtailment within catchment-level management scenarios: (i) incorporating a better representation of dynamic irrigation water budget calculations into economic decision-making at the farm level to enhance the ability of the hydro-economic framework to quantify return flows and to improve agricultural water use optimisation; (ii) Improving economic modelling procedures to optimise dynamic structural (crop mix and irrigation technology choice) responses of irrigation farmers while taking the assurance of water supply within a state contingent framework into account.

Cost: R3 000 000
Term: 2015 – 2019

THRUST 4: WATER RESOURCE PROTECTION AND RECLAMATION IN AGRICULTURE

Programme 1:
Sustainable water resource use on irrigation schemes and within river catchments

Guidelines for technology transfer to manage irrigation-induced salinity with precision agriculture

University of the Free State (Soil, Crop and Climate Sciences); Department of Agriculture, Environment and Rural Development; SASRI; Stellenbosch University

2499

The salt load associated with irrigation is a major obstacle to sustained productivity for farmers in most semi-arid regions throughout the world, including South Africa. With the correct design and operation of irrigation and drainage systems, together with the implementation of best practices, sustainable irrigation is nevertheless possible, as advocated internationally and by research published by the Water Research Commission. The actual contribution of this knowledge to sustainable and productive irrigated farming systems is however questionable in the absence of appropriate management guidelines. Hence, there is a need to develop guidelines for technology transfer to manage the salt load associated with irrigation at farm and field level. With the ever-increasing availability and affordability of technology to support decisions within a field, through the adoption of precision agriculture or site-specific crop management, the opportunity also exits to apply these management guidelines at a much smaller scale for a decision support system (DSS) that incorporates guidelines and uses models for recommendations to better match water and salt management, and soil and crop requirements as they vary in a field. This project will combine models that were developed with WRC funding, i.e., BEWAB and SWAMP, and advances in spatial delineation of site-specific management units (SSMUs), for example, soil sensing systems, terrain sensing, airborne and satellite optical imagery or proximal crop reflectance sensors, for development of salinity management guidelines at a farm level.

Cost: R4 000 000
Term: 2015 – 2020

Programme 2:
Impact assessment and environmental management of agricultural production

Vulnerability, adaptation to and coping with drought: The case of the commercial and subsistence extensive livestock sector in the Eastern Cape

University of the Free State (DiMTEC)

2280

Dry periods and droughts remain the major meteorological factor with devastating impacts on the livelihoods of most rural people in South Africa. The agricultural sector specifically incurs millions of Rands

in losses every year. For example, the direct mean annual loss (MAL) to the extensive livestock sector in the Northern Cape alone is in the excess of R350 million. Little evidence is available of the required adaptations to reduce vulnerability and increase resilience of farming enterprises to natural hazards such as drought. Given the expected increase in these extreme events due to climate change, more research is essential on how vulnerability can be reduced in order to prevent future disasters. The proactive approach towards drought risk management emphasizes the need for coordination and collaboration among all role players. This includes coordination between monitoring agencies in terms of reliable early warning systems, communicated in a comprehensible way to decision-makers, farmers, agricultural businesses and all that have an interest in agriculture. Collaboration at national and provincial level between the Department of Agriculture, Forestry and Fisheries (DAFF) at national level, provincial Departments of Agriculture, National and Provincial Disaster Management Centres (NDMC and PDMC), Department of Water Affairs (DWA), South African Weather Service (SAWS) and others is essential in this regard.

Cost: R2 950 000 (incl. leverage)
Term: 2013 – 2017

Assessing the impact of erosion and sediment yield from different land uses in farming and forestry systems and their effect on water resources in selected catchments of South Africa

University of KwaZulu-Natal (Centre for Water Resources Research)

2402

Recent soil erosion mapping and modelling studies conducted by DAFF and the ARC-ISCW indicate that large parts of South Africa consist of highly erodible soils with widespread soil erosion evident. Soil erosion not only involves the loss of fertile topsoil, reduction of soil productivity and reduction in crop yield over time, but also causes water management problems, especially in semi-arid regions such as South Africa where water scarcity is frequently experienced. It must be noted that soil erosion cannot be prevented but must be limited. Siltation of storage dams is acknowledged to be a major problem in South Africa and better understanding of erosion and sediment yield is important to limit the cause of siltation. Phosphates are also linked to sediments contributing to eutrophication of dams and estuaries. Sediments in water furthermore increase the wear and tear of nozzles and hydraulic pumps for irrigation. It has also been highlighted in completed studies that better knowledge of limiting erosion will contribute to changing the behaviour of farmers by adopting conservation farming practices. Incorrect land use practices including overgrazing of natural grasslands is one of the major contributing factors to erosion and sediment yield. Completed WRC-funded research recommended that further investigation should focus on the connectivity of

sediment delivery pathways and develop precautionary measures to limit the direct discharge of sediment into streams. Attention in this project will be given to quantification of sediment detention, retention or reaction to specific controls in stream networks, including farm dams, wetlands and buffer strips.

Cost: R2 200 000
Term: 2014 – 2018

The modelling of rainy season characteristics and drought in relation to crop production in the Levubu catchment of the Limpopo Province: Climatology and climate change perspective

ARC (Institute for Soil, Climate and Water)

2403

Drought is one of the most disastrous climate-related hazards in the world, which has significant impact on agriculture, environment, infrastructure and socio-economic activities. In semi-arid regions like the Limpopo Province, drought is the climate hazard that has the most detrimental effect on crop production. The most affected people are the resource-poor farmers whose productivity is threatened by frequent droughts. The quantification and monitoring of drought is of critical importance politically, economically and environmentally in most countries. Agroclimatological information is important to improve agricultural production as well as protecting the agricultural resources from deteriorating. The frequencies, means, extremes, deviations, exceedence of thresholds, spatial variability and trends of agroclimatological parameters are important for assessing and managing agricultural risk. Many practices like the use of irrigation, improved cultivation and improved crop varieties have been developed over the years to adapt agriculture to climate variability and climate change, but agricultural productivity can further be increased, costs of production reduced and crop failures avoided through use of weather and climate information. In this project, analyses of agrometeorological information will support the farming community in better planning, improving preparedness and adaptive capacity, risk assessment, evaluation of current climate and agricultural interactions and simulation of future trends.

Cost: R2 000 000
Term: 2014 – 2018

Seamless forecasting of rainfall and temperature for adaptation of farming practices to climate variability

University of Cape Town (Environmental and Geographical Science); University of Fort Hare; University of Venda; CSIR; Centre for Water Resources Research (CWRR); ARC (Institute for Soil, Climate & Water); South African Weather Service

2496

The proposed research directly follows on from a previous WRC project (2012) which explored the application of weather and climate forecasts in agricultural decision-making. This included applying weather and climate forecasts within hydrological

models to produce hydrological forecasts. The aim of this study is to develop an operational and robust climate–crop–water integrated assessment tool for the production of medium-scale agricultural forecasts (including water supply). The time scale of concern is monthly to a few months ahead with the particular intention to inform seasonal decision making. The spatial resolution of the project addresses community-scale issues and information that will improve response to climate variability. Consequent agricultural scenarios will be simulated through widely proven and extensively tested crop models, under common and expert-recommended management. These management alternatives could include some operational issues (deciding the implementation details of an action), but the major target is to better inform tactical decisions (deciding of actions not modifiable during the crop season, e.g., land–water–crop–fertiliser resource allocation, planting, etc.). However, the developing/modelling phase is only a part of a concretely applicable project. Stakeholder engagements from the inception to the end of the project will help to frame the research objectives and advancements into field constraints, e.g., maize yield estimates. The larger part of the project will encompass testing the approach in two smallholder farming communities, namely one in Eastern Cape and one in Limpopo. In addition to those smallholder farming communities, commercial farmers will be engaged in KwaZulu-Natal with respect to the application of hydrological forecasts in decision-making. These real-life experiments will demonstrate the feasibility and evaluate the benefits of the approach, as well as highlight the barriers and enablers of up-scaling this tool and disseminating its recommendations at a wider scale.

Cost: R4 500 000
Term: 2015 – 2020

Emerging contaminants (veterinary pharmaceuticals and hormones) from agriculture in water systems around Cape Town and Stellenbosch, Western Cape

Cape Peninsula University of Technology (Chemistry); CSIR

2500

Agriculture remains a significant source of emerging contaminants (EC) in the environment and in agriculture systems. The ECs that are currently the predominant sources of surface water contamination (relative to non-agricultural sources) and which are of potential concern include veterinary medicines such as antibiotics, anti-parasitic agents, and hormones (such as natural and synthetic oestrogens and androgens). The use of veterinary drugs for food production focuses on the control and improvement of animal health through therapeutic and prophylactic treatment. The disadvantage of this practice is that pharmaceuticals and their metabolites are released into the environment, finding their way to natural water systems and becoming potential risks to non-target organisms and to humans who may be exposed to such contaminated water. Livestock farming is prevalent in South Africa and especially in the Western Cape Province where it contributes substantially to the province's economy.

The use of these chemicals in livestock farming in the province is widespread. Despite this, data on the presence of these chemicals in the Western Cape environment in particular is scarce or non-existent. Analysis of these data will be necessary for regulatory agencies in government departments and city authorities to develop guidelines for their sustainable use in agriculture in order to maintain public confidence in their water systems and food sources.

Cost: R890 000
Term: 2015 – 2017

Quantifying and managing agricultural nitrogen and phosphorus nutrient pollution from field to catchment scale

University of Pretoria (Plant Production and Soil Science); University of the Free State; CSIR; Omnia Fertilizer
2501

The DWS maintains a monitoring network of surface and subsurface water quality (including inorganic N and P concentrations) dating back to 1972. These data are extremely valuable for improving our understanding of N and P contamination levels in different parts of South Africa, but require extensive value-add. The potential further exists to identify hotspots where agriculture contributes significantly to these enriched N and P levels. The accurate quantification of agricultural contributions to surface and subsurface water N and P levels is, however, hindered by (i) the quality of models available and issues with upscaling from plot to catchment scale, (ii) the lack of adequate data for model parameterisation, initialisation and calibration, and (iii) the lack of adequate, independent datasets for model testing and verification. Plot-scale models simulate crop growth and soil water and nutrient dynamics fairly well, while catchment-scale models simulate N and P transport pathways over longer distances. The latter category of models runs the risk of incorrectly simulating nutrient dynamics through over-simplification and the lack of feedback loops. As a result, an interplay between more detailed plot-scale models and less detailed catchment-scale models is required. This project aims to build on work done in a previous WRC research project, to further improve the quantification of N and P pollution as well as develop and disseminate knowledge on appropriate mitigation measures.

Cost: R4 000 000
Term: 2015 – 2019

THRUST 1: WATER UTILISATION FOR FOOD, FORAGE AND FIBRE PRODUCTION

Programme 1:
Programme 1: Water-efficient production methods in relation to soils, crops and technology in rain-fed and irrigated agriculture

Water use of avocado and macadamia orchards

University of Pretoria; ARC; University of KwaZulu-Natal (Pietermaritzburg); independent consultant

2552

Cost: R5 160 000
Term: 2016 – 2021

The general aim of this research is to quantify water use of avocado and macadamia trees in relation to yield at an orchard scale. Specific project aims are:

- To measure unstressed water use of avocado and macadamia according to seasonal growth stages from planting to mature canopy size, for selected cultivars and locations
- To model stressed water use of avocado and macadamia according to seasonal growth stages from planting to mature canopy size for selected cultivars and locations
- To determine the influence of water stress during different phenological stages of avocado and macadamia on yield and quality for selected cultivars and locations
- To quantify water use efficiency and water use productivity of avocado and macadamia for selected cultivars and locations

Assessing the water footprints of selected fuel and fibre crops in South Africa

University of the Free State; SASRI; ARC

2553

Project aims:

- To assess the green-, blue- and grey-water footprint of selected fuel and fibre crops and their respective derived crop products in South Africa
- To develop water footprint benchmarks for sustainable freshwater use in the production of the selected fuel and fibre crops in South Africa
- To develop benchmarks for the economic productivity of the water footprints of the selected fuel and fibre crops
- To conduct a sustainability assessment of the blue-water footprint of food and fibre production in South Africa
- To identify and prioritize key strategic intervention points in the food and fibre production chain for the most efficient results

- To model the economic and social implications associated with changed water use behaviour through the implementation of recommended intervention strategies to change water use behaviour towards sustainable freshwater use
- To assess the water footprints of selected fuel and fibre crops in the context of projected future climate change scenarios in South Africa

Cost: R3 000 000
Term: 2016 – 2021

THRUST 2: WATER UTILISATION FOR FUEL-WOOD AND TIMBER PRODUCTION

Programme 1:
Water-efficient production methods and systems in agro-forestry, woodlands and forestry plantations

Water-efficient production methods and systems in agro-forestry, woodlands and forestry plantations

University of Pretoria; University of KwaZulu-Natal (Pietermaritzburg); Hydrological Research & Training Specialists
2554

The aim of the study is to understand and quantify the water use of different agricultural and ecological land-use components of the Maputaland Coastal Plain, which could potentially be developed into an integrated, multiple-use agroforestry system(s), as an alternative to commercial plantation forestry in water-stressed catchments.

Project objectives are:

- Understand with accuracy the water use of plantation forestry and indigenous species within a commercial, community woodlot and mixed plantation or agroforestry environment in Maputaland
- Understand the ecological pattern and water use of natural vegetation systems that could be incorporated in agroforestry systems in Maputaland
- Develop and evaluate groundwater models of the Maputaland Coastal Aquifer to determine the impacts of land use in the context of plantation forestry, natural vegetation systems and a mixed plantation environment

Cost: R2 408 000
Term: 2016 – 2019

THRUST 3: WATER UTILISATION FOR POVERTY REDUCTION AND WEALTH CREATION IN AGRICULTURE

Programme 1:
Sustainable water-based agricultural activities in rural communities

Water use for food and nutrition security at the start-up stage of food value chains

University of KwaZulu-Natal (Pietermaritzburg); ARC Institute for Soil, Climate & Water; Free State Department of Agriculture

2555

Project aims:

- Conduct a detailed literature review of techniques and practices (homestead, community and school gardens) to improve water use for food and nutrition security at the start-up stage of food value chains, for early childhood development and household food security and livelihoods enhancement in peri-urban and rural environments
- Describe and analyse the current natural resources (water, soils, climate), human resources (demographics, gender, age, vulnerability, agency, current social reality, state of health, nutritional status and needs etc.), institutional arrangements, farming systems and water use in homestead, community and school gardens and food value chains at start-up level
- Identify and select climate-smart technologies and practices to improve water use for improved crop production to match dietary and nutritional needs for early childhood development and for improved households and livelihood enhancement
- Demonstrate and implement selected technologies for improved production at homestead, community and school gardens in the selected areas, for improved household and livelihood enhancement
- Evaluate, monitor and analyse water use for food and nutrition security at the start-up stage of food value chains at homestead, community and school gardens, for improved households and livelihood enhancement
- Explore the role of homestead, community and school gardens in producing sufficient food and in entering the food value chain for producers in the selected areas, for improved households and livelihood enhancement
- Monitor and evaluate the influence of workable institutional arrangements (water, land use security and market players) and organisational structures on incentives and/or disincentives for homestead, community and school gardens, with the intention of entering the food value chain for improved households and livelihood enhancement
- Develop guidelines on best management practices to improve water use for food and nutrition security at the start-up stage of food value chains for improved households and livelihood enhancement

Cost: R3 870 000
Term: 2016 – 2020

Assessment of the effectiveness of policies and strategies for governance of smallholder irrigation farming in KwaZulu-Natal Province, South Africa

University of KwaZulu-Natal (Pietermaritzburg); University of Limpopo; University of Zululand

2556

The overall research aim is to assess the effectiveness of policies and strategies, rules and regulations and governance of programmes that provide support to smallholder farmers on irrigation schemes in KwaZulu-Natal Province. Specific project objectives are:

- To review the existing policies, strategies, rules and regulations and governance of programmes and their influence on the performance of irrigation schemes in South Africa and beyond
- To review literature on the assessment of the effectiveness of policies, strategies, rules and regulations, and governance on irrigation performance
- To describe and explain how policies, strategies, rules and regulations and governance programmes affect irrigation schemes with respect to: land and water allocation and land tenure, intergenerational relationships, gender, tradition and culture
- To describe the factors that influence the effectiveness of policies, strategies, rules and regulations, old or new, focusing on factors such as: how information is communicated to irrigation farmers, gender, generational differences, level of education, household level factors
- To specify appropriate changes to existing policies, strategies, rules, regulations and governance programmes that can enhance the performance of smallholder irrigation schemes in South Africa; this can include recommendations on new policies, strategies, rules, regulations and governance programmes that can enhance the performance of smallholder irrigation schemes in South Africa

Cost: R3 000 000
Term: 2016–2020

Programme 2:
Integrated water management for profitable farming systems

Review and update the South African Irrigation Design Manual and Irrigation User Manual

ARC; Bioresources Consulting; Rural Integrated Engineering (Pty) Ltd

2559

Project aims:

- To update and improve the South African Irrigation Design Manual to ensure that current best practices are employed in the design process which will help safeguard the irrigation industry amid the current over-exploitation of our country's water resources and a decrease in energy availability and the subsequent rise in energy costs
- To update and improve the South African Irrigation User Manual in order to assist both commercial and subsistence irrigation farmers as well as irrigation scheme managers in the quest to meet the stated goals in National Water Resource Strategy 2, of

improved water use efficiency by providing quality and relevant information about current trends and the latest technological developments in the irrigation industry

Cost: R1 990 000
Term: 2016 – 2019

Developing a research agenda for promoting underutilised, indigenous and traditional crops
University of KwaZulu-Natal (Pietermaritzburg)
2603

Project aims:

- To conduct a state-of-the-art literature review on past, present and ongoing work on underutilised, indigenous and traditional crops and their status, potential, challenges and opportunities along the value chain in South Africa; the review will pay particular attention to drought tolerance in indigenous crops
- To develop a list of priority underutilised, indigenous and traditional crops for South Africa. The prioritisation of crops will focus on key areas of crops that are known to be drought tolerant and nutrient dense and that have potential to contribute to food and nutrition security during periods of drought
- Develop mechanisms of identification of local research champions for underutilised crops and strengthening of the current database on professionals working on underutilised crops
- To develop a national guideline and research agenda for prioritising research on drought tolerant and nutrient dense underutilised crops in South Africa. The agenda should align with international initiatives to allow South Africa to tap into global funding for underutilised crops

Cost: R200 000
Term: 2016

THRUST 4: WATER RESOURCE PROTECTION AND RECLAMATION IN AGRICULTURE

Programme 1:
Sustainable water resource use on irrigation schemes and within river catchments

Improving on-farm irrigation water and solute management using simple tools and adaptive learning

University of Pretoria; CSIRO Land and Water

2557

Project aims:

- To deploy farmer-friendly monitoring tools that measure soil water, nutrients and salt
- To develop a system of quick data sharing through on-line visualisation of data from the monitoring tools linked to a virtual discussion, learning and teaching space with skilled facilitators
- To further refine simple monitoring tools to address on-farm farmer experiences
- To determine how this combination promotes learning that improves irrigated farm productivity

Cost: R2 000 000
Term: 2016 – 2019

Salt accumulation and waterlogging monitoring system (SAWMS) development

Stellenbosch University; ARC Institute for Soil, Climate & Water; Griekwaland-Wes Korporatief

2558

Project aims:

- To develop a system that automatically analyses multi-temporal (current and historical) satellite imagery for identifying areas within cultivated fields that are likely to be affected by waterlogging or salt accumulation
- To disseminate information about waterlogged and salt-affected areas to end-users through the development and implementation of a web-based application
- To demonstrate, apply and evaluate the system in suitable irrigation schemes
- To improve the system based on user feedback and make recommendations for national implementation

Cost: R2 386 000
Term: 2016 – 2019

Programme 2:
Impact assessment and environmental management of agricultural production

Modelling of water flows with change in land management in selected river catchments

University of KwaZulu-Natal (Pietermaritzburg); University of the Western Cape; University of Lethbridge; Rhodes University

2560

Project aims:

- To assess how changes in land management alter water flows and the generation and delivery of eco-system services within river catchments
- To quantify how changes in land management modify water flows emphasising base-flow and floods for the ecological Reserve, as well as yield from storage, run-of-river and groundwater extraction
- To quantify how changes in land management modify sediment dynamics, with reference to functioning of aquatic ecosystems, maintenance of infrastructure, sedimentation of dams and production of crops
- To quantify how changes in land management modify water quality with reference to nutrient dynamics and environmental health

Cost: R6 000 000
Term: 2016 – 2021

Use of winery wastewater as a resource for irrigation of vineyards in different environments

ARC Infruitec-Nietvoorbij; Stellenbosch University
2561

The general aim is to assess the fitness for use of augmented winery wastewater for irrigation of different soil types with varying rainfall quantities and leaching levels, based on vineyard performance in terms of yield and wine quality:

- To determine the appropriate level of in-field dilution/ augmentation of winery wastewater with raw water with specific reference to the pH, EC, SAR/PAR and COD
- To measure the change in mainly Na and K status of soils with different clay content, with low/high rainfall and low/high leaching levels with application of augmented winery wastewater
- To develop appropriate management guidelines for using augmented winery wastewater as a resource for irrigation of vineyards
- To refine regulations for general authorisation of augmented winery wastewater for irrigation of vineyards

Cost: R4 000 000
Term: 2016 – 2022

Coping and adaptation strategies for agricultural water use during drought periods

Cape Peninsula University of Technology; Department of Agriculture, Forestry & Fisheries
2602

Project aims:

- Review of the current knowledge of drought and drought occurrence in South Africa, including the review of current drought polices and strategies, national and provincial response strategies
- Review of drought coping and adaptation strategies in dryland cropping systems, irrigation, livestock and mixed systems. Identify potential strategies that can be adopted by South Africa, including strategies from Sub-Saharan Africa and other regions
- Identify policy and research gaps, and make recommendations of what should be done in South

Africa under current drought conditions, and future droughts
- Suggest a national drought response strategy for agricultural water use in South Africa

Cost: R200 000
Term: 2016

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