# IMPROVING THE UPTAKE AND IMPACT OF RESEARCH-BASED KNOWLEDGE IN THE DIGITAL AGE

## *A case study on water measuring and metering in commercial irrigated agriculture*

*Sarah Slabbert, Nadja Green and Isobel van der Stoep*

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# Improving the uptake and impact of research-based knowledge in the digital age

A case study on water measuring and metering in commercial irrigated agriculture

A report for the Water Research Commission and
the Department of Agriculture, Forestry and Fisheries

prepared by

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This report emanates from a Water Research Commission (WRC) project, K5/2712//4, titled "An investigation and communication strategy to support the uptake of available WRC research-based knowledge by irrigation schemes and commercial irrigated agriculture".

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# Executive summary

The global demand for food and freshwater is increasing due to factors such as population increases, increases in the per capita demand for water and economic development. In addition, the demand for freshwater is also influenced by the need to protect aquatic ecosystems, and socio-political factors such as equitable access to water.

In South Africa, as in the rest of the world, agriculture is the largest user of freshwater resources, surface and groundwater included. For South Africa, agricultural use amounts to about 60% of the total use. Irrigated agriculture is therefore increasingly under pressure to produce more food with less, or the same amount of, water.

This goal can only be achieved if research on crop water use and advances in irrigation technology are applied appropriately in irrigation systems. The accurate monitoring and measuring of water use are integral to this process.

Research organisations such as the Water Research Commission (WRC) are one of the role players in the agricultural system that produce the required research and development. State-funded research organisations are accountable to government and tax payers to demonstrate not only that they have produced research-based knowledge, but that this knowledge has been taken up and has had an impact.

Local and international studies show that uptake of research-based knowledge/innovation in agriculture tends to be disappointing.

**This study explored the journey from research to uptake through a case study in water measuring and metering in irrigated agriculture with the aim to address the challenge that local and international research organisations face: How do you ensure that your research products are adopted by the target audience?**

The first part of the report discusses the 'ideal' situation in terms of the context outlined above. An overview of the literature found that the ideal is neither clear-cut nor simple. In addition, it is constantly evolving as the examples below illustrate.

In policy and even academic narratives, the call on agriculture to use less water is phrased in terms of ''water use efficiency''. Recent research has shown that there is no clear and common definition of the term. As a result, its use is fraught with misunderstandings and miscommunications, at all levels. However, the need to accurately monitor and measure water use is implicit in the narratives.

The drive for research uptake and innovation adoption has been criticised in the literature as supporting the modernisation/diffusion paradigm by framing uptake and adoption as normative concepts. The drive for uptake and adoption has also been criticised as not considering the constraints of the target audience and their right to reject uptake or adoption.

The literature acknowledges that communication is integral to the uptake of research-based knowledge and the adoption of agricultural innovation in the development context. Hence also the use of the term ''development communication''. But what is the ideal relationship between a research organisation and its target audience and which communication model has the best chance to facilitate uptake/adoption? The field of development communication has evolved quite dramatically from a linear model, in which research-based knowledge is diffused or transferred to a target audience, to a participatory model, in which the target audience is actively involved in the creation of research-based knowledge/innovation. In recent literature, a hybrid model is proposed as 'the ideal'.

The evolution of the development communication runs parallel with the way that communication has evolved in the digital age. In the digital space, the passive target audience of the diffusion model has disappeared: Content is not distributed to users; users actively search, seek, collate, evaluate, apply and distribute content – the so-called Knowledge Societies. This poses new challenges, but also new opportunities for research organisations when they engage with target audiences.

The complexities of the ideal situation sketched in Part 1 of this report confirmed the rationale for the case study: To develop communication strategies that facilitate uptake/adoption, it is necessary for a research organisation to understand the knowledge networks of its target audiences, the context in which they function and the constraints under which they operate and make decisions.

Part 2 of the report sets the scene for the case study: It outlines the legislative and management context at the time of the case study. It also provides context regarding the WRC's interaction with the target audience by discussing the reports, guidelines and training material that the WRC published and disseminated on water measuring and metering in commercial irrigation, as well as stakeholder engagement and other communication activities.

The third part of the report discusses the case study. The case study investigated the context and constraints of commercial irrigators/growers in four Water User Associations (WUAs) along the Orange River, regarding water management practices, with specific reference to water measuring and metering. The case study also investigated the knowledge networks of WUA management, growers and their intermediaries.

Two key findings of the case study are the following:

Commercial irrigators have different roles when it comes to water management. On-farm, they run a business enterprise, which means that they manage water to improve irrigation efficiency and water productivity. In the same role, they also manage water as a critical resource whose availability and quality are major risks. On-scheme, commercial growers have a different role. Here they are members of a Water User Association, and as such they have a co-responsibility to minimise water losses resulting from infrastructure, bad management practices and unauthorised withdrawals. And in all roles, they are accountable to government and DWS as the custodian of water in South Africa.

The case study explains how decisions on water measuring and metering are made in this complex space. To complicate matters further, decisions are influenced by the economic climate, market forces and the socio-political and regulatory context. And all three are currently perceived as uncertain.

For decision-making, the commercial irrigators in the case study draw on a network of knowledge sources. In all four studied WUAs, leading irrigators and intermediaries (advisers) are strong influencers. Each irrigator has their own network of knowledge sources, but, within a WUA, and even across adjacent WUAs, the strong influencers tend to be the same people and organisations. The channels through which they access knowledge range from personal interactions and visits to traditional media to the digital space. Personal interactions and mobile phones are preferred channels.

The WRC does not feature on the map of the knowledge sources that these growers use. This explains why, despite the concerted communication efforts of the WRC and the researchers who produced the reports, guidelines and training material on water measuring and metering, awareness and uptake of this knowledge were found to be disappointing.

Advisers, in turn, draw on a network of knowledge sources that is very different from the growers. They fill the gap between science and application by collecting, evaluating and translating research-based knowledge for growers into practical and affordable business solutions that they can implement with immediate effect. The success of GWK as intermediary illustrates the need that growers have for a dedicated consultation service that integrates all aspects of the farming enterprise.

The WRC features on the advisers' map of knowledge sources although not prominently. It was evident therefore that the WRC should channel its research-based knowledge through these intermediaries to reach commercial irrigators but that it would be essential also to strengthen brand awareness.

The insights from the literature review and the findings of the case study have been integrated into a communication strategy that aims to improve the awareness, acceptance and application of water measuring and metering in irrigated agriculture in South Africa. The main features of the strategy, which appears in Part 4 of the report, are the following:

A roundtable discussion forum facilitated by the WRC is proposed to address the need for commercial irrigators and government to find common ground, in terms of the terminology used and the actions that these parties perceive to be necessary to manage South Africa's water resources and provide food security in a sustainable manner. Common ground is required to build trust.

The strategy proposes several co-innovation partnerships between the WRC, intermediaries, local water user organisations and growers as mechanisms to make sure that the WRC and its research cross the knowledge paths of commercial irrigators. The proposed communication channels and activities were selected with the same purpose in mind. Several practical tips are given. It is recommended that messages reflect an understanding of the business of commercial farming, its challenges, risks and rewards and a sensitivity for the current context and the associated perceptions.

The specific needs of these irrigators in the short term and the long term are also addressed in the strategy. For example, the study found that irrigators have very specific short-term knowledge needs regarding water measuring and metering in view of Government notices 131 (2017) and 141 (2018). A series of dialogues combined with targeted online communication will create platforms where irrigators can discuss issues, share good practice and get technical support. For the long term, it is proposed that the WRC play a facilitating role to integrate the metering data that DWS requires into on-farm water management practices.

The conclusions of the case study and the principles of the communication strategy are not limited to water measuring and metering; they have a wider application value for research organisations like the WRC. The study confirmed how important it is for the research community to have an in-depth understanding of their target audiences and to embrace them as partners in the quest for the knowledge that will secure food and water for the future.

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Ms Lizelle Botha

Ms Nadja Green

Mr Frans Mehale

# List of acronyms and abbreviations

| | |
|---|---|
| AIS | Agricultural Innovation System |
| AKIS | Agricultural Knowledge and Information System |
| CMA | Catchment Management Agency |
| DAFF | Department of Agriculture, Forestry and Fisheries |
| CEO | Chief Executive Officer |
| CGA | Citrus Growers Association |
| CRI | Citrus Research International |
| DFTS | Dried Fruit Technical Services |
| DWS | Department of Water and Sanitation |
| ET | Evapotranspiration |
| FAO | Food and Agriculture Organisation |
| h | hour |
| ha | hectare |
| HTB | Hoëtegnologieboerdery (High precision farming) |
| IB | Irrigation Board |
| ICT | Information and communications technology |
| IFG | International Fruit Genetics |
| IPCC | International Plant Protection Convention |
| IT | Information technology |
| km | kilometre |
| KSA | Key strategic area |
| m | meter |
| NARS | National Agricultural Research System |
| NWRS | National Water Resources Strategy |
| NW&SMP | National Water and Sanitation Master Plan |
| OWK | Orange River Wine Cellars |
| R&D | Research and development |
| s | second |
| SAAFWUA | South African Association of Water User Associations |
| SABI | South African Irrigation Institute |
| SANCID | South African National Committee on Irrigation and Drainage |
| SAPPA | South African Pecan Nut Producers Association |
| SAPWAT | South African Procedure for estimating Irrigation Water Requirements |
| SATI | South African Table Grape Industry |
| SSE | Specialist System Engineering |
| WAS | Water Administration System |
| WHO | World Health Organisation |
| WRC | Water Research Commission |
| WRM | Water Resource Management |
| WUA | Water User Association |

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# Introduction

## 1 CONTEXT AND SCOPE

This is the final report of the Water Research Commission (WRC) project (K5/2712//4), titled “An investigation and communication strategy to support the uptake of available WRC research-based knowledge by irrigation schemes and commercial irrigated agriculture”.

The study can be regarded as a contribution to the 'impact narrative' that is called for in the 2017/18 Annual Report of the WRC. The Annual Report states that the organisation will continue to focus on "the development of its impact narrative that provides a pathway from research to impact. This entails a continuous review of current actions and activities as well as the identification of new actions that will ensure impact realisation".

The study falls within the scope of Programme 2 of Thrust 3: Integrated water management for profitable farming systems, and focuses on irrigated agriculture, and specifically on the case study of measuring and metering water use on-scheme and on-farm as a mechanism to improve water productivity and irrigation efficiency.

## 2 THE AIMS OF THE STUDY

The aims of the study were the following:

1. To enable the WRC to understand the factors that shape the use of research-based knowledge in commercial irrigated agriculture;
2. To give the WRC insight into the uptake and impact of its research products in commercial irrigated agriculture;
3. To identify success stories and map opportunities;
4. To develop a communication strategy, based on the outcomes of aims 1-3, to improve awareness, acceptability and application of water metering by irrigation schemes and in commercial irrigated agriculture.

## 3 THE STRUCTURE OF THE REPORT

The report is structured in four parts:

Part 1 outlines the ideal situation in terms of the uptake of research-based knowledge and the adoption of innovation in agriculture with specific reference to water measuring and metering in commercial irrigated agriculture.

Parts 2 and 3 comprise a communication-based assessment. Part 2 analyses the situation at the time when the research project started. Part 3, in describing the methodology and the findings of the field research, sketches the situation as found during the research.

In Part 4, a communication strategy, is developed to achieve the objectives outlined in Aim 4, namely, to improve awareness, acceptability and application of water metering by irrigation schemes and commercial irrigated agriculture.

# 4 TERMINOLOGY

As it was important for this study to align with previous studies on the same topic, some of the terms that will be used in the report are defined below:

*Table 1: Definitions*

| Term | Definition |
|---|---|
| Irrigation | Irrigation is a broad term referring to any means of delivering water to growing plants. It can take a number of different forms, from irrigation ditches to drip irrigation and more.[1] |
| Irrigation scheduling | Much has been written on irrigation scheduling methods and results, but a clear definition of the term 'irrigation scheduling' is scarce:<br><br>“Irrigation scheduling is determining when to irrigate and how much water to apply” (Van der Stoep, 2015).<br><br>“Scheduling irrigation involves making a decision of how much water to apply and when”.[2]<br><br>In terms of this definition, a grower makes use of irrigation scheduling if the person follows any process to determine the frequency and duration of watering. |
| Objective and scientific irrigation scheduling | The adjectives 'objective' and 'scientific' are added in the literature to give a particular status to irrigation scheduling methods.<br><br>Stevens (2006) conducted a comprehensive literature review on the different irrigation scheduling methods used in South Africa.<br><br>He clustered irrigation methods into seven groups:<br>1. Plant measure: plant-based monitoring like sap flow, leaf water potential, and phytomonitoring<br>2. Real-time evapotranspiration (ET): the use of real-time ET calculations collected by weather stations<br>3. Long-term ET: the use of long-term ET figures such as evaporation pans, pegboard and the Green Book<br>4. Models: the use of soil water balance models or crop growth models to calculate ET<br>5. Feel and appearance method: the use of a tile probe, soil auger, shovel or spade to determine the soil water content<br>6. Soil measure: measure soil water content and potential with soil water sensors such as tensiometers, neutron probes, capacitance sensors and dielectric sensors<br>7. Intuition or subjective scheduling: the farmer uses his experience, knowledge and intuitive feeling. |

[1] https://www.maximumyield.com/definition/751/irrigation
[2] https://forages.oregonstate.edu/nfgc/eo/onlineforagecurriculum/instructormaterials/availabletopics/irrigation/scheduling

| | |
|---|---|
| | If 7 is 'subjective' scheduling, Groups 1 to 6 would therefore be examples of 'objective' irrigation scheduling methods.<br><br>Stevens (2006) and Stevens et al. (2005) equate all 'objective' irrigation scheduling methods to scientific scheduling.<br><br>Leib et al. (2002), as quoted in Stevens (2006), define scientific scheduling as: "soil, plant and atmospheric measurements to inform the farmer about when to apply water and how much water to apply to obtain a desired objective". In terms of this definition, Group 7 would not be scientific scheduling. |
| Water metering | Water metering and water measuring are regarded in some literature as synonyms. In this study, we will use the term 'water metering' to refer to measuring with a device. The volume of irrigated water applied to crops can be determined through various methods. Making use of a water measuring device is one method. |

# 5 DELIVERABLES OF THE PROJECT

The deliverables of the project can be requested from BHI32. See Appendix C for the contact details.

# Part 1: The ideal situation

The first subsection of Part 1 puts the 'ideal situation' in context. It is followed by a literature review that unpacks different aspects of the 'ideal situation': terminology; solution for water scarcity; the role of a research organisation[3] like the WRC; the path to uptake/adoption; the relationship between a research organisation and its target audiences; communication models for uptake/adoption; and communication strategy.

The reader will see that the ideal is neither clear-cut nor simple. Plus, it is constantly evolving.

## 1 MORE FOOD; LESS WATER

The agricultural sector, in South Africa and globally, faces the challenge to balance food security with water scarcity.

Across the globe, irrigation consumes the bulk of freshwater resources. The global figure is 69%[4].

Irrigated agriculture has repeatedly been named the largest consumer of freshwater resources in South Africa (60% in the National Water Resources Strategy (NWRS) [DWS, 2012]; 61% in the National Water and Sanitation Master Plan (NW&SMP) [DWS, 2018] – see Figure 1).

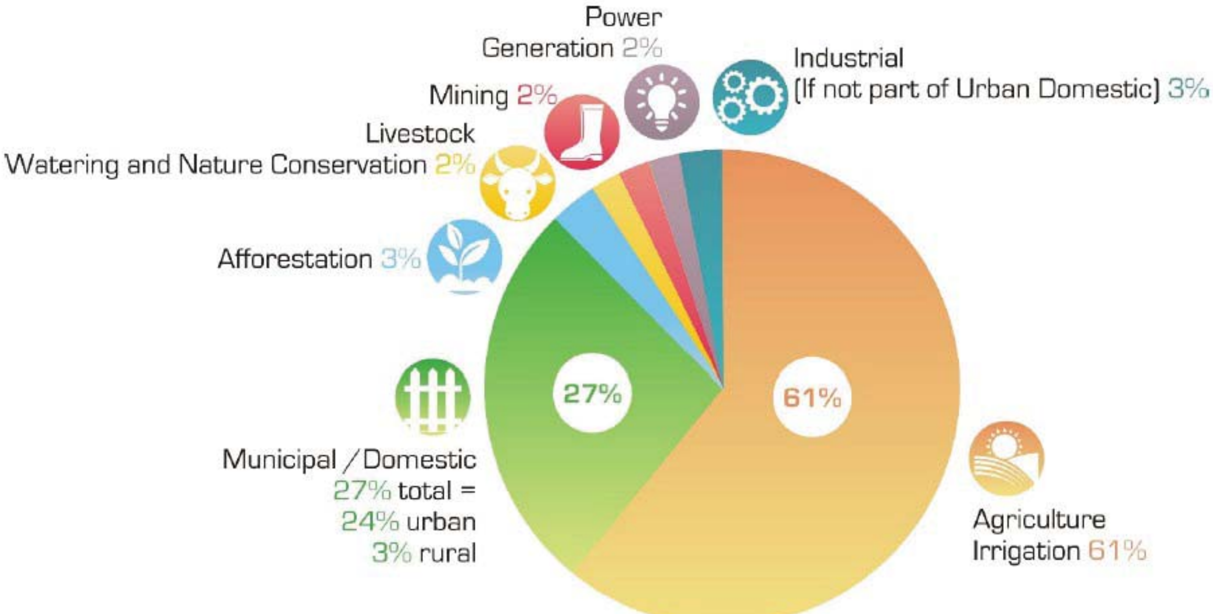



*Figure 1: Water use per sector (DWS, 2018)*

[3] At the request of the project manager, the report does not distinguish between organisations and institutions. The term 'organisation' is used consistently to be in line with North (1990).
[4] http://www.fao.org/nr/water/aquastat/tables/WorldData-Withdrawal_eng.pdf

As the population grows and there is an increasing demand for the equitable and sustainable distribution of resources, the pressure on irrigated agriculture to produce more food with less water mounts, as the quote in Figure 2[5] demonstrates.

In the NWRS, DWS (2012) stresses the importance of the sector for the national economy:

> "The agriculture sector supports a significant portion of the South African economy and contributes massively to rural development. It assures food security for the country and contributes to job creation and employment throughout the food production value chain. Water conservation and water demand management must thus become entrenched in the agriculture sector".

> "The Irrigation Strategy for South Africa has set a target of an increase of more than 50% of irrigated land in South Africa. For future scenarios, the DWA assumes that the amount of water allocated for agriculture remains the same; all land reform projects and revitalisation of smallholder irrigation schemes will use the same amount of water as before. **An increase in irrigation will be effected through water-use efficiency, and selected new development**" (emphasis added).

*Figure 2: Quote from the NWRS (DWS, 2012:10)*

# 2 THE 'IDEAL' TERMINOLOGY

## 2.1 WATER USE EFFICIENCY

The term 'water use efficiency' is widely used and propagated in irrigated agriculture literature.

Unfortunately, the term 'water use efficiency' is used in different meanings in the literature and by stakeholder groups in agriculture, creating confusion in the discourse.

Batchelor et al. (2017) in an FAO (Food and Agriculture Organisation) publication recommend that the term be avoided, and replaced by 'water productivity' and 'irrigation efficiency' for the following reasons:

> "...a universal definition has yet to be agreed and adopted (Steduto, 1996; Pereira et al., 2002; Hsiao et al., 2007; Perry, 2007, Van Halsema et al., 2012; Pereira et al., 2012). In the water sector, the term 'water use efficiency' is generally understood to be a dimensionless ratio between water use and water withdrawn, while in the agriculture sector it is often used to measure the efficiency of crops (irrigated or rainfed) to produce biomass and/or harvestable yield (Pereira et al., 2012). The net result has been many miscommunications and misunderstandings at the policy level in both the agriculture and water sectors. Therefore, it is recommended that the term 'water use efficiency' be avoided, and use should be made only of either 'irrigation efficiency' or 'water productivity' ".

For the purpose of this report, we will use the terms as defined in Batchelor et al. (2017), following Perry (2007).

[5] The target of 50% has since been revised in the National Development Plan.

## 2.2 WATER USE FRACTIONS

Since the definitions of irrigation efficiency and water productivity refer to water use fractions, we include a figure that explains the different types clearly:

**Water use fractions**

**1) Consumed fraction** comprising of:

(a) **Beneficial consumption** e.g. evapotranspiration from an irrigated or rainfed crop (but not the soil).
(b) **Non-beneficial consumption** e.g. evaporation from bare soil, weeds, roads and reservoirs.

**(2) Non-consumed fraction** comprising of:

(a) **Recoverable fraction:** e.g. deep percolation of excessive irrigation or rainfall to an aquifer without adversely affecting the water quality of this aquifer or treated urban wastewater.
(b) **Non-recoverable fraction:** e.g. water flowing into a saline sink or heavily polluted aquifer.

*Figure 3: Water use fractions (Batchelor et al., 2017:76)*

Batchelor et al. (2017) note that:

> “It is now widely accepted that, while irrigation losses appear high, with on average about 40 percent of the water supplied to agriculture reaching plant roots, a large part of these ‘losses’ returns, locally or downstream, in the form of return flow or aquifer recharge. As important, this return flow may be re-used and/or serve important environmental functions” (FAO, 2012).

## 2.3 IRRIGATION EFFICIENCY

According to Batchelor et al. (2017), irrigation efficiency measures engineering or management efficiency, which distinguishes it from water productivity.

Irrigation efficiency for a specific domain is defined as a ratio:

$$\text{Irrigation Efficiency} = \text{Quantity}_{Req} / \text{Quantity}_{Div}$$

The numerator refers to the volume of water required ($Q_{Req}$) for irrigation (including water needed for crop transpiration, leaching to prevent salinisation, weed control, etc.). The denominator refers to the volume of water diverted ($Q_{Div}$) from the source of supply.

They recommend that the term be limited to measure conveyance efficiencies and application efficiencies.

The term 'irrigation efficiency' will also be used in this study to describe the efficiency of irrigation water management at scheme level. In this context, the numerator refers to the volume of water available to irrigators for abstraction in terms of their authorisations and the denominator refers to the volume of water diverted from the source. System losses are classified as non-beneficial water use fractions that may be non-recoverable (for example, evaporation from a canal) or recoverable (for example, seepage from unlined canals) (Batchelor et al., 2017: 85). Reinders et al. (2010) use the term in a similar meaning within a water balance framework.

## 2.4 WATER PRODUCTIVITY

Batchelor et al. (2017) define water productivity as follows:

$$\text{Water Productivity} = \text{Crop yield (Actual)} / \text{Volume water consumed}$$

Water consumed can be fractioned into the beneficial fraction (mainly transpiration) and the non-beneficial fraction (mainly evaporation through soil).

Crop yield does not necessarily refer to volumes or tonnes produced; it is also used to refer to the value of the crop in monetary terms. For this reason, growers might decide to improve water productivity by changing to a higher value crop.

Batchelor et al. (2017) note that the equation is particularly useful for water valuation approaches, because it can be applied in a wider sense by replacing the numerator with economic, social or environmental attributes. For example, Rand per volume water consumed, jobs per volume water consumed, or biodiversity per volume water consumed.

Batchelor et al. (2017) point out the risk of misconceptions if the denominator (volume consumed) is replaced by volume water used, because it would then add the non-consumed fraction, which includes beneficial return flows and aquifer replenishment. “This tends to hide rather than explain the potential trade-offs and reallocations of water uses and users in a water scarce basin when increases in agricultural production are propagated” (Batchelor et al., 2017:86).

# 3 THE 'IDEAL' SOLUTION FROM DIFFERENT PERSPECTIVES

The ambiguity of the term ‘water use efficiency’ is illustrated in the sections below when the call for greater 'water use efficiency' is interpreted from the perspective of the regulator, the Water User Association (WUA) and the commercial irrigator.

Even though goals and definitions may differ, **all three perspectives imply that the volumes of irrigation water used be accurately and precisely measured and monitored.** Put differently, they all require water balances and benchmarking (Levidow et al., 2014).

## 3.1 'WATER USE EFFICIENCY' FROM THE PERSPECTIVE OF THE REGULATOR

For Batchelor et al. (2017), the primary objective of regulatory authorities is to balance the needs of all abstractors, and this includes the aquatic environment.

According to NWRS (DWS, 2012: 12), it is the goal of the water sector of South Africa in the context of the 2030 vision to ensure that:

> “Water is efficiently and effectively managed for equitable and sustainable growth and development”.

So, what does the call for increased 'water use efficiency' in irrigated agriculture mean from the perspective of the regulator?

The NW&SMP (DWS, 2018) comments as follows on the current situation: "Agricultural consumption is largely unmetered, and there are concerns about unauthorised abstraction and water wastage in the sector". Metering is regarded in the NW&SMP as essential to achieve the stated objectives. For this reason, introducing regulations for metering across all existing lawful use and licenced users by 2020 is stated as a priority action (DWS, 2018:39).

Diminishing 'water wastage' in agriculture is not explained in the NW&SMP. It could mean several things:

- Increasing on-scheme irrigation efficiency by reducing water losses due to old infrastructure that is not maintained and poor management.
- Increasing on-farm water productivity. This translates to two scenarios:
  - Irrigators achieving a higher yield with the authorised volume of water to increase/improve food security, but of which crop? The one the irrigator planted last year? But the price went down so much that it makes economic sense for the irrigator to change to another type of crop
  - Irrigators achieving the same yield (of which crop?) with a reduced percentage of the authorised volume of water so that more water becomes available for other uses or for other irrigators.

The NW&SMP (DWS, 2018: 12) puts forward a plan to implement the Water Administration System (WAS) on all government irrigation schemes and reallocate savings to black applicants by 2023, but the Master Plan does not specify if the savings should come from the first bullet point or the second or both. According to an official from the Department of Water and Sanitation (DWS), the intended water savings should come from the first bullet.

## 3.2 'Water use efficiency' at WUA level

For irrigation schemes and their management, the call on agriculture to increase 'water-use efficiency' translates to actions to improve irrigation efficiency. In particular, they need to report to the regulator and members:

- how much water does the scheme take from the source;
- how much does each member take; and
- what are the losses?

They furthermore need to be able to report to the regulator and members how they deal with surpluses, how they deal with drought conditions, and how they create opportunities for black irrigators.

Metering and measuring the total volumes that the scheme uses from the source, and the abstraction volumes of members are essential input data to this end.

## 3.3 'Water use efficiency' at farm level

For farmers, the term 'water use efficiency' means getting the highest economic benefit from the available water resources. Batchelor et al. (2017) cite Knox et al. (2012) when they note in this regard that:

> "For many (possibly most) farmers, concepts of water efficiency are linked to maximising the farms' economic productivity rather than saving water, except perhaps when their own allocated resources may be inadequate.
>
> Any water 'saved' would be allocated to additional crops".

For commercial irrigators in South Africa, the call to produce more food with less water takes place in a context of weak economic growth, decreasing profit margins, and extreme climatic conditions. In this context, it has become essential for commercial irrigators to improve their water productivity by:

- Continuously improving their understanding of crop water needs in specific soil and atmospheric conditions. And not just the water needs of crops, but those of specific cultivars;
- Constantly monitoring ET, soil water and atmospheric conditions, and adapting irrigation scheduling accordingly to meet crop or cultivar water needs accurately and precisely;
- Constantly monitoring water quality;
- Minimising non-beneficial water losses; and
- Continuously monitoring and improving cost-effectiveness.

To be able to undertake the above actions, a commercial irrigator needs accurate and precise information on all aspects of irrigation water use, preferably real-time.

In addition, given the South African environmental, socio-political and economic context, irrigation water supply and quality are critical risks that irrigators must manage or at least attempt to manage. In terms of the current institutional framework, many irrigators are members of local water resource management organisations, which is either a WUA or an Irrigation Board (IB). In this capacity, they share the accountability of their local water resource management organisation to the regulator and fellow members.

# 4 THE 'IDEAL' ROLE OF RESEARCH ORGANISATIONS SUCH AS THE WRC

The vision and mission statements of public research organisations refer to their role to inform decision-making through research-based knowledge in support of national and global goals, such as the Sustainable Development Goals.

For example, the WRC envisages in its vision statement "highly informed water decision-making through science and technology at all levels, in all stakeholder groups, and innovative water solutions through research and development for South Africa, Africa and the world".[6] To realise this vision, it is the WRC's mission to be a knowledge hub that informs decision-making, creates innovations and develops sustainable solutions.

The organisation's 2017/18 Annual Report (WRC, 2018:17) refers to a paradigm shift towards outcome-orientated goals. "Driving sustainable development solutions" is one of them. This goal focuses on developing knowledge products that are fit-for-use to ensure the uptake of research.

The primary objective of key strategic area (KSA) 4, Water Utilisation in Agriculture, is to "increase national and household food security and to improve the livelihoods of people on a farming, community and regional level through efficient and sustainable utilisation and development of water resources in agriculture".[7]

The secondary objectives of KSA4 are to:

- Increase biological, technical and economic efficiency and productivity of water use;

[6] http://www.wrc.org.za/about-us/vision/
[7] http://www.wrc.org.za/water-utilisation-in-agriculture/

- Reduce poverty through water-based agricultural activities;
- Increase profitability of water-based farming systems;
- Ensure sustainable water resource use through protection, restoration and reclamation practices.

We have argued above that measuring or metering irrigation water is relevant to achieve the goal of food security in a water-scarce context. **For commercial irrigation, KSA4 will therefore be realising the vision and mission of the WRC if:**

- **it has produced innovative and solution-driven research-based knowledge on irrigation water measuring and metering;**
- **this knowledge is informing decision-making at WUA and on-farm levels; and**
- **there is uptake.**

# 5 The 'ideal' path to uptake/adoption

## 5.1 The concept of research uptake

The concept of research uptake stems from the so-called development context and it is typically found in the literature of the United Nations and international donor organisations. The concept of 'development' is viewed as the thrust to achieve the Sustainable Development Goals. In this context, research uptake can be defined as "all the activities that facilitate and contribute to the use of research evidence by policymakers, practitioners and other development actors".[8]

Research organisations like the WRC are often required to demonstrate the impact of the research that they produce. For research to have impact, it must be 'taken up' or applied by users. Research organisations are therefore required to produce evidence of uptake.

In the development context, research uptake is an 'ideal'. It is a normative concept in terms of which it is desirable for policymakers, practitioners and development actors to use research evidence in decision-making.

Critiques of the concept argue that dismissal is also uptake; adoption is not always desirable; not all research has uptake as a goal; uptake is slow – it can take decades; it does not follow a simple linear path and it is unpredictable (Mendizabal, 2013). Backeberg and Sanewe (2006) agree that not all research should be adopted. According to them, the application potential of research must be purposely tested in the research-based innovation cycle.

In the discourse on water use efficiency, the uptake of research-based knowledge and adoption of technological innovation are regarded as the same or a parallel process (Levidow et al., 2014).

## 5.2 Uptake and the adoption of innovation

Theories of innovation in agriculture describe how uptake takes place in the adoption of innovations in an agricultural context. The main theories and their evolution from a vertical process to a systems approach are discussed below.

[8] https://www.nwo.nl/en/about-nwo/organisation/nwo-domains/wotro/Impact+toolkit/Impact+toolkit+-+Research+Uptake

### 5.2.1 The diffusion of innovations model

The diffusion of innovations theory is probably the most widely known and the most commonly cited. The theory was developed by the American communication theorist and sociologist, Prof Everett Rogers, and popularised through his influential book, *Diffusion of Innovations*, which was first published in 1962. The 5th and last edition appeared in 2003.

Rogers had a special interest in agriculture, hence the many examples of the adoption of innovation in agriculture in his book. He explains it in the preface to the fifth edition*: "*I became interested in the diffusion of agricultural innovations by observing farmers in my home community near Carroll, Iowa, who delayed for several years in adopting new ideas that could have been profitable for them*"* (Rogers, 2003). The diffusion of innovation in agriculture was also the topic of his doctoral thesis.

Rogers defines an innovation as "an idea, practice, or object that is perceived as new" (Rogers, 2003: Preface). The emphasis is therefore not exclusively on new technology. This broad definition makes the model applicable to a broad range of academic fields and types of innovations.

His definition of the term 'diffusion of innovation' captures the five variables that determine if, how fast, and how effective, innovation is adopted: "Diffusion is the process in which (1) an innovation is (2) communicated through certain channels (3) over time among (4) the members of (5) a social system" (Rogers, 2003:23). Each variable is discussed in a chapter of his book.

According to Rogers (2003:270), the factors that determine if, and the speed with which, an innovation is adopted include:

- The perceived attributes of an innovation;
- The nature of communication channels diffusing the innovation at various stages in the innovation-decision process;
- Individual traits and knowledge-searching behaviour; as well as
- The nature of the social system in which the decision-making unit operates.

The Rogers model is descriptive and aims to explain how innovations spread and get adopted or rejected. Interspersed with the descriptions, he makes predictive statements or, as he calls them, 'generalisations'*.* He bases the generalisations on the findings of diffusion studies. He makes no attempt to present a predictive model for the interaction of these independent variables. If, when and how the diffusion of a particular innovation in a particular context with particular actors will take place remain largely unpredictable in terms of the Rogers model.

Rogers classifies individuals according to their innovativeness and the time that they take to adopt an innovation. He is probably best known for these categories and his famous S-curve, which to this day is widely applied, even in market segmentation. The diagrams below give an overview:

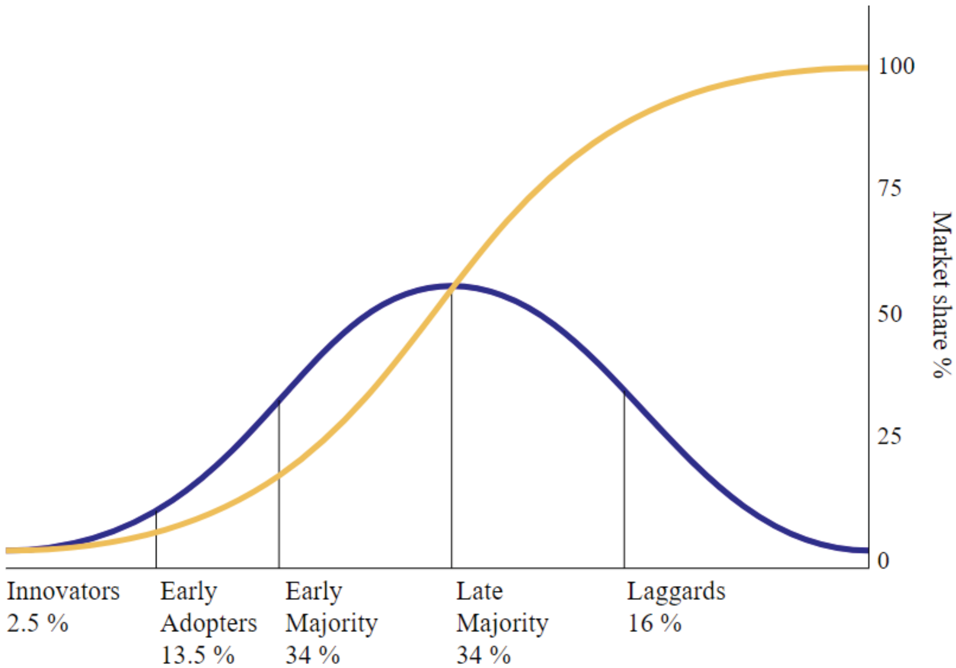



*Figure 4: The adoption curve (Rogers, 2003)*

According to Rogers, adopter distributions form a normal curve over time. With each successive group of consumers adopting the new technology (the blue line), its market share (the yellow line) will eventually reach the saturation level. The critical mass point occurs when enough individuals in a system have adopted an innovation for the innovation to become self-sustaining (Rogers, 2003:348).

Rogers divides the continuum of innovativeness into five adopter categories:

*Table 2: The main personality traits of the five adopter categories (Rogers, 2003)*

| Category of adopters | Main trait |
|---|---|
| Innovators | Venturesome |
| Early adopters | Respect |
| Early majority | Deliberate |
| Late majority | Sceptical |
| Laggards | Traditional |

Rogers groups these five categories further into 'early adopters' and 'late adopters'.

According to Rogers, the diffusion of innovation comprises a linear process of five stages for the individual (or another decision-making unit such as a WUA):

1. Gain first knowledge of an innovation
2. Form an attitude towards the innovation (persuasion)
3. Make a decision to adopt or reject
4. Implement and use the new idea, and finally
5. Confirm that the decision was the correct one, or not.

Rogers points out that the decision process described above is "an information-seeking and information-processing activity in which an individual obtains information in order to gradually decrease uncertainty about the innovation" (Rogers, 2003:38).

According to Rogers (2003:38), individuals mainly search for technical information through mass media channels in the first stage; when it comes to the persuasion stage, the individual seeks evaluative information through interpersonal networks. A WRC study (Slabbert Associates, 2016) found that this differentiation of function between communication channels is not always true for all contexts and individuals.

Chapter 8 of Rogers (2003) deals with interpersonal networks and the major role that they play in the information-seeking and information-processing activity.

Lastly, Rogers postulates that the individual (or organisation) that decides to adopt or reject an innovation functions in a social system. Key aspects of a social system affecting the decision-making process are:

- Social structures and communication flows
- Norms and values
- The role of change agents or intermediaries such as opinion leaders or extension officers
- The nature of decision-making in a particular social context, for example individual versus collective decision-making versus authoritative decision-making
- The social consequences of an innovation.

Rogers (2003:373) defines change agents as "an individual who influences clients' innovation-decisions in a direction deemed desirable by a change agency". A change agent usually seeks to secure the adoption of new ideas, but they may also attempt to slow the diffusion process and prevent the adoption of certain innovations with undesirable effects.

The change agent could have different roles in the innovation-decision making process:

- Making the target audience aware of their needs
- Establishing credibility, trustworthiness and competency with the target audience
- Analysing and understanding the target audience's perspective
- Creating an intent to change in the target audience
- Translating an intent into action
- Reinforcing messages after the target audience has adopted the innovation to stabilise the new behaviour
- Shifting the target audience from reliance to self-reliance.

Critical success factors of change agent intervention include the intensity of their contact with customers, their level of customer-orientation, their compatibility of the innovation programme with customers' needs and empathy with the client.

The diagram below summarises key components of the diffusion of innovations model (Rogers, 2003:177).

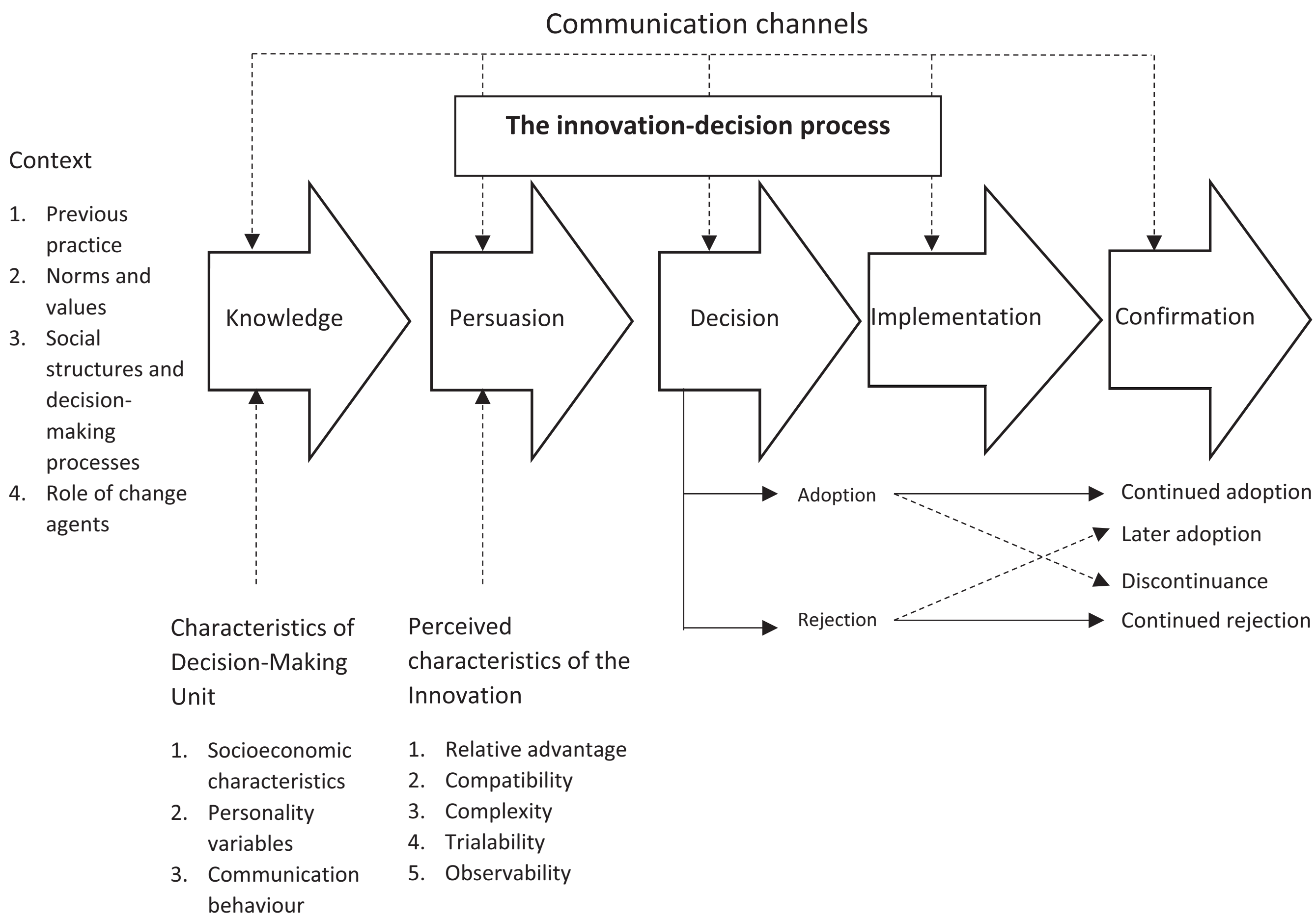



*Figure 5: Key components of the diffusion of innovations model (Adapted from Rogers (2003:177))*

Rogers recognises that the classical top-down, or centralised, diffusion of innovation from an expert source such as government or a research organisation is not the only diffusion system. Innovations can also originate from a user and spread among peers in a decentralised manner. Below is his graphic depiction of the two processes:

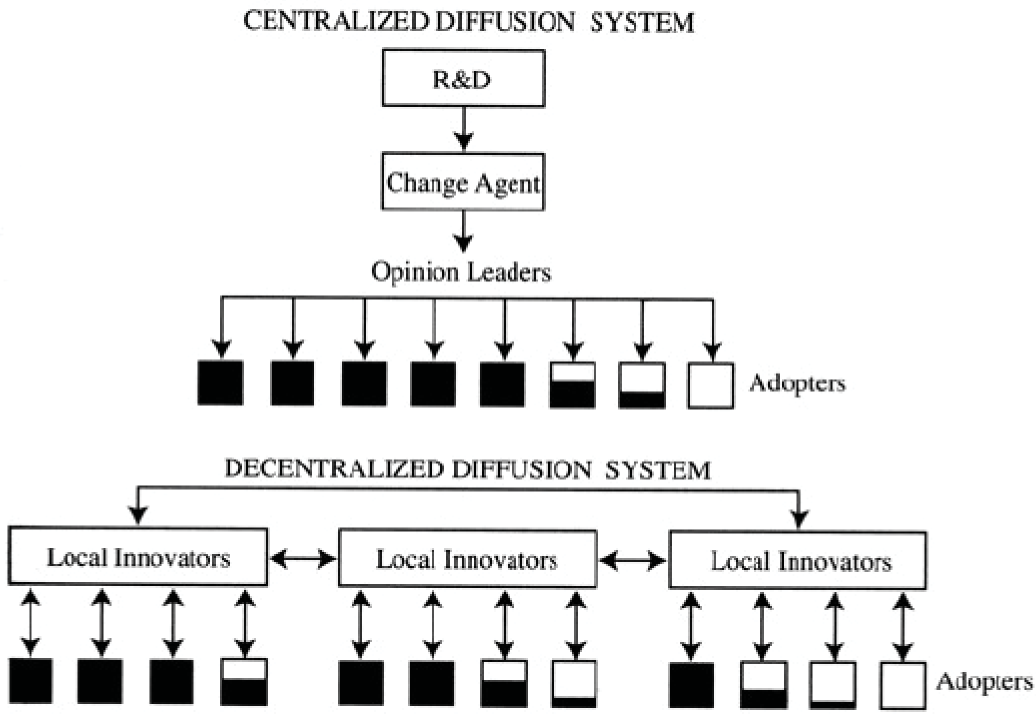



*Figure 6: Centralised versus decentralised diffusion of innovation (Rogers, 2003:401)*

Major criticisms against the diffusion model include the linearity of the model and its pro-innovation and anti-rejection bias. Gildemacher and Wongtschowski (2015) cite Arnold and Bell (2001), Leeuwis and Aarts (2011), Biggs (2007) and Hall et al. (2006) as advocating the shift towards non-linear innovation system thinking.

### 5.2.2 Agriculture Innovation System (AIS)

Innovation system thinking in agriculture evolved from the national agricultural research system (NARS) to agricultural knowledge and information systems (AKIS) to the agriculture innovation system (AIS).

Gildemacher and Wongtschowski (2015:4) define an innovation system as "a network of organisations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organisation into economic use, together with the institutions and policies that affect their behaviour and performance".

The focus of earlier studies was on the role of education, research and extension in developing and diffusing innovation knowledge through a linear process to the farmer. Spielman and Birner (2008:8) explain how frameworks of innovation in agriculture have evolved:

> “...the agricultural innovation system (AIS) approach includes the farmer as part of a complex network of heterogeneous actors engaged in innovation processes, along with the formal and informal institutions and policies environments that influence these processes. In effect, the AIS framework represents a move away from a more linear interpretation of innovation as a sequence of research, development, and dissemination, to an interpretation that recognises innovation as a complex web of related individuals and organisations—notably private industry and collective action

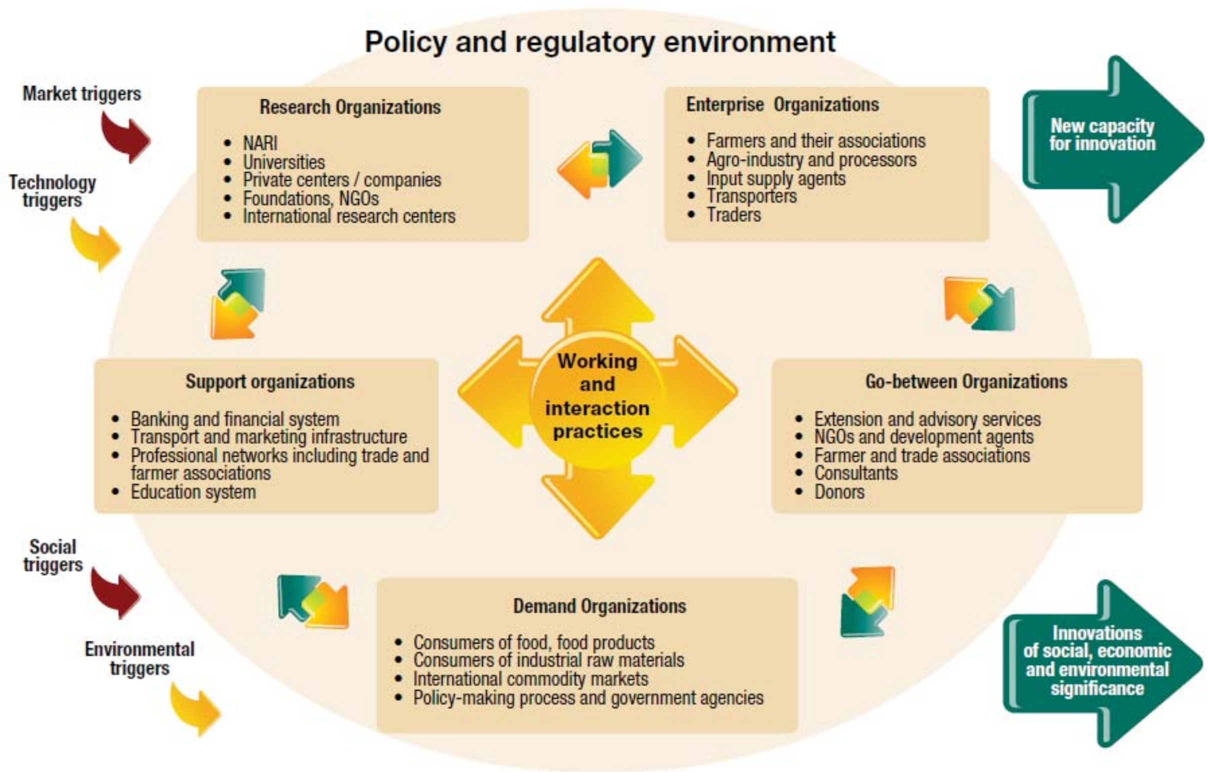
organisations—all of whom contribute something to the application of new or existing information and knowledge".

An economic sector work study conducted by the World Bank (2006) lists aspects that are indicative of the changing context of agriculture that led to the evolution from a research system to an innovation system approach:

1. "Markets, and not production, drive agricultural development
2. The economic environment of agriculture has become more dynamic, interconnected and evolutionary – largely due to globalisation, also urbanisation
3. Rate of change has increased, with a need for more rapid responses – competition, trade rules, technological paradigms, climate, pest and diseases
4. The role of the private sector in generating and using knowledge has grown
5. ICT (information and communications technology) has radically changed the accessibility of knowledge and information
6. The knowledge structure of agriculture is changing – eroding the primacy of public agricultural R&D (research and development) and R&D organisations".

In terms of innovation system thinking, "a multitude of actors (farmers, extensionists, input suppliers, researchers, etc.) contribute to agricultural innovation, and it is a combination of the quality and skills of the individual actors, but also, importantly, the quality of their interaction, which determines the capacity to innovate" (Gildemacher & Wongtschowski, 2015:4). These actors and their interactions are the catalysts of the innovation process.

Figure 7 below depicts the systemic and dynamic interrelationships between different groups of actors (research organisations, growers and grower organisations, support organisations, intermediaries and demand organisations) that are needed to create an enabling environment for the implementation of innovations in agriculture (Inter-American Institute for Cooperation in Agriculture, 2014:13). The figure also shows how these interrelationships are embedded in a sociopolitical and regulatory context and influenced by social, market, technological and environmental events (triggers).




Source: Adapted from the OECD (2013).

*Figure 7: The dynamics of the innovation system (IICA, 2014:13)*

Gildemacher and Wongtschowski (2015) emphasise that agricultural innovation is a complex process that involves the interaction between a range of actors. In the NARS model, research organisations are the main actors; in the AIS model they are one of the many actors.

On the other hand, Gildemacher and Wongtschowski (2015) do not completely reject the notion of a chronological process. The figure below illustrates the innovation process model that they propose. The model has three actions and three results. It can re-activate itself at any point.

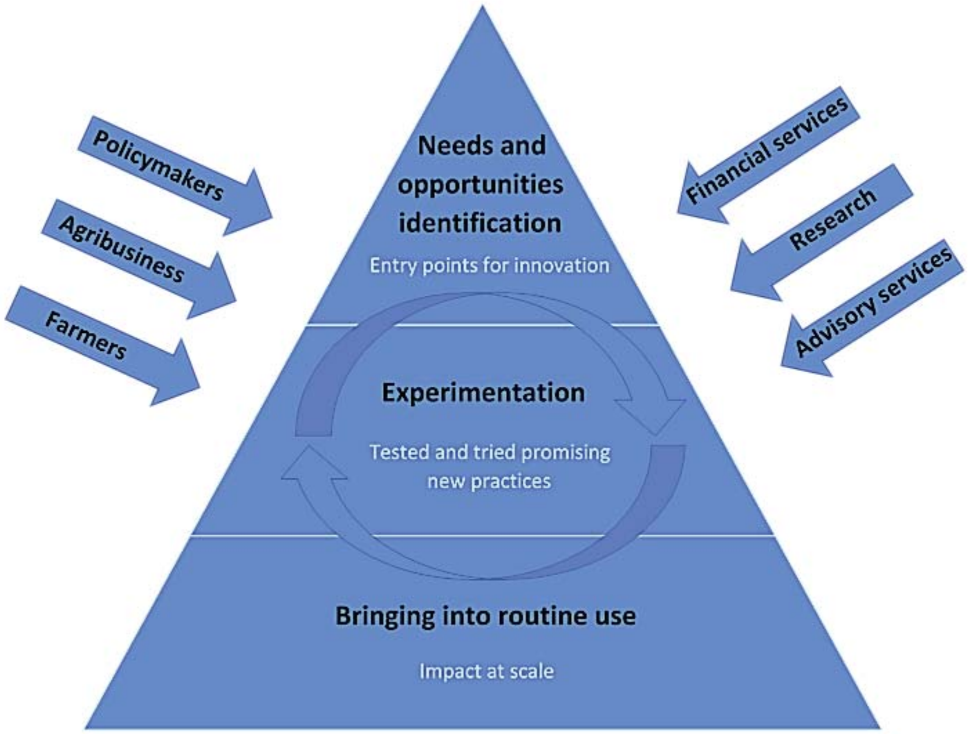



*Figure 8: The agricultural innovation process (Gildemacher & Wongtschowski, 2015:5)*

Like Rogers, they also do not attempt to predict the outcome of innovation: "Agricultural innovation is a process of discovery, and as such outcomes are unable to be predicted" (Gildemacher & Wongtschowski, 2015:7).

According to them, research, and by implication, research organisations like the WRC, have an important role to play in each of the key actions of the innovation process:

1. Opportunity and needs identification
    a. Identifying new entry points for innovation by studying farming practices
    b. Identifying 'best bet' innovations for a particular context
2. Experimentation
    a. Designing experimentation to give valid and reliable results
    b. Documenting the experimentation process and analysing results
3. Bringing the innovation to routine use
    a. Synthesising experimentation results and giving direction to implementation
    b. Facilitating stakeholder interaction.

Gildemacher and Wongtschowski (2015) identify two types of interventions that could catalyse - to use their term - innovation in agriculture:

- Stimulating, facilitating and directing the three actions, and
- Capacitating actors to play their respective roles.

The actors in the innovation process, their roles and interactions are dynamic as the authors have pointed out. We would add a third type of intervention: Identifying and capacitating new actors, new roles and new interactions. That is an innovation process in itself.

#### 5.2.3 Criticism of adoption models

According to Annandale et al. (2011), who refer to Vanclay (2003), technology-driven approaches often fail to capture the specific goals of farmers. They also fail to understand the constraints under which farmers operate.

Knox et al. (2012) frame the same argument in terms of the confusion around the term 'water use efficiency':

> "Using financial criteria for water efficiency rather than an engineering one appears a sensible approach when assessing irrigation performance at the farm level, since any managerial (e.g. scheduling) and operational (e.g. equipment) inefficiencies associated with irrigation are implicitly included in the assessment. It also allows comparison between individual irrigators (benchmarking) and between different water sectors (e.g. agriculture, leisure, industry). However, estimating the direct financial benefits (value) of water to the farm is only part of the equation; assessing indirect economic benefits, such as the importance of irrigated production to the sustainability of rural communities is equally important, but much harder to achieve.
>
> Demonstrating efficient or 'best' use of water is not straightforward, but farmers and the water regulator need a rational approach that reflects the needs of the farming community whilst providing a policy framework for protecting the environment".

# 6 THE 'IDEAL' COMMUNICATION RELATIONSHIP AND MODEL

Communication is integral to the uptake of research-based knowledge and the adoption of agricultural innovation in the development context. Hence also the term 'development communication'.

Mefalopulos (2008) defines development communication as "supporting sustainable change in development operations by engaging key stakeholders". Its main functions are to "establish conducive environments for assessing risks and opportunities; disseminate information; induce behaviour and social change".

The concept of development has been severely criticised in the past as a Western-centric construct aimed at keeping the Third World dependent on the wealthy nations (Huesco, 2008). Development communication has been modified to address this criticism. The shift in social paradigms and the impact on communication models for development communication are discussed below.

## 6.1 SOCIAL PARADIGMS

The evolution of social paradigms and communication models runs parallel in the 20th century and beyond.

Two contrasting social paradigms have dominated the discourse of development communication: modernisation/diffusion and participation (Huesco, 2008; Mefalopulos, 2008).

The modernisation/diffusion paradigm is underpinned by the philosophy that resources/aid, communication and technology can modernise an underdeveloped world and lead it to development. In innovation theory, the work of Rogers (2003) was seminal in this regard.

In the 1970s and 1980s, the dominant diffusion paradigm was challenged and deconstructed by Latin American scholars in particular (Huesco, 2008). They related the dominant development paradigm to neo-colonialism and the extension of capitalist relations (Huesco, 2008). In the eyes of these scholars, the modernisation paradigm is a dependency paradigm.

Huesco (2008) refers to the “First Latin American Seminar on Participatory Communication” in 1978 where scholars at the time concluded that "uses of mass media in development imposed the interests of dominant classes on the majority of marginalised people". Huesco (2008) refers to Escobar (1995) who regarded development aid as an extension of the geopolitical struggle between the capitalist West and the communist East.

The Latin American scholar, Paulo Freire (1970, 1973, 1997), was instrumental in a fundamental shift in the relationship between researcher and subject, teacher and learner, sender and receiver towards "a co-learning relationship guided by action and reflection" (Huesco, 2008). In his theory of dialogical pedagogy, Freire advocated dialogue as the ‘ethical communication choice’ (Huesco, 2008).

## 6.2 Communication models: transmission versus constitutive

The early communication models of the 20th century, such as the models of Lasswell (1948) and Shannon and Weaver (1949), were linear models, a sender or a source, transmitting to a receiver. Lasswell (1948) famously summarised a linear communication process in five-questions: “Who says What through Which channel to Whom with What effect?”

Linear models of development communication reflected and supported the diffusion paradigm. These models are also called transmission models in which communication is described as a transfer of information (Craig, 1999).

Later models, such as the Schramm model (1955) and the Berlo model (1963) expanded the basic linear model to add aspects such as coding, decoding, channel and message. Communication models became more sensitive to the social context in which communication takes place and the reciprocal nature of communication.

In the 1970s, Barlund introduced the transactional model of communication, recognising that communication is a two-way process in which the sender is also receiver, and vice versa. The model emphasises the shared experience of those participating in the communication, the relationship between the participants and the shared construction of meaning in the interaction.

The transactional model of development communication reflects and supports the participatory paradigm as illustrated in the simplified figure below:

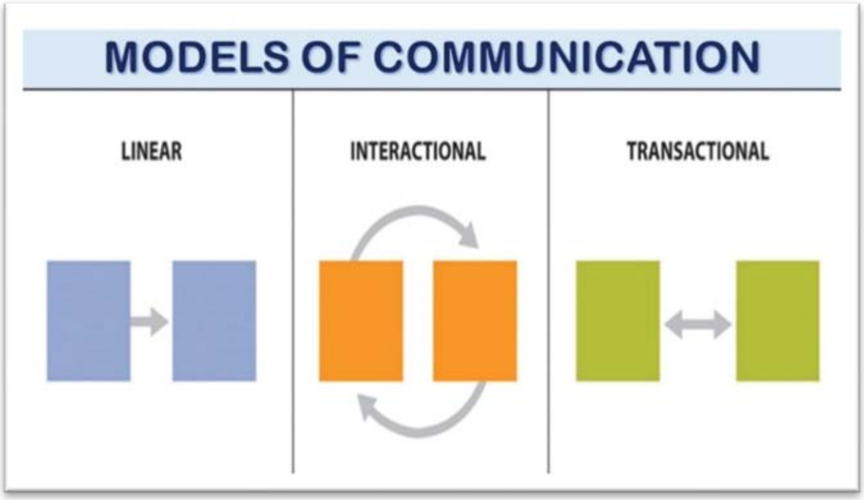



*Figure 9: Models of communication* [9]

Craig (1999) calls transactional models 'constitutive', because they conceptualise communication as a process that constitutes shared meaning.

The shift in paradigm led to the rise of the participatory approach and participatory communication in development literature as illustrated in the figure below. Servaes and Malikhao (2005) refer to the shift in focus as a shift ''from a communicator-centric to a more receiver-centric orientation, with the resultant emphasis on meaning sought and ascribed rather than information transmitted".

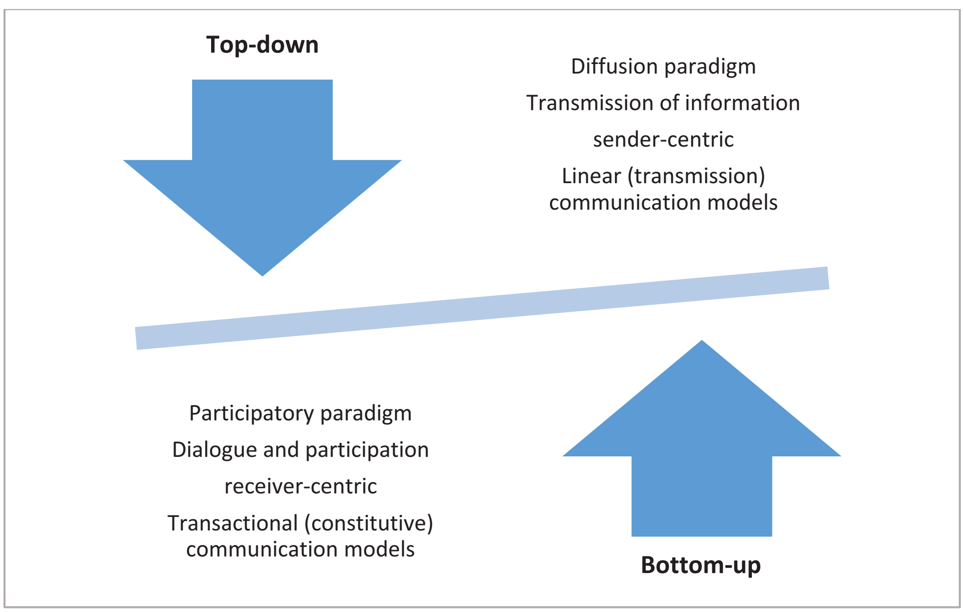



*Figure 10: Social paradigms and communication models*[10]

[9] https://2012books.lardbucket.org/books/an-introduction-to-organizational-communication/s06-02-rethinking-communication.html (No other information available on the source; not in references.)
[10] Figures without sources have been developed by the authors.

Was the shift in approach in development communication indeed a shift in paradigm or is development communication still operating within the diffusion paradigm, but following a participatory approach to create the illusion that relationships between the developed and the developing world have changed? Mefalopulos (2008) is an example of how participation and diffusion is integrated in a World Bank publication:

> "Over time, its (communication's – explanation added) linear flow has been replaced with a more complex perspective in which communication is envisioned as a horizontal process aimed, first of all, at building trust, then at assessing risks, exploring opportunities, and facilitating the sharing of knowledge, experiences, and perceptions among stakeholders. The aim of this process is to probe each situation through communication in order to reduce or eliminate risks and misunderstandings that could negatively affect project design and its success. Only after this explorative and participatory research has been carried out does communication regain its well-known role of communicating information to specific groups and of trying to influence stakeholders' voluntary change".

Huesco (2008) is critical of many applications of participatory communication, but he concedes that the two paradigms are the end points of a spectrum of relationships and communication models, and that both have practical value.

## 6.3 What is the ideal paradigm and communication model for uptake?

Most contemporary literature in the field of development communication rejects in principle a linear diffusion paradigm and linear communication models for communication strategies that aim to enhance the uptake of research-based knowledge (Gildemacher & Wongtschowski, 2015; Mefalopulos, 2008; Huesco, 2008). The participatory paradigm and transactional communication models have become increasingly popular, although hybrid models are also proposed, and most communication strategies include knowledge transfer activities (WHO, 2017). The figure below depicts examples of different types of communication within a hybrid model.

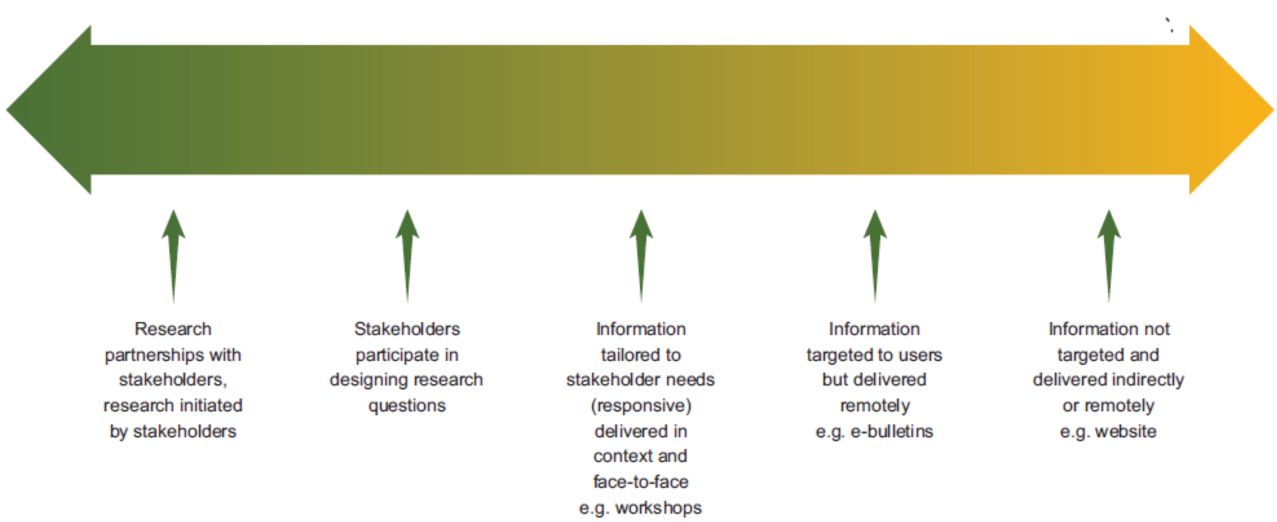



*Figure 11: Different types of communication within a hybrid model (Adapted from Andrews, 2012)*

The suitability of a specific configuration of social paradigms and communication models depends on the target audience. In Part 4 of the report, Figure 11 will be adapted to the context of this study.

# 7 THE 'IDEAL' COMMUNICATION STRATEGY

## 7.1 FRAMEWORK FOR A COMMUNICATION STRATEGY

As mentioned before, communication is integral to the uptake of research-based knowledge and the adoption of innovation in agriculture. Rogers (2003), for example, regards development communication campaigns as a typical intervention strategy to change behaviour towards the adoption of innovation.

As a result, there is an abundance of communication strategy frameworks and guidelines for participatory communication or stakeholder engagement in the development communication literature. Hence, it is difficult to identify the 'ideal' framework for a communication strategy.

Mefalopulos and Kamlongera (2004) define communication strategy development as "a well-planned series of actions aimed at achieving specific objectives through the use of communication methods, techniques and approaches".

This study will follow the four-phase framework for a communication strategy of Mefalopulos (2008):

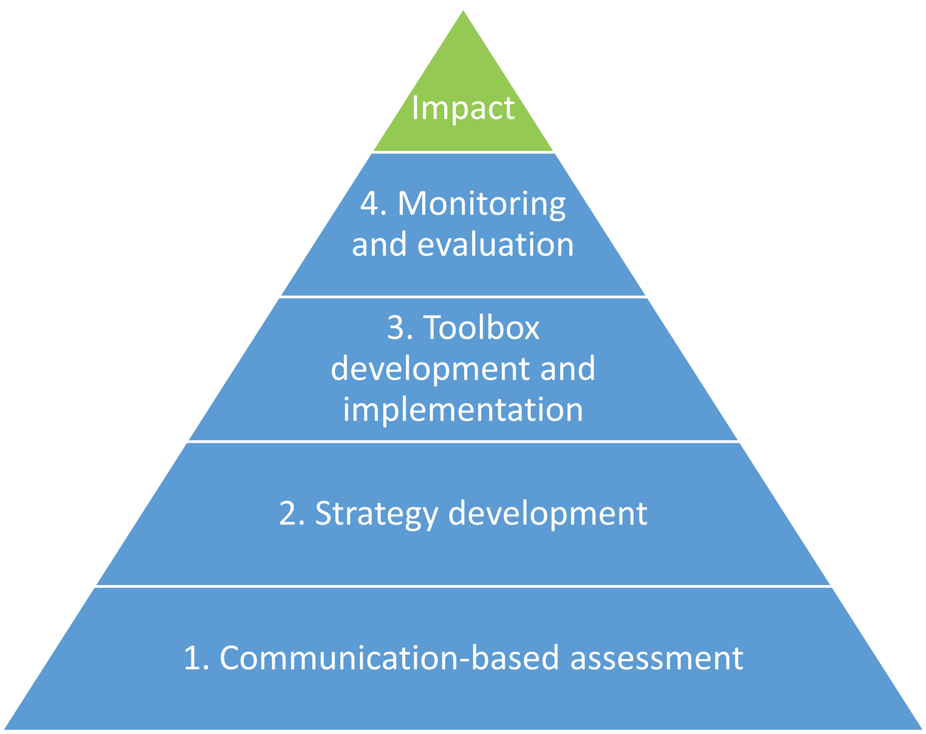



*Figure 12: Four-phase framework of Mefalopulos (2008)*

In terms of this framework, the first phase of a communication strategy will always be a situational analysis and setting of objectives, in other words, **assessing** where you are now from a communication perspective and deciding where you want to be. In the second phase, one develops a **strategy** to take you from where you are to where you want to be. The third phase refers to implementing the strategy through specific **communication actions and activities** directed at specific target audiences.

A communication strategy needs to be **monitored and evaluated** and improved. It also must adapt to contextual changes and integrate feedback in a continuous learning cycle.

## 7.2 Principles of effective communication

The World Health Organisation (WHO) (2017) developed six principles of effective development communication. All six are receiver-centric.

- accessible
- actionable
- credible and trusted
- relevant
- timely
- understandable.

Cash et al. (2003:8087) reiterate some of these principles when they state that efforts to mobilise science and technology for sustainable development are more likely to be effective "when they manage boundaries between knowledge and action in ways that simultaneously enhance the salience, credibility, and legitimacy of the information they produce". This requires active, iterative, and inclusive communication between experts and decision makers.

These principles will be followed to develop the communication strategy in Part 4.

## 7.3 The impact of the digital age on communication

Communication strategies have to consider that they will be implemented in the digital age. Participatory communication is the landmark of the digital age, as Orihuela (Not dated) explains in an article that identifies 10 new paradigms of the digital age (reduced for the purpose of this report to seven):

1. A passive audience is replaced by an active user who seeks content, exploring and navigating spaces. Users create their own content; they write, they photograph, they interpret, they publish.
2. Online media are multimedia, integrating audio, video and text.
3. Online media is real-time. “Sharing news and opinions with the ability to interact in real-time are the seed of cybercommunities” (Orihuela, Not dated).
4. An overflow/abundance of information.
5. The disappearance of editor-mediated content. Anyone can publish on the web on blogs, webinars, social media platforms, etc. and anyone is free to comment and criticise or agree.
6. Content is not distributed to users; users access and interpret content in an interactive process. They actively search, seek, collate, evaluate, apply and distribute content – the so-called Knowledge Societies (Servaes & Malikhaom, 2005). “Client-server architecture of the internet started a new model based on the decisions of the users” (Orihuela, Not dated).
7. Content is organised in a virtual space that is controlled by the user; it is not controlled by a narrator. “Users perform activities: they meet each other, learn, gather and share news and opinions, do shopping and gaming, entertain and create. Hypertextual narratives empower the user, shifting the control of the narrative from the narrator to the reader” (Orihuela, Not dated).

### *7.3.1.1 Social media use in South Africa*

According to the South African Social Media Landscape Report (Patricios & Goldstuck, 2018), Facebook is used by 29% of the South African population (i.e. 16 million Facebook users). Figure 13 shows the use of Facebook, Twitter, Instagram, LinkedIn and YouTube in South Africa.

Fourteen (14) million out of the 16 million Facebook users use their cell phones or tablets to access the platform. Stripped-down apps like Facebook Lite, which is often zero-rated for data costs by mobile network operators, allowed the platform to spread through South Africa's entire population.

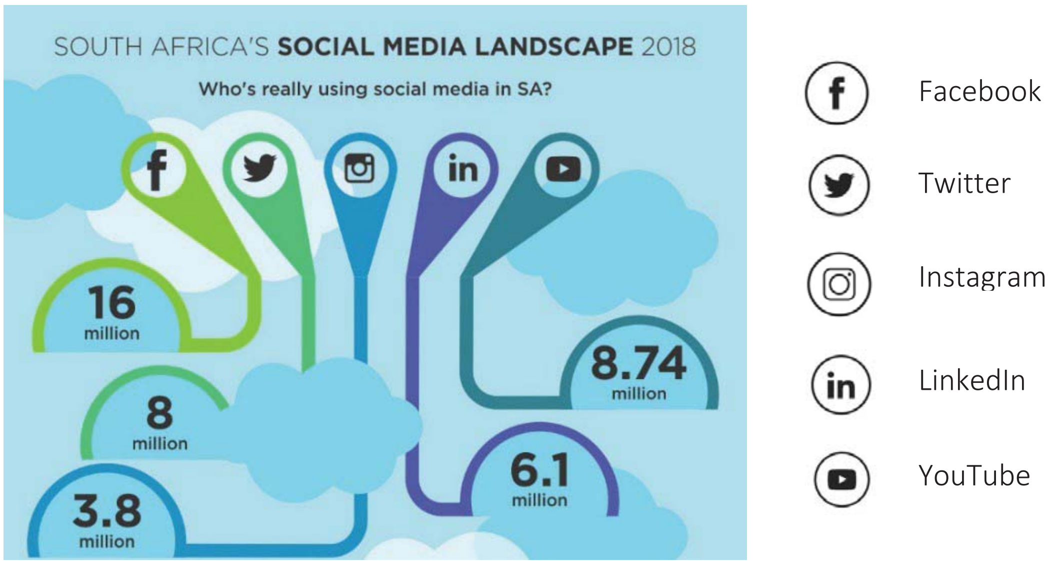



*Figure 13: Social media use in South Africa (Patricios & Goldstuck, 2018)*

### *7.3.1.2 Social media as a tool to share information, build connections and engage in conversations*

"Social media provides opportunities to speak directly to audiences, build connections and relationships, share information and engage in conversations. The risk, however, is that social media may also give free reign to readers to say whatever they want, and to post and share their own content" (Motion & Kearnes, 2014).

Luoma and Barnebee (2017) state that social media can be used not only to disseminate information and garner support, but also to start conversations. "You want to engage with your audiences and hear what they have to say about the topic. You may even want to consider discussion groups using Facebook or LinkedIn" (Luoma & Barnebee, 2017). Social media is therefore a powerful tool to improve awareness, acceptance and application.

### *7.3.1.3 Implications for the communication strategy*

The challenges and opportunities of the digital age will be considered when the communication strategy to facilitate the uptake of water measuring and metering is developed in Part 4.

# Part 2: Water measuring and metering at the time of the research

Part 2 sets out the situational context, including the legislative and management context of water measuring and metering in agriculture, when the study commenced in April 2017. It also discusses previous WRC studies that are relevant for this study.

## 1 THE CHALLENGE OF NON-UPTAKE AND NON-ADOPTION

According to Annandale et al. (2011), ''the emerging story of apparently successful research projects but only patchy adoption of its outputs by the industry remains the key challenge for the irrigation research community".

Although no exact figures were available, the WRC's review of the proposal that led to this research mentioned that the research products on water measuring and metering in irrigated agriculture were not widely applied. This was confirmed in a discussion that the project leader had with Mr Nic Knoetze of South African Association of Water User Associations (SAAFWUA) in 2017.

The challenge of non-uptake of research-based knowledge or the non-adoption of innovation in irrigation has also been found in other aspects of irrigated agriculture, in South Africa and internationally. Jumman (2017:10) cites examples of poor adoption of irrigation scheduling from Australia, the USA, Spain and Canada.

The research of Stevens (2006) is often quoted in the literature as evidence of low uptake of research-based knowledge in agriculture in South Africa. Stevens (2006) reports that ''only 18% of the irrigation farmers in South Africa make use of objective scheduling methods, while the rest make use of subjective scheduling methods such as intuition, observation, local knowledge and experience''. As the figure includes commercial irrigators and small-scale irrigators, the figure for commercial irrigation is probably higher.

This was confirmed in the same study. Interviews with a representative sample of 134 commercial irrigators found 76 (57%) of them to be using objective or scientific scheduling. Annandale et al. (2011) quote a similar figure from Haarhoff (2011):

> "For example, the Orange Vaal Water Users Association, managed by GWK, includes ... about 2 600 centre-pivots of which more than two-thirds is objectively scheduled, 55% to 65 % by the GWK service, which makes use of 2 systems" (Haarhoff, 2011).

The literature cites a range of factors that support or inhibit uptake and adoption of research-based knowledge in commercial irrigation. We will just refer to a few that are relevant for this study.

1. The economic capacity of the farming business: Stevens et al. (2005) as cited in Annandale et al. (2011), found that scheduling method is closely related to irrigation system, and that, in turn, is a function of the size of the farming business. Large-scale irrigators are more likely to adopt more sophisticated scheduling methods.

2. Support and training (Jumman, 2017):
   The important role of a dedicated support service/user-friendly decision support system that integrates all variables of irrigated agriculture holistically, including volumetric data, into a measurement of water productivity and return on investment is highlighted in Annandale et al. (2011), Levidow et al. (2014) and Knox et al. (2012).

   Levidow et al. (2014) list the elements of a successful decision support system: "giving farmers a simple, timely, user friendly, free-of-charge, informative system helpful to decide how much to irrigate in everyday practice; tailoring the tools for a large number of crops; calculating the irrigation profitability; and assessing the economic benefit, especially its relevance to the next irrigation". Annandale et al. (2011) discuss the GWK model as an example of a successful dedicated support service.
3. The legislative and management context.
4. Market forces (for example EurepGap, the IPCC (International Plant Protection Convention) and the international retailers that buy South African produce.
5. The attributes of the innovation (Jumman, 2017). Benade et al. (2010) refer specifically to the following attributes of water measuring and metering devices: affordability, accuracy, reliability, ease of installation, availability.
6. The communication gap between the scientist and the farmer (Levidow et al., 2014; Knox et al., 2012).
7. Grower traits, such as age, education, social connectedness and adoption history (Jumman, 2017).
8. The presence of leader growers (Jumman, 2017).

In a WRC press release of 30 August 2013, Dr Gerhard Backeberg cautions against unrealistic uptake or adoption expectations: "International evidence shows that the lead time for research-based knowledge to become applicable and accepted in the market takes 25 to 35 years. Perseverance and a continuous drive to support exploitation of available knowledge to implement water measuring and metering over the next 10 to 20 years is therefore essential". Although some researchers are more optimistic - Steiger (2013) states that the lead time from research to implementation is 5 to 10 years; Holterman (2015) suggests 12 to 14 years – the shortening of the time to market remains a challenge for the water sector (Holterman, 2015).

In the next two sub-sections, we will discuss the legislative and management context at the time of the research.

# 2 THE LEGISLATIVE CONTEXT

Agricultural water use is governed by the National Water Act (36 of 1998). In terms of the National Water Act, the National Government, acting through the Minister as the trustee of the nation's water resources, must ensure that our water resources are protected, used, developed, conserved, maintained, controlled in a sustainable and equitable manner, for the benefit of all persons and in accordance with the Constitution.

The National Government, acting through the Minister, has the power to regulate the use, flow and control of all water in the Republic.

In terms of subsection 26(1), the Minister may, subject to subsection (4), make regulations:

- limiting or restricting the purpose, manner or extent of water use;
- requiring that the use of water from a water resource be monitored, measured and recorded.

On 17 February 2017, Government Notice 131 was published. The regulations are applicable to "all taking of water from a water resource for the purpose of irrigation where the water user is required to measure such water". The regulations give the Minister the power to issue a directive at water users to install a self-registering water measuring device that is suitable for the water to be measured. In terms of such a directive, the water user must keep record of all the data obtained from the measuring device. Furthermore, the user must maintain the water measuring device and ensure that its accuracy is verified on a regular basis.

# 3 THE MANAGEMENT CONTEXT

In terms of the National Water Act (36 of 1998), catchment management agencies (CMAs) are responsible for water resource management over an entire water management area.

CMAs' functions include:

- Allocating water in a way that ensures enough water for everyone: for people, for food, for industry and for nature (within the allocable water determined by DWS);
- Processing licence applications and issuing licences;
- Checking that all water users and waste dischargers are registered and have the required authorisation or licence and enforcing compliance;
- Checking actual water use and waste discharge against licence or authorisation conditions and enforcing compliance; and
- Collecting revenue from water users and waste dischargers.

At the time of this research, only two CMAs were functional. The other seven CMAs were in various stages of establishment.

WUAs are local water resource management organisations whose functions are also governed by the National Water Act (36 of 1998). The National Water Act (36 of 1998) describes the role of WUAs as follows: "Although water user associations are water management institutions, their primary purpose, unlike catchment management agencies, is not water management. They operate at a restricted localised level and are in effect co-operative associations of individual water users who wish to undertake water-related activities for their mutual benefit. A water user association may exercise management powers and duties only if and to the extent these have been assigned or delegated to it".

WUAs' functions in terms of regulating water use include:

- Preventing unlawful water use;
- Preventing water from any water resource being wasted;
- Supervising and regulating the distribution and use of water from a water resource according to the relevant water use entitlements, by erecting and maintaining devices for:
    - measuring and dividing; or
    - controlling the diversion of the flow of water.

Not all local WRM organisations are WUAs. Irrigation Boards (IBs) originated from the Irrigation and Conservation of Water Act (8 of 1912) that was replaced by the National Water Act. The National Water Act (36 of 1998) calls for all IBs to be transformed into WUAs. The transformation of IBs to WUAs was slow. According to Knoetze (2019) there are still 223 IBs.

The slow pace of transformation was given as a reason to disband both WUAs and IBs when, in 2013, the then Minister of Water and Environmental Affairs proposed in a Policy Review (DWS, 2013) that "... WUAs and Irrigation Boards (IBs) will cease to exist with the appropriate functions related to a state-owned water scheme being delegated to a CMA or Regional Water Utility". The NW&SMP (DWS, 2018), on the other hand, states that local water resource management institutions will replace WUAs and IBs.

Against this background, this report uses the term WUAs to refer to the case study and local WRM organisations to refer to a more generic local water resource management entity.

# 4 THE ROLE OF THE WRC

## 4.1 GUIDELINES AND TRAINING MATERIAL FOR WATER MEASURING AND METERING

Over the last 10 to 15 years the WRC has published research reports, guidelines and training material for the managed implementation of irrigation water measuring and metering. See the table below for a summary of the available research reports, guidelines and training material.

*Table 3: WRC research reports, guidelines and training material on water measuring and metering*

| Title | Authors | Year | WRC Report No. |
|---|---|---|---|
| Electric power supply measurement as an alternative to measure flow-rates of hydraulic pumps | Du Plessis FJ | 2004 | 1190/1/04 |
| Guidelines for irrigation water measuring in practice | Van der Stoep I<br>Benadé N<br>Smal HS<br>Reinders FB | 2005 | TT 248/05 |
| Training guidelines for implementation of on-farm and on-scheme water measuring and metering | Benadé N<br>Du Plessis FJ<br>Van der Stoep I | 2010 | K8/695//4 |
| Standards and guidelines for improved efficiency of irrigation water use from dam wall release to root zone application | Reinders FB<br>Van der Stoep I<br>Lecler NL<br>Greaves KR<br>Vahrmeijer JT<br>Benadé N<br>Du Plessis FJ<br>Van Heerden PS<br>Steyn JM<br>Grové B<br>Jumman A<br>Ascough G | 2010 | TT 465/10 |

| | | | |
|---|---|---|---|
| Guidance for sustainable on-farm and on-scheme irrigation water measurement | Van der Stoep I<br>Pott A<br>Viljoen JH<br>Van Vuuren AMJ | 2012 | TT 550/12 |
| Irrigation efficiency training material | Van der Stoep I | 2015 | KV 342/15 |

## 4.2 CURRENT COMMUNICATION AND STAKEHOLDER ENGAGEMENT

Th WRC's current knowledge dissemination activities and engagement with stakeholders aim to ensure uptake and impact of the research-based knowledge it produces.

## 4.3 PARADIGM SHIFT

The WRC has shifted in its communication from a diffusion paradigm to a more participatory approach.

The terminology ('transfer' and 'disseminating knowledge') that is used in the description of the WRC's core strategy[11] is evidence of an underlying diffusion paradigm:

> "The WRC provides the country with applied knowledge and water-related innovation, by continuously translating needs into research ideas and, in turn, transferring research results and disseminating knowledge and new technology-based products and processes to end-users".

On the other hand, the WRC engages intensively with its stakeholders and target audiences, mainly through workshops and roundtable discussions, to consult them on research needs, which are then integrated into the research agendas of the respective KSAs. It also has entered into numerous research partnerships with local and international organisations at different levels. The term 'technology exchange' was introduced to refer to these types of activities.

The 2017/18 Annual Report of the organisation explains the paradigm shift as follows:

> "The WRC model of dissemination was to produce research and transfer knowledge to academics and practitioners, who would then convert the knowledge into solutions. However, this linear approach does not achieve the level of impact that is required in changing sector with severe water, skills and infrastructure challenges. National policies also call for knowledge and solutions to be accelerated to the communities.
>
> A paradigm switch is required to take research outputs into outcomes and impact for the broader society. Hence, the WRC has re-orientated its strategy to focus on impact using the knowledge tree objectives, shifted R&D to a Development focus in order to narrowing the implementation pathway by accelerating solutions to the market and enhancing uptake. The WRC has invested in partnership building to achieve these objectives and the multi-plier effect".

[11] http://www.wrc.org.za/about-us/vision/

## 4.4 KNOWLEDGE MANAGEMENT MECHANISMS

### 4.4.1 General mechanisms

The WRC uses the following mechanisms to engage with stakeholders and encourage the uptake of their research products:

| Publications | Online | Dialogues | Partnerships |
|---|---|---|---|
| • Water Wheel and Water SA<br>• Books, booklets and pamphlets<br>• Articles in publications<br>• Reports (online and hard copies)<br>• Knowledge Reviews<br>• Policy briefs<br>• Press releases<br>• CDs | • Websites<br>• Apps<br>• Web-based models and databases | • Workshops<br>• Reference Group involvement<br>• Roadshows<br>• WISA and other conferences, e.g. SANCID and SABI<br>• Exhibitions and open days<br>• Symposia | • Local, national and international partnerships<br>• Sponsorships |

*Figure 14: Knowledge management mechanisms that the WRC uses*

## 4.5 SPECIFIC MECHANISMS

The following mechanisms were specifically used to encourage uptake of the WRC's guidelines and training material on irrigation water measuring and metering:

### 4.5.1 Workshops

The guidelines for irrigation water measurement that were developed as part of WRC Project No. K8/695//4 were presented to stakeholders at six workshops held across South Africa (WRC report TT465/10). The venues and dates are listed below.

*Table 4: Venues and dates of workshops*

| | Province | Town | Venue | Date |
|---|---|---|---|---|
| 1 | Western Cape | Stellenbosch | Elsenburg | 30 Aug 2006 |
| 2 | Eastern Cape | Sunland | Lower Sundays River WUA | 31 Aug 2006 |
| 3 | Mpumalanga | Nelspruit | Lowveld college | 20 Sep 2006 |
| 4 | North West/Gauteng | Pretoria | Agricultural Research Council | 21 Sep 2006 |
| 5 | KwaZulu-Natal | Pietermaritzburg | Cedara | 12 Oct 2006 |
| 6 | Northern Cape/Free State | Jacobsdal | Oranje Riet WUA | 18 Oct 2006 |

At each workshop, a local representative of DWS (DWAF at the time) gave an overview of the Department's view on the current situation and expectations of irrigation water measurement. The DWS perspective was followed by an overview of the guidelines for irrigation water measurement implementation.

#### 4.5.2 Dedicated website

The guidelines and training material were complemented in another WRC project (WRC report KV 342/15) by the development of a website (www.watermeter.org.za). The website features a summary of the reports, an article on the advantages of measuring irrigation water, the guidelines and training material and the 2017 regulations.

#### 4.5.3 Articles and Agri SA

Several articles on irrigation water measuring and metering was also published:

- Three articles in the magazine of the South African Irrigation Institute (SABI): April/May 2015; August/September 2017 and June/July 2018. The 2018 article focused on the selection of water meters for piped flow applications.
- An article with the title "Is metering of irrigation water use practically possible?" in **agri** (October/November 2013).

Shortly after the publication of Government Notice 131 of 2017, a presentation on the topic was given at a meeting of Agri SA's Natural Resources Policy Committee in Centurion.

#### 4.5.4 Follow-up training workshops to DWS officials

In 2017, Ms Isobel van der Stoep conducted training workshops for DWS officials to help them implement the guidelines DWS was busy preparing at the time. The workshops were a joint effort between Ms Van der Stoep, DWS and the water meter industry, and covered the purpose and background of the regulations, the DWS guidelines for the implementation of the regulations, hydraulic principles of measurement, and devices for pipe flow measurement and open channel measurement. Presentations were made by several suppliers such as Monitoring and Control Laboratories, Flowmetrix, Netafim, Xylem Water Solutions and FloCheck Instrumentation.

#### 4.5.5 Press release

On 30 August 2013[12], the WRC published a press release with the title, "Irrigation water metering – It makes plain good sense". According to the press release, the WRC projects "highlighted the need to use different communication channels to disseminate available knowledge, allow progression of time from awareness to persuasion to implementation and ongoing adaptation. It also recognises the role of demonstration for observing and evaluating the benefits of irrigation water measuring".

[12] http://www.wrc.org.za/wp-content/uploads/mdocs/08%20water%20meters%20p%2020-21.pdf

#### 4.5.6 Retrospective evaluation of these mechanisms

Ms Isobel van der Stoep, who is one of the authors of the WRC guidelines and training material on water measuring and metering, evaluates the effectiveness of the above specific mechanisms to facilitate uptake as follows:

“Although the irrigation community uses electronic communication, experience over the past 17 years has shown that face-to-face interaction is very valuable to unpack and clarify written communication, such as regulations or guidelines, for water users.

Focused contact sessions that feature a diverse group of specialists, including agents such as GWK, in a way that accommodates the water users’ programmes and availability, and arranged through the communication channels that they are familiar with (such as growers’ organisations or WUAs), have the best chance to be attended.

Water users in remote areas show great appreciation when technical specialists make the effort to visit them and try to understand the situation on the ground. Once the first contact has been made, they are more willing to approach these specialists (usually by phone or email) when they need assistance. This follow-up interaction offers the opportunity to share and recommend research-based knowledge."

# Part 3: The case study

Part 3 discusses the case study, which investigated the context and constraints of commercial irrigators in four WUAs along the Orange River, focusing on water management practices, and water measuring and metering. The case study also investigated the knowledge networks of WUA management, growers and their intermediaries.

## 1 CHANGES IN THE LEGISLATIVE AND MANAGEMENT CONTEXT

When this study started in April 2017, Government Notice 131 of 2017 had already made water measuring and metering a pertinent topic for CMAs, WUAs, IBs and commercial irrigators.

The first directive in terms of Government Notice 131 of 2017 was issued early in 2017 to agricultural water users in the Berg River/Theewaterskloof Dam system. They were instructed by DWS to install water measuring devices by 1 June 2017.

Notice 131 of 2017 was followed by Government Notice 141 of 23 February 2018, which published a national directive to all IBs and WUAs to install water measuring devices for water taken for irrigation purposes and to monitor compliance to the regulations.

The National Water and Sanitation Master Plan (NW&SMP) which was also published in 2018 confirmed the Department's intention to enforce metering in its action plan (DWS, 2018:33).

The report will refer to the impact that the regulations and the national directive have had on the discourse on measuring and metering irrigation water in the studied area.

Little progress was made in the course of the study with the implementation of the remaining CMAs. In January 2018, DWS published an internet article [13] that stated its intention to collapse the nine CMAs into a single entity. A new Minister was appointed since and it was announced that the nine CMAs will be retained.

## 2 RESEARCH METHOD

### 2.1 THE CASE STUDY METHOD

The research used the case study method, which is "an empirical enquiry into a specific phenomenon in its real-life context, using multiple sources of information" (Yin, 1993). Case study research methods are qualitative, and the aim is usually to get an in-depth understanding of a complex phenomenon.

According to Yin (1993:59), the case study method is particularly useful in situations where "the boundaries between phenomenon and context are not clearly evident". Initial discussions with the project manager and Mr Nic Knoetze of SAAFWUA on water measuring and metering in commercial irrigation indicated the relevance of Yin's comment for the South African context.

[13] http://www.dwa.gov.za/Communications/Articles/2018/IA%20-%20DWSs%20intention%20to%20introduce%20a%20single%20CMA%20gathers%20steam.pdf

## 2.2 SAMPLING

### 2.2.1 Multi-case sampling

To broaden the generalisability of the study, four Water User Associations (WUAs) were included as cases in the study. Meyer (2001) refers to this methodology as multi-case sampling.

Critical case sampling was used as a first step to include schemes suggested by DWS and SAAFWUA. In a second step, minimum variation sampling was used to select four schemes along the Orange River where weather conditions are similar, and all have canal systems with some river abstraction. All four sampled schemes are managed by WUAs. One of the four WUAs applied water metering on-scheme at the time of the research. Figure 15 shows the position of the four WUAs on a map of South Africa.

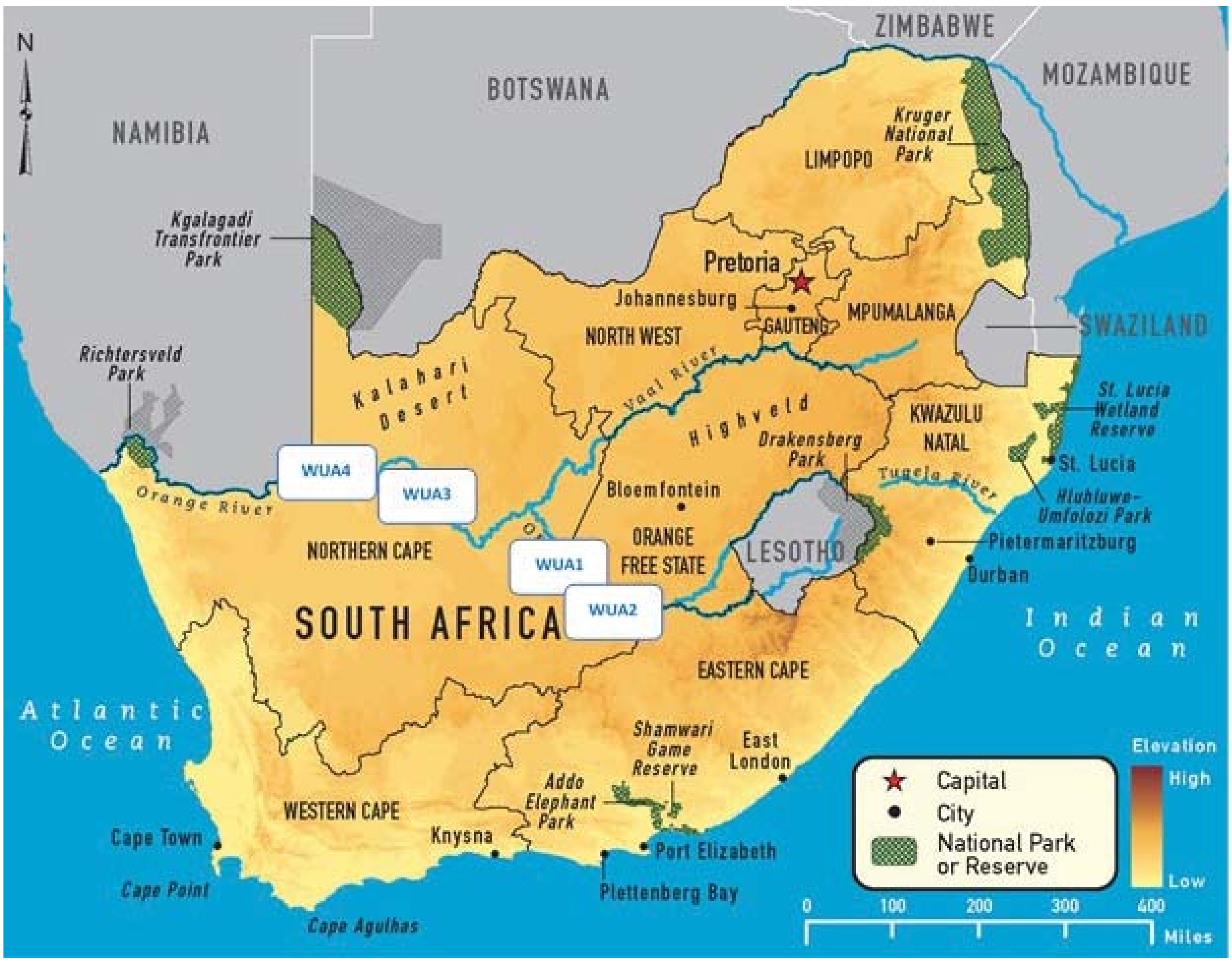



*Figure 15: The four WUAs sampled for the case study (Adapted from CDC, 2013)*

### 2.2.2 Triangulation

To strengthen the validity of the findings, the phenomenon of water measuring and metering in commercial irrigation was researched from three perspectives: Water User Associations, commercial growers/irrigators and their intermediaries or specialist advisers. The management of the WUAs and the growers were the primary target groups of this research.

##### *2.2.2.1 Water User Associations*

In each scheme, the Chief Executive Officer (CEO) of the WUA and the Chairperson of the Board were interviewed.

### 2.2.3 Commercial irrigation growers/irrigators

Eight to ten (8-10) commercial irrigation growers were selected per scheme and WUA.

The research team relied on the CEO of the WUA to select the grower sample for each WUA. The following selection criteria were given:

- 6 large growers; 4 medium-size growers (all WUA CEOs and Chairs reported that small-scale growers are being bought out, hence the selection of medium-sized and large growers)
- An age distribution of growers (from young to very experienced)
- A female grower and a black grower (commercial, not emerging), if available
- A distribution of canal and river abstraction
- A distribution of irrigation methods that are used on the scheme
- Growers who measure water use and growers who do not measure their water use
- A distribution of the crops that growers plant on the scheme.

In total, 36 interviews were conducted with growers.

### 2.2.4 Intermediaries/specialist advisers

The secondary target audience of the research was intermediaries who act as knowledge conduits to the primary target audience: organised agriculture, government departments, grower associations, training organisations, consultants, suppliers, other research organisations, NGOs.

The research team compiled an initial sample of intermediaries. The sample was discussed at the first Reference Group meeting and changes and further suggestions were made.

However, very few of the initial sample of intermediaries were mentioned by the interviewees. The research team decided to sample intermediaries from the people and organisations that the WUA management and the growers actually mentioned as knowledge sources, because the interviews with intermediaries aimed to identify successful conduits of research-based knowledge to the primary target audience.

The following criteria were used to sample the intermediaries:

- The relevance of the context in which the intermediary was mentioned for this study: water management and water measuring or metering
- Scheme representation (intermediaries across schemes)
- Crop representation (grains, vegetable seed, cotton, grapes (wine, table, raisins), citrus and pecans).

In total, 21 intermediaries were interviewed.

## 2.3 DATA COLLECTION METHODS

The research comprised semi-structured qualitative interviews. The qualitative information gathered from face-to-face interviews with respondents in their own environment is from experience much richer than any other method can elicit. It was therefore decided to visit the WUAs at their offices and the growers on their farms.

The site visits gave the research team the opportunity to observe farming conditions. It also gave respondents the opportunity to show the research team how knowledge has been applied.

The research proposal proposed a survey of intermediaries. However, the research team decided that they would get more valid and richer information through a personal telephone interview.

## 2.4 Discussion guides

Discussion guides were developed for each of the three groups of interviewees.

The flow of the discussion guides was as follows:

1. The introduction clarified roles and gave the respondent an opportunity to give information on:
    a. For the WUA, the scheme and farming in the area
    b. For the grower, their farming unit, crops and practices
    c. For intermediaries, their organisation or company and their role in commercial irrigation.
2. The interviewer then explained the purpose of the interview and made sure that the interviewer and the interviewee have a common understanding of the concept 'knowledge'.
3. The discussions guides included questions about water management, costs, improving efficiencies, the role of measuring and metering and increasing profits.
4. Questions about reliable and trusted knowledge sources and influences explored networks of intermediaries/change agents, and different pathways for research-based knowledge to reach individuals and organisations.
5. Questions about further studies, attending conferences and symposia, information days, Apps, etc. explored more ways in which respondents keep up to date with new technology and other innovations.
6. In the first part of the interview, mention of the WRC and its knowledge products would be spontaneous. Only in the last part of the interview did the interviewer ask directly about their awareness of the WRC and use of its knowledge products.

## 2.5 Format of interviews

Dr Sarah Slabbert and Ms Isobel van der Stoep were the interviewers. The interviewers acted as a team. They complemented each other very well, and the interviewees responded positively to their rapport.

All the grower interviews took place on the farms, either in an office or in the home of the grower; three were conducted in the field. Nine interviews included field visits where the team was shown pivots, micro and drip irrigation, dams and canals, pumps, meters and measuring structures.

Unfortunately, Ms van der Stoep was only available to participate in the WUA1 and WUA3 interviews. Two research assistants, Ms Lizelle Botha and Ms Nadja Green, assisted Dr Slabbert in WUA2 and in WUA4 with note-taking and the summaries.

Dr Slabbert and Ms van der Stoep each did 10 telephonic interviews with the intermediaries. Two intermediary interviews were face-to-face.

## 2.6 Data analysis

The qualitative data was analysed and interpreted according to themes that relate to the structure of the discussion guides, which, in turn, is aligned to the project outcomes and aims. Relevant quantitative information was captured in Excel and further analysed. Some of the findings are presented in charts.

Lastly, the findings were related to the literature review to identify implications and opportunities for a communication strategy for the WRC.

## 2.7 Feedback workshops

When the research approach was developed, two workshops were planned to:

a) Give the participants feedback on the findings of the research and at the same time market the WRC and its research;
b) Support the implementation of measuring and metering with a presentation on the technical aspects of water metering, followed by a question-and-answer session;
c) Harness support for water measuring and metering.

The Honours student who participated in the project, Mr Frans Mehale, initially proposed two workshop formats: a scenario format and a participatory rural appraisal format. Section 3.5 of Part 3 will explain how the workshop format was adapted to fit the findings and the changes in the regulatory context.

# 3 Findings

## 3.1 Water measuring and metering in practice

### 3.1.1 At scheme level

The table that follows compares water management practices, including water measuring and metering across the four researched schemes:

*Table 5: Comparison of water management practices across schemes*

| Topic | WUA1 | WUA2 | WUA3 | WUA4 |
|---|---|---|---|---|
| CEO | From the area, also farming, management experience<br>Build on well-established management practices,<br>Perception: strict, but fair and consistent | Not from the area, but with farming background; IT (information technology) expertise. Found very little management systems in place when he started<br>Understaffed; overworked<br>Perception: "doing a good job/his best" | From the area, management experience<br>Relatively new<br>Perception: turning dysfunctional management system successfully around | Acting, from the area, grower<br>Major labour issues<br>Trouble with DWS and the CMA<br>Perception: dealing with a very challenging situation |
| Board – grower members | Close and supportive cooperation between CEO and Chair<br>Mostly older growers | Chair and CEO do not agree on water meters at abstraction<br>Supportive Board of young, successful growers | Close and supportive cooperation between CEO and Chair<br>Supportive Board | Board of prominent growers |
| Area | 17 500 ha of scheduled land | Approximately 16 400 ha of scheduled land. 5 600 ha is irrigated from the canal | 9 200 ha of scheduled land, of which 7 800 ha are irrigated from a 275 km canal network, and the remaining 1400 ha with water withdrawn directly from the Orange River | 11 000 ha of scheduled land<br>Estimated 7 000 ha still under flood irrigation[14] |
| Annual water allocation | 11 000 $m^3$/ha | 11 000 $m^3$/ha | 15 000 $m^3$/ha (downstream of Dam)<br>10 000 $m^3$/ha (upstream of Dam) | 15 000 $m^3$/ha |
| Management system | Constitution and regulations of each sub-region. Strict rules and stiff penalties for not following the rules<br>Self-regulatory: growers open and close sluices and pumps<br>Result: less staff; more affordable price, and money available for maintenance, etc.<br>Check with meter readings and spot checks | Constitution and regulations.<br>Stiff penalties for over-planting<br>Self-regulatory: growers open and close sluices and pumps | Constitution and regulations.<br>Strict rules and stiff penalties for not following the rules<br>Sluice gate settings are used as the actual abstractions<br>Self-regulation with spot checks | Constitution only<br>13 people on motor cycles who open and close the sluices; self-regulatory when there was a strike |

[14] The number is not a correct reflection of the practice. Several growers pay for their canal allocation, but withdraw water from the river.

| Topic | WUA1 | WUA2 | WUA3 | WUA4 |
|---|---|---|---|---|
| Risk-based approach | Yes – has a risk and mitigation plan | No – for example, pivots above the canal are a risk to the canal, but rule not consistently applied | Attempt to introduce a risk-based approach | The WUA does not follow a risk approach. They address most issues as they occur. No evidence that they apply research-based knowledge for risk abatement |
| Withdrawal and distribution | Schemes 1 and 2 withdraw from canal; schemes 3 and 4 from the river. Scheme 5 from the Riet River canal.<br>Request system (SMS) for canals.<br><br>River – pump as needed; river levels monitored, and releases adjusted accordingly | Canal and river<br>Use as needed; river levels monitored, and releases adjusted accordingly | Canal and river<br>Request system (cards) for canals<br>River – pump as needed | Canal and river<br>The WUA releases water into canal according to legal amount of water per hectare, irrigators' requests (cards), estimated water losses, plus experience of circumstances in which end-canals do not have enough water for the last users in the line.<br>Over-abstraction for domestic users, communities or municipalities is regarded as a financial loss, but a negligible % of the total abstraction.<br>Request system (cards) for canals<br>River – pump as needed |
| Abstraction control | They do crop planning based on crop factor and then check actual use with meters on abstraction pumps and sluice control<br>All abstraction points are metered: mechanical and electrical (FloCheck) meters<br>Spot checks<br>On 11 February 2013, they decided to restrict abstraction to 5 days/week during peak time. 1.3 litre/s/ha for 120 hours (5 days)<br><br>Growers are restricted to plant 85% of scheduled hectares to provide for heat and drought conditions | Use crop factor to regulate water use; check with satellite imagery and farm visits. Meters at abstraction points not enforced | Sluice control system for canals; spot checks<br>River abstraction points linked to GPS point; volume abstracted must be measured. River-irrigation: WUA monitors area irrigated to make sure growers don't irrigate more than their registered areas<br>Approach: eliminated excuses to conform; improved relationship between water users and water bailiffs<br><br>Communicated regulation on water meters as a directive to members | Large growers pump from canal and river<br>The water control officials of the WUA open and close sluices according the requested water schedule<br><br>Communicated regulation on water meters as a directive to members; largest and most influential installing meters. Deadline given: Oct 2017<br><br>Municipal water use difficult to control – faulty or no meters<br>*River abstraction is increasing. E.g. someone buys canal water and pays the canal tariff, but the water is abstracted from the river. At the moment, the WUA* |

| Topic | WUA1 | WUA2 | WUA3 | WUA4 |
|---|---|---|---|---|
| | | | | *cannot control river abstractions.*[15] |
| Data management | Growers send in meter readings<br><br>Electrical meters: Cooperated with Energy Insight to get real-time data from electrical meters: actual flow, flow regime, flow tempo and Volts on the different phases | No volumetric real-time data of abstractions | No volumetric real-time data of abstractions | Growers are beginning to send in meter readings<br><br>No volumetric real-time data of abstractions |
| Water transfer | Growers may transfer water at the end of the water year | Growers may transfer surplus water to another grower. Internal process to approve temporary internal transfers but not to someone who will be exceeding their quota | Allow temporary transfers | No mention of transfers<br>Transfer of canal rights to river rights |
| Additional planting | Because they meter, growers are allowed more crop per drop.<br>17 000 scheduled ha; 22-23 000 irrigated because of increased efficiencies | Growers may plant more crops or put up new pivots, but get a penalty if they use more water than their scheduled hectares | No mention of allowing additional hectares<br><br>Growers expressed need to transfer canal rights to river rights | No mention of allowing additional hectares |
| Water meters (on-scheme) | All the WUAs are moving towards water meters and telemetry as part of modernisation and better management. | | | |
| | Parshall flumes with electronic depth sensors and acoustic Doppler velocity meters are used for large inlet canals.<br>In process to upgrade telemetry; plan to phase out mechanical meters. Interim solution to have real-time metering on mechanical meters | Installed SonTek water meters (ultrasonic) in die main canal to keep track of the water levels<br>Meters give problems; exploring alternatives | 10 measuring stations along canal, fitted with telemetry | In September 2017, DWS installed meters at the inlets of the three canals (plus-minus 19 000 $m^3$/h). They are electronic meters and the WUA receives the readings electronically on their computer<br><br>Measuring water use on the sluice system is not always accurate due to the Parshall flume becoming submerged<br>Return flows: 13 points, no meters – no idea how much water flows back to river |

[15] Direct quotations from the WUA management, growers or intermediaries are in italics.

| Topic | WUA1 | WUA2 | WUA3 | WUA4 |
|---|---|---|---|---|
| WAS | Introduced modules, expanding, most advanced of the WUAs | Introduced modules | Introduced modules | Introduced modules. Employed someone to put the manual data into WAS. The request cards will also be put on the WAS system |
| Critical risks | Ageing infrastructure: Canals (leaking and rusting taps, disintegration of concrete walls, water losses, runoff water, algae, grasses) are a major risk in all four schemes. The WUAs do annual maintenance, but because funds are limited, it is mainly crises management.<br>Water quality (WUA1 (river water in the north), WUA3, WUA4)<br>Vandalism (WUA4); In WUA4, the WUA perceives itself to be at risk | | | |

#### *3.1.1.1 Driving factors for measuring or metering water use on-scheme*

From the discussions with the CEOs and Board chairs, it was evident that, in the studied areas, measuring or metering water use at scheme level is driven by the following factors:

- The accountability of WUAs to DWS/the regulator/government: CEOs accept that accountability, particularly also because members expect the WUA executive and the Board to deal with issues that relate to the Department or government in general, and to present the WUA to government as efficient, well-managed and able to report on its water use.
- The accountability of WUAs to their members: This includes making sure that all members get their fair share of water in all circumstances:
    - making sure that every grower gets their licenced quota of water as needed, including those at the far ends of the canals;
    - making sure that water is distributed fairly, that no grower abstracts water unlawfully; and
    - making sure that the system is monitored and maintained as well as resources allow.
- The capacity of the CEO and the Board to respond to these accountabilities, and also the cooperation between the CEO and the Board.
- Clear and comprehensive regulations that all members have signed, and which are consistently applied. CEOs acknowledge that there will always be dissenting members.

    *I would rather struggle with the 5% who makes trouble, than have the other 95% unhappy because I can't control that 5%. That 5% will always test the boundaries, but if you act decisively and control them tightly, you know you won't have trouble from the other 95%. They will keep in line. (CEO, WUA1)*

- The availability of new technology to increase irrigation efficiency: telemetry, advanced volumetric meters and data processing packages. Innovation and new solutions are introduced by service providers or researchers who include a particular WUA in their research, through contact with other WUAs or water utilities and other networks. Examples from WUA1 are the following:
    - The CEO was on the Reference Group of Mr Francois du Plessis' study (WRC Report No 1190/1/04). This is how he got introduced to the FloCheck meters.
    - The executive management visited Central Breede WUA to get first-hand experience on their use of the FloCheck meters.
    - For telemetry, the executive management visited Joburg Water to see how well the Specialist System Engineering (SSE) system works.
- Use of the Water Administration System (WAS) system.
- A limited water supply, whether permanent as is the case with WUA1, or in the form of water restrictions in drought conditions, forces greater irrigation efficiency on-scheme.

The dual accountability of a WUA to its members and DWS is a fine balancing act, which is easily thrown out of balance by distrust between members and DWS, the perceived inefficiency and inconsistency on the part of the Department and the interference of DWS into the daily affairs of a WUA, as was reported in WUA4.

Several statements indicated that it is important for the management of a WUA to stay out of the DWS spotlight by toeing the line.

> *If DWS sets water restrictions, the WUA and the growers will have to make plans to meter their water use. (CEO, WUA2)*

It was interesting that two of the WUAs (WUA3 and WUA4) interpreted the regulation on water meters (Government Notice 131 of 2017) as a directive that all growers should meter abstraction and communicated it as such to their members because they felt the regulation would support them to manage withdrawals. At the time of the research, the largest and most prosperous growers of WUA4 had already started to install meters on their pumps, leading the response from the water users.

#### *3.1.1.2 WUA management's perceptions of members' water management practices*

**WUA1:**

Growers are innovative and aware that they must become more efficient.

> *Many of the growers are involved in GWK's high precision programme. If your input cost is R20 000, R30 000 per hectare, you want to be sure that you are getting it back.*
>
> *He (the grower) won't use less water; he will do more crop per drop. With 17 000 scheduled hectares, we irrigate between 22 000 and 23 000 hectares. (CEO, WUA1)*

Growers are also beginning to use water differently. Previously, they would plant maize and wheat under a pivot; nowadays, with pecans that require more water, they would plant one crop under the pivot and use the water of the second crop for their pecans.

They are prepared to invest in technology. New technology has the advantage that you get your data real-time and you can make corrections immediately. In previous years, you sometimes had to wait a month to get the results.

**WUA2:**

The CEO gave the larger growers a 9 out of 10 in terms of their efficiency. According to the CEO, it is important for the members to be efficient with their water management. 80% of the members use scientific irrigation scheduling. The growers are very innovative. They are not afraid of using technology, especially the younger ones. This includes telemetry, probes for irrigation scheduling, satellite images and meters.

However, according to the CEO, while there is no leadership from DWS, or control on the schemes that DWS manages, the growers will not buy into water meters.

**WUA3:**

Growers modernise their systems (by changing from flood irrigation to drip irrigation, or introducing on-farm telemetry systems, etc.). Capacitance probes for irrigation scheduling is also being used to improve the accuracy of applying water. However, the CEO said that 30% to 40% of the growers are from an older generation and the perception is that they do not want to use new technology.

**WUA4:**

Costs have become so high that growers can no longer afford to be ineffective. The ineffective growers no longer exist. Growers pump water long distances at high pressure; they do not want to pump a single drop unnecessarily.

> *He (the grower) will use too much water to irrigate an extra hectare, but he will not use too much water per hectare. (CEO, WUA4)*

The export growers must measure their water use for the EurepGap, but they prefer to meter the volumes that go to the blocks instead of withdrawal volumes.

### 3.1.2 At farm level

The first four subsections (3.1.2.1 to 3.1.2.4) provide the context for subsections 3.1.2.5 to 3.1.2.8, which describes measuring and metering in practice at farm level.

**It should be noted that the practices described in this section (3.1.2) are as recorded at the time of the research. Commercial irrigators in the studied areas are continuously implementing new technologies and experimenting with new practices, hence figures and practices may already be different.**

#### *3.1.2.1 Water management practices*

The following table presents a summary of scenarios and water management practices found on the farms in the study areas.

*Table 6: Comparison of water management practices across farms*

| Topic | WUA1 | WUA2 | WUA3 | WUA4 |
|---|---|---|---|---|
| Crops | Maize, alfalfa, wheat (winter), sunflower seed, cotton, 1000 ha pecans, 4 000 ha wine grapes | Maize, soya beans, popcorn, potatoes, introducing pecans | Raisin grapes, wine grapes, table grapes, alfalfa, 1200 ha pecans to date, limited cotton and vegetable seed | Table grapes, raisin grapes, citrus, introducing pecans and new crops like blueberries, vegetable seed |
| Economic aspects and strategies | Select crops and planting areas according to water availability and market prices. Export market important for permanent crops like pecans. Innovate to increase profitability (cotton, nurseries), mechanise to reduce labour requirements, always looking to expand areas | More established / conservative cash and field crop area, selecting crops according to market prices. Mainly local markets but exposed to movement in international markets and prices. Some introduction of permanent crops. Implementation of new technology (not water meters), mechanisation | Marginalised irrigation area, far from major towns, with challenging climate, aging irrigation systems (mostly flood), relatively poor soils, low profitability on small areas with limited opportunities for expansion or improvements (mechanisation) | High income irrigation area with established infrastructure closer to urban areas. High value permanent crops, often exported, with a large degree of mechanisation and automation to manage water<br>*Table grapes is a business, not farming.* |
| Perceived risks | Weather (hail, frost), water availability, variability of river flows, salt content / quality of the water, cost, quality and availability of electricity, maintenance of machinery (tractors, pumps, pivots), politics, markets, cash flow, skills/knowledge of farm workers, unregulated water users | Water availability, electricity supply and quality (power surges), weather (hail, frost, lightning), fire, contractors, debt, market prices, crop damage by animals and pests | Cash flow, lack of opportunities for expansion, drainage/soil problems caused by flood walls, climate (frost, hail, heat), floods, theft/vandalism of products and equipment by unemployed local community, life expectancy of the canal. Labour, politics. Fire of the reeds next to the river | Water quality, salinisation, untimely rain, frost, hail, heat waves, condition of the infrastructure (canals), cost of electricity, labour-intensive growing practices, algae in the water (especially from the canal) |
| Irrigation methods | Pivots for seasonal crops<br>Micro and drip irrigation for pecans | Pivots for seasonal crops<br>Micro and drip irrigation for pecans | Flood irrigation is common for raisin grapes, flood and pivots for seasonal crops<br>Flood, micro and drip irrigation for pecans | Micro and drip irrigation for table grapes, citrus and pecans; flood irrigation for raisin grapes and vegetable seed |
| Basis of irrigation scheduling | Capacitance probes (GWK and others), seasonal programme / previous experience, weather station data | Crop factor, capacitance probes (IrriCheck, Aquacheck and others), soil augers, profile pits, seasonal programme, weather station data | Seasonal programme / previous experience, capacitance probes (DFM and others) to a lesser extent, soil auger | Capacitance probes (DFM, IrriCheck and others), seasonal programme, previous experience, profile pits, soil auger, evaporation pan, weather station data |
| Use of water meters | Mechanical and electromagnetic meters at farm edge and on pivots (two growers)<br>FloCheck meters (at the farm edge, for the WUA), sluice gate settings (for the WUA) | Ultrasonic meters on pivots (only 1 grower) | Sluice gate settings (for the WUA)<br>No individual meters | Mechanical and ultrasonic meters (7 of the 10 growers) |

#### *3.1.2.2 Irrigation scheduling practices*

The four WUAs reported the use of scheduling methods as shown in the table below. The numbers refer to mentions; not growers. Most growers use a combination of methods from different groups.

*Table 7: Irrigation scheduling methods*

| | WUA1 | WUA2 | WUA3 | WUA4 |
|---|---|---|---|---|
| **Plant measurements** | 0 | 0 | 0 | 0 |
| **Predictive methods** | | | | |
| Seasonal plans | 2 | 1 | 6 | 7 |
| Models | 0 | 0 | 0 | 0 |
| **Direct measurement methods** | | | | |
| Weather station data | 0 | 1 | 0 | 4 |
| Soil augers and profile pits | 5 | 7 | 5 | 9 |
| Soil water content measurement (probes) | 8 | 9 | 2 | 7 |
| **Experience** | 1 | 3 | 1 | 2 |

The use of weather station data is probably higher than reported, because five growers interviewed in WUA1, and two interviewed in WUA2 belong to GWK's Hoëtegnologieboerdery (high precision farming) (HTB) group. Weather station data is integrated into the scheduling advice that GWK provides.

Water users in the study areas seem to favour methods where some aspect of the soil-plant-climate continuum is measured or observed directly rather than crop growth models. The study areas used in this project, especially WUA1, have been used in many WRC and other research projects where crop growth models were developed and/or refined, and yet despite this, direct measurements or observations are still widely used.

Soil water content measuring methods, especially capacitance probes, are widely used in the study areas, even by growers using flood irrigation. In many cases, the growers that were interviewed emphasised the importance of investigating the soil by using augers or profile pits to check or confirm the data they are getting from the probes.

The findings reinforce the idea that no amount of measurement can replace the value of first-hand observations made in the field or orchard. Computer models can be used to predict water requirements, and sophisticated equipment used to monitor soil and other parameters, but the effect of the actions taken by the irrigator should also be verified by observing the condition of the soil and the plants. Water users are very aware of this important management aspect. There is a secondary benefit to these practices as it also helps to assess soil health and root development under the irrigation system.

The numbers above show a significant increase in growers' understanding of irrigation efficiency and the optimal use of the available water amongst the growers in this area. The continued work and commitment by GWK with their scheduling services have contributed greatly to the insight and understanding developed by growers in especially the areas of WUA1 and WUA2.

#### *3.1.2.3 The trend to increase water productivity*

Several growers attested to the fact that water use in commercial irrigation is becoming increasingly effective and efficient, even though the level of sophistication might differ from grower to grower:

Grower 5 in WUA2 explained that the previous generation did mainly flood irrigation. His father imported in 1978 pivots from the United States. Those pivots gave 12 mm per 24 hours, day in day out. They totally over-irrigated. They did not know about scheduling and they washed out all the nutrients. When he came to the farm, he had to drain 300 ha. The Department of Agriculture, Forestry and Fisheries (DAFF) helped him. He put in main lines and side lines and filtering material.

Another grower described the shift to greater water productivity and irrigation efficiency as follows:

> *There have been significant improvements over the past 20 to 30 years in terms of on-farm practices. The recent drought has also forced growers to evaluate their own effectiveness and to make adjustments. Sprinklers are improving; drop size is improving; pressure is coming down - this means that you get larger drops that simulate rain and have less impact on soil. (WUA2, grower 4)*

This particular grower uses the following data and decision-making process for each pivot:

- History of water applied.
- History of soil moisture (probe and manual data).
- A scheduling program for the next 10 days (based on current probe and manual data (added as a daily shortage), weather data, soil data, crop factor, experience). They consolidate the data on a Thursday, and on a Friday, they program for the next 10 days. They pre-program for rain expected, but the program allows them to add rain data and to adjust.
- He only uses on average 80% to 85% of the recommended ET figure (he received this figure from Bertus van der Westhuizen) as the correct figure. If he does not make this adaptation, he over-irrigates.
- The scheduling programme is then interpreted/simplified into a scheduling chart for the 'water men' who have to go out and set the pumps.

Growers using the high end of available irrigation technology are starting to invest and experiment with the automatisation of pivots that can vary the application of water for different soil types, crops or inclines. OVK, for example, is experimenting with drones to measure the water retention capacity of different soils. This data will then feed into the pivot's water application program.

These growers are also exploring ways to optimise soil health and seed/cultivars. They experiment with cover crops and soil preparation methods.

The example below from WUA4, Grower 1, illustrates how growers of permanent crops use a variety of cover crops to keep moisture in:

- Mulch – maize, wheat, whatever is available
- They plant black oats between the rows. Plant in March/April, spray it dead in November
- Apply organic material every four years
- They buy compost from Upington municipality's gardening services: 4 000 to 5 000 tonnes for all their farms. They give 8 to 10 tonne per hectare
- They do weed control.

The same grower also shared information on their soil preparation method: They rip the sandy soil and make phosphate corrections where needed. Previously they tilled the soil, but the soil experts said they were destroying the soil structure. They then add organic material such as cattle manure. They also add gypsum for salts. A field prepared in this manner has a lifetime of 25 years, according to the grower.

A trend to go more organic with fertilisers and pesticides was found mainly in WUA4.

Grower 3 of WUA4 said that, if you want to follow a completely biological approach, you have to create an ideal soil environment for the plant in terms of water, oxygen and food. The relationship between water and oxygen must be 100% managed. They struggled for very long to get an indicator of the ideal soil environment that makes sense. They now use nematology. *We calculate the different types of nematodes to get the optimal ratio for bacteria and fungi – we try to create a 'forest' effect for the roots.* They strive to be in the optimal zone, because this gives the roots the ideal zone. Until recently, they struggled because nobody could count the bacteria or fungi. The nematodes are the indicator of bacteria or fungi.

In contrast, in the area of WUA3, farms are smaller than in the area of WUA4. As a result, growers have less resources to invest in technology and other innovations.

Flood irrigation is very common in this area. It is mainly a function of the size of the farm and the available resources. Growers with less than 100 ha find it difficult to afford controlled irrigation – both the irrigation system and the cost of electricity. Growers who cannot afford high-end technology and who still use flood irrigation are implementing a number of methods to optimise flood irrigation. Methods include:

- Concrete channels
- Siphon pipes
- Food valves - this gives you an enormous saving, according to interviewees
- Laser levelling of fields
- Optimal row length
- Adding probes to monitor soil moisture, while continuing to check with a soil auger.

While the trend is to replace flood irrigation with controlled irrigation, it was interesting that a grower implementing the latest technology (Grower 5 of WUA4), 'simulates' flood irrigation in their micro irrigation schedule for citrus, because they have found that to be the most effective for heavy clay soil.

> *We irrigate 20 hours at a time and then we stay away for four to five days to get oxygen into the soil.*

#### *3.1.2.4 Critical risks*

Perceived risks varied from area to area, and between individuals in an area.

For small commercial growers the risk of **insufficient cash flow** to repay seasonal loans and other debts is critical. These growers are also the hardest hit by water restrictions.

They have limited means to mitigate the risk of less water by improving their water productivity or irrigation efficiency. They don't have the financial resources for probes and expensive irrigation packages, and the cost of electricity to lay new lines, especially if you have to pay upfront, makes it too expensive for most of them to change from flood irrigation to controlled irrigation (micro or drip) for high yield crops.

Extreme weather events such **as frost, hail, heat or untimely rain** were mentioned most often. Mitigating measures include watching the weather forecast closely on various websites, adapting irrigation schedules, replacing existing crops or cultivars with more resistant ones and insurance.

To mitigate **the risk of water availability** on-farm, growers follow different planning methods to provide for a dry and hot season, or a season with water restrictions. Some are prepared to take more risks than others.

In the planning stage, they will:

- Increase irrigation efficiency, for example by investing in more advanced irrigation technology;
- Plan to plant more drought-resistant cultivars or crops that need less water;
- Focus on high-yield crops;
- Plant less (less profit, leading to cash flow problems).

Grower 9 of WUA2 said that he does his planning at the start of a new season as if it would not rain at all. In this way, he would never exceed his authorised water allocation.

In-season, growers would make the following adaptations to stay within their water allocation:

- Plant less hectares in the late season or lower the stand.
- Plant a crop that needs less water, such as popcorn, in the late season.
- Sacrifice a low-yield crop (currently maize, because the price is not good).
- Manage their water use to move closer to the 'danger zone' (WUA4, grower 1).
- Keep their water use in winter time very low (in WUA4, they would sometimes not give water for 6 weeks). This enables them to have sufficient water during summer.

Growers are very concerned about the **water quality** of the Vaal River, as well as the Orange River downstream of Upington, and the impact that it could have on exports. Growers who export regularly test the water that they use for irrigation to monitor quality. According to them, E. coli levels are increasing.

> *It is like a thief stalking us in the dark. (WUA4, grower 5)*

They are particularly concerned about the impact of municipal effluent on river water quality. One grower (WUA2, grower 4) got a quote for a pond to pre-treat irrigation water. The cost was R40m. This grower suggested the following solution for the problem: *Municipalities should not discharge effluent into the Vaal River. They should mix their own effluent with river water and then treat it to drinking water standard.*

In irrigation, the cost of water is directly related to **the cost of electricity**, except in the case of flood irrigation. Electricity makes up a significant portion of input costs. A co-owner of a large family irrigation farming business said that they spent the previous year (2016) R35m (on electricity) to irrigate 4 300 ha. Any unnecessary water that you pump inefficiently adds to this cost.

> *When you waste water, you waste money. (WUA2, grower 2)*

The **condition of, and maintenance requirements of both on-scheme and on-farm irrigation-related infrastructure** is of great concern to the growers and it also has an impact on water availability. All the WUAs have an annual maintenance programme, but they said that they did not have the funds to do the full refurbishment that was needed. Only government can do that.

#### *3.1.2.5 Different methods to measure or meter water for irrigation*

All irrigators agree that measuring the volume of water used for irrigation is part of modernisation and better management in irrigation farming. It goes hand in hand with precision farming, greater efficiency and the use of technology. A recurring slogan was:

> To measure is to know *(Om the meet is om te weet)*

Different methods are however used to measure the volume of water that is used for irrigation, and the measured volumes are applied for different purposes:

1 Irrigation scheduling
Add all volumes applied through sprinkler/drip package determined from a seasonal water use value multiplied by the area irrigated.

The most common method used is to add up their irrigation scheduling programme. One grower said, for example, that he does not have to meter his water use, because the calculation shows that he uses significantly less water than his allocation. He can irrigate an additional 400 ha.

2 Sluice gate measurements
Growers who request water from the canal through an SMS or card system also said that they add up their requests to measure how much water they have used.

3 Calculation
Pump hours multiplied by volume pumped per hour, or electricity used on a water pump multiplied by a conversion factor, to get volume.

*You can multiply the amount of water per hour per ha (5m$^3$/ha per hour) with the actual running time of the pump that takes the water to the pivot. There is an hour meter on the pump. I can send these readings to the WUA as an accurate measurement of my water use. My father does it in this way (for WUA1). (WUA2, grower 8)*

Grower 9 of WUA2 does the same, with the assistance of GWK: He installed hour meters on his pumps at his own cost, because he wants to be sure exactly how much water he uses. For each system, he multiplies the runtime of the meter by a factor that GWK determined for him. He can even calculate profit in Rand per volume of water used.

4 Measuring devices on pivots, distribution pumps and abstraction pumps
The table below gives a quantitative analysis of water meters that growers used at the time of the research. The abbreviations are as follows: M=mechanical meter; EM=electromagnetic meter; FC=FloCheck meter; US=ultrasonic meter. "Yes" and "no" indicate whether a grower withdraws or abstracts from this source.

*Table 8: Use of water meters in WUA1*

| WUA1 | G1 | G2 | G3 | G4 | G5 | G6 | G7 | G8 |
|---|---|---|---|---|---|---|---|---|
| **On-scheme** | | | | | | | | |
| **Abstract from river** | Yes | Yes | Yes | Yes | No | No | No | No |
| **Meter type** | M & EM | M | M & EM | | | | | |
| **Abstract from canal** | No | No | No | No | Yes | Yes | Yes | Yes |
| **Meter type** | | | | | FC | | M | M |
| **On-farm** | | | | | | | | |
| **Meter type** | | | | M | | | FC | |
| **Where?** | | | | Pivots | | | Pivot (1) | |

*Table 9: Use of water meters in WUA2*

| WUA2 | G1 | G2 | G3 | G4 | G5 | G6 | G7 | G8 | G9 | G10 | G11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **On-scheme** | | | | | | | | | | | |
| **Abstract from river** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Meter type** | | | | | | | | | | | |
| **Abstract from canal** | No | No | No | No | No | Yes | Yes | Yes | No | No | No |
| **Meter type** | | | | | | | | | | | |
| **On-farm** | | | | | | | | | | | |
| **Meter type** | | | US | | | | | | | | |
| **Where?** | | | Pivots (3) | | | | | | | | |

Grower 5 of WUA2 explains as follows why he believes that the best place to have a meter is at the pivot: *I have five pump stations at the river, but having a meter at each of these pumps would not give me water use information for each crop, because some of their water goes to maize pivots, some to alfalfa pivots, etc.* He has ultrasonic meters on three of his Zimmatic pivots. On these pivots, software has been installed which enables him to control them from his phone (the software is FieldNet by Lindsay).

*Table 10: Use of water meters in WUA4*

| WUA4 | G1 | G2 | G3 | G4 | G5 | G6 | G7 | G8 | G9 | G10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **On-scheme** | | | | | | | | | | | |
| **Abstract from river** | No | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | | |
| **Meter type** | | | | US | | | | | | | |
| **Abstract from canal** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | |
| **Meter type** | US | | | US | | | | | | in process | |
| **On-farm** | | | | | | | | | | | |
| **Meter type** | US | | M | US | M | | US | | M | unknown | |
| **Where?** | Pumps to blocks | | | | | | | | | | |

Seven of the eight growers interviewed in WUA4 export their produce. Growers producing export crops are also often required to keep record of their water use as part of their international marketing obligations, which can also be regarded as a driver for implementing metering. It is important for growers of WUA4 to measure and monitor water use per block, which explains why so many of them have meters on their distribution pumps. Grower 10 of WUA4, for example, has a meter on each of their 17 distribution pumps. At the time of the interview, they were planning to put water meters on their abstraction pumps.

The slowest adoption rate for metering was found in the WUA3. In this WUA, large areas are still irrigated using flood systems, farming enterprises are more marginal, and a water meter is therefore seen as an expensive item. None of the growers interviewed in WUA3 have a water meter. All eight of them irrigate from the canal where a sluice gate measures volume. Three growers also pump from the river, but they don't have water meters on their abstraction pumps. Nobody has on-farm water meters.

The types of water meters used across the four WUAs are shown in the figure below.

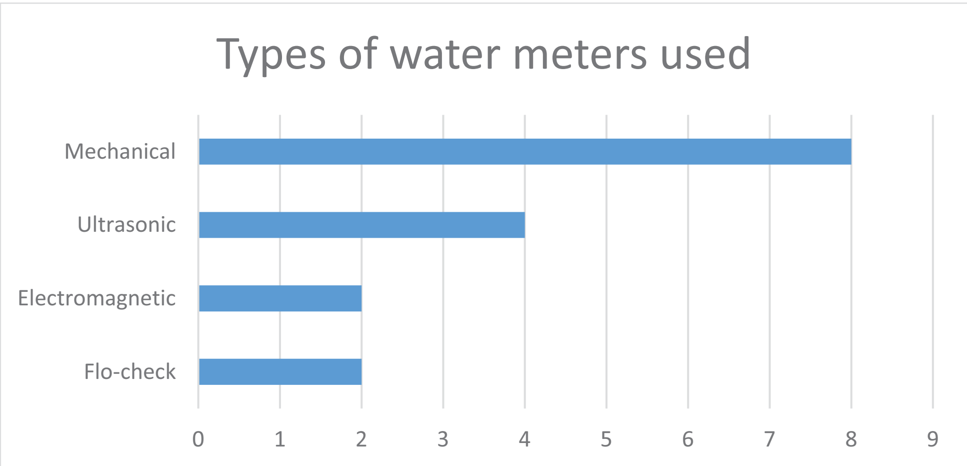



*Figure 16: Types of water meters used*

Mechanical meters are still common but many of the respondents using these meters indicated that they would like to upgrade to electromagnetic or ultrasonic meters due to the unreliability of the mechanical meters as well as the high maintenance requirements.

As in the case of the scheduling tools, the growers in these areas show a significant degree of maturity regarding their knowledge and use of measuring devices. They are mostly well informed about the different devices available, and the advantages and disadvantages.

WUA1 has played an important influencer role with their drive towards implementing metering for better water management. They were also one of the study areas for the WRC projects that resulted in WRC reports TT248/05 and TT550/12 on irrigation water measuring.

### *3.1.2.6 Different interests at stake*

Water management for the WUAs (on-scheme) and the grower (on-farm) are driven by different interests:

1. WUAs are driven by their accountability to members and DWS
2. Growers are driven by business interests – better yield, higher profitability, achieved by greater precision and lower costs. However, growers are also members of WUAs. As such, they share in the WUA's accountability to other members and DWS.

At the abstraction point on the farm edge these interests meet as the figure below depicts.

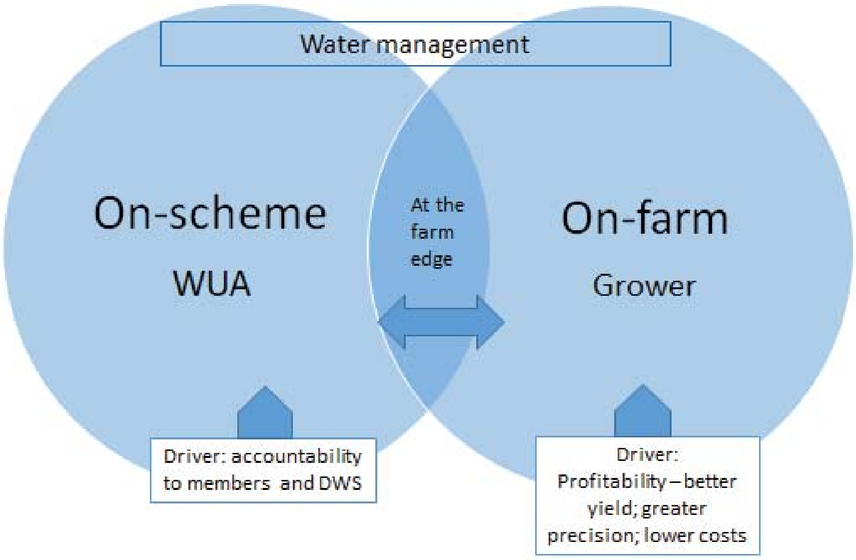



*Figure 17: Different interests meet at the farm edge*

The way the WUA CEO and the irrigator think about water measuring or metering on the farm edge will be essentially different. 'Water use efficiency' at scheme level translates to irrigation efficiency; at farm level it translates to water productivity and irrigation efficiency. One could say that WUAs 'farm' with water; water is their business. Growers don't farm with water; they farm with crops. For them, water is a critical resource.

### *3.1.2.7 The views of growers*

Growers were not equally conscious of the different roles explained above and not all were able to express their views in these terms. The more conscious growers were those who are active in the WUA as Board members.

However, the different interests are reflected in growers' views on measuring and metering irrigation water volume, which is discussed below.

**Managing the risk of water availability and quality**

In their relationship with the WUA, growers manage the risks associated with water as a critical resource - availability and quality. Their views on water metering at the farm edge reflect their risk mitigating strategy.

*Table 11: Views on water metering at the farm edge*

| Arguments in favour of water metering at the farm edge | Concerns about water metering at farm edge |
|---|---|
| • To create an enabling environment: Grower 1 of WUA4 said that they put in meters, because it is important for them to prove that they do not exceed their quota of 15 000m$^3$/ha. In the same line, Grower 5 of WUA4 said that he was installing meters because that is what government wants.<br>• To demonstrate that WUAs work as local resource management organisations.<br>*You cannot monitor water restrictions of river abstractions if you do not have a meter. (CEO, WUA3)*<br>• Mechanism to enforce regulations.<br>*There will always be growers who take chances and use more water than they are entitled to. The only way to address this problem is by installing meters and policing usage of everyone. Rules must be enforced. (WUA2, grower 3)* | • Uncertainty about the impact of water use data on the availability of water: Will there be sufficient buffers for very hot and dry conditions, or will my water allocation be restricted to actual use in favourable conditions? WUA1, which has regulated compulsory metering of abstraction volumes, has attempted to achieve flexibility and a sufficient buffer by prohibiting full planting and allowing temporary water transfers towards the end of the season.<br>• Will there be any incentive for greater efficiency, or will you be penalised for greater efficiency by receiving less water? Will my water allocation be cut if I use less water?<br>*Implementing metering is as a bigger risk than the lack of metering, as water requirements vary from year to year. Having a fixed allocation gives you the flexibility to manage your water within varying requirements on the farm. Unexpected rainfall also increases risk. (WUA2, grower 11)*<br>• Concern that you need more than the licensed amount in hot and dry conditions<br>*We are allowed 11 000m$^3$/ha, but in a dry season you need more than that. (WUA2, grower 5)*<br>• Inconsistency and inefficiency of DWS (as regulator)<br>*While there is no control and leadership from DWS, the* |

| | |
|---|---|
| | *growers will not buy into water meters. There is supposed to be a rule that if you want to plant more hectares, you need to install a meter to show you are still efficient. DWS does not control or enforce this rule. The reports submitted to DWS only land on a desk and are never read. (CEO, WUA2)*<br>• Waiting for guidelines from the Department<br>*We don't have meters yet. We would like to set up meters, but we're waiting for government to make it clear what types would be acceptable or whether they will be prescribing a particular type of meter. We measure our water use by doing a sum for each block. (WUA4, grower 8)* |
| Inhibiting factors:<br>• Lack of CEO and Board support and the absence of regulations, as in WUA4<br>• Lack of early adopters: *I will only install a meter if everyone else installs meters. (WUA2, grower 3)* | |

**Improving water productivity and on-farm irrigation efficiency**

From this perspective, growers put forward arguments in favour of, and against, water metering at the farm edge.

*Table 12: Arguments in favour of, and against, water metering at the farm edge*

| Arguments in favour of water metering at the farm edge | Arguments against water metering at the farm edge |
|---|---|
| • Plant more hectares<br>*At the moment, growers are only allowed to plant according to their allocation based on the crop factor. It is almost impossible to convince the WUA to plant more. If a grower meters his water use and he has some water left at the end of the water year, he might be able to prove that he can manage to plant more hectares than at present. (WUA2, grower 3)*<br>• Expectation that they will only pay for water used | • The lack of clear and demonstrated value to growers<br>*I don't think that meters would add value to my business. At the moment, it is possible to make the sum of how much water is used by using my electricity bill and the amounts of water that were applied. As long as you don't withdraw more and as long as you do not plant more than the crop factor table tells you to plant, there is no need for meters. (WUA2, grower 1)* |

| | |
|---|---|
| *(In our scheme), you pay for your full enlisting. Some people use it all up. In Australia, there is an incentive system where you only pay for what you use. You get a discount, or you can plant more hectares.* He thinks this is a good idea, but to do this, you have to have a water meter that measures accurately. (*WUA3, grower 3)*<br>• Improve planning, possibility to expand, and greater precision.<br>• Enable them to calculate water balance on-farm<br>Grower 4 from WUA4 needs flow meters to see exactly how much water they use to determine the concentration of fertiliser they need to add.<br>Another grower from WUA4, Grower 5, said that meters would show how much water they lose from their dams and how much they use for domestic purposes. | *I measure after the balancing dam where the water goes to each pivot. You only want to measure what you apply. Two sets of meters will be impractical. You want to measure what you irrigate. (WUA2, grower 2)*<br>Another grower of the same WUA feels that he does not need meters because his planning and management are sufficiently sophisticated:<br>*I am continuously driving to be more water and energy effective. I can put up meters, but it will only be a nice to have. If I had a shortage, or a concern that I might go over my allocation, then I would have to put up meters, but that is not the case. (WUA2, grower 4)*<br>• Cost:<br>○ Growers in WUA3 have less resources to invest in technology and other innovations: *Growers with less than 100 ha find it difficult to afford controlled irrigation – both the irrigation system and the cost of electricity.*<br>○ The cost of maintenance and calibration: It is pricey to calibrate the meters regularly. *It costs about R3 000 per meter, for 30 meters it would cost him R90 000 (WUA1, grower 1)*<br>• Lack of hands-on and updated information on which meters are the most practical; affordable; and reliable.<br>• Concern about the correctness of readings and the impact if the meters and data are not managed efficiently: maintenance, calibration, data processing. |

WUA4, Grower 7, captures arguments for, and against, abstraction meters as follows:

> *Meters add value, because we need to do our irrigation per cubic metres, instead of per hour. We are three farms that use the same abstraction point; the water goes to the dam and from there it goes to the three farms and their blocks. We look at the electricity bill and divide it proportionally according to the hectares that each has. It would be more correct to do the division according to cubic metres.*
>
> He has meters after the filters. They add the most value because it shows you the cubic metres that goes to each block as well as if there is a problem with a filter or a pump. He uses ultrasonic meters, installed by Agrico/Gariepbesproeiing. They had mechanical meters previously, but they just give too much problems.
>
> He is not convinced about the value that meters on the canal or the river add. *There are so many variables: when it rains, the water quality becomes sandy, currently algae affect the effectivity of the pump ("jou suigpomp verstop"), all these factors impact on the meter readings. The pump work harder, but it delivers less water.* He is not convinced that meters on the abstraction point from the canal or the river add value to efficient water use.
>
> *I know that it is important for government to know who uses how much water, but at the end of the day you only have so much water per hectare to use. You cannot withdraw more than that. There are guys higher up on the scheme, close to Prieska, who plant and irrigate more hectares than their scheduled hectares. But that should be easy to sort out. Count the hectares and do the sum. You can even do this with Google Earth. You don't need a water meter to sort this out.*
>
> *It does not make sense to force growers to install a water meter at great cost if, for example, that pump only withdraws water for 10 ha. Also, meters have to be read, and the readings have to be processed and it must be supported by a regulating system.*
>
> *Meters at abstraction points only add value if you want to prove that you are using less water per hectare than your allocation and could therefore develop more land.*

#### *3.1.2.8 Suggestions to demonstrate the business value of metering*

Since the above views were recorded, the publication of Government Notice 141 of 2018 made water meters at the farm edge a done deal. At the feedback workshops that were held at the WUAs, it became clear that the discourse around the installation of water meters at the farm edge has changed from Why? to How?

**Given the views of growers outlined above, the installation of water meters at the farm edge will probably have a greater chance of success if the business value of the data could be demonstrated to growers.**

The CEO of WUA1 cited an example. The WUA used the withdrawal data of the Modder River WUA to calculate for growers the water needs of pecans in different stages (0-4 years; 4-10 years; 10 years and older) over a period of five years. (The users said that the South African Procedure for estimating Irrigation Water Requirements (SAPWAT) figures were not reliable.)

Several growers mentioned that methods to measure scheme water use and on-farm water use must serve the scheme management and on-farm production:

> *The WUA should install a meter at the abstraction point of a grower to prove to the rest of the growers that it is a method that works. They must give practical proof that a meter will add value to the farming business.* (WUA3, grower 2)

> *The meter must be fitted with technology to send a simultaneous report to the WUA and the grower. Eskom already uses similar technology. It is fitted to poles and sends information via satellite. It might be worthwhile for Eskom and the WUA to use the same infrastructure for electricity and water management.* (WUA2, grower 3)

Mr Nic Knoetze of SAAFWUA suggested in a similar vein that WUAs should focus on success stories and growers who have increased their profitability by measuring their water use accurately. SAAFWUA asked a successful grower to give a seminar at the 2017 South African National Committee on Irrigation and Drainage (SANCID) symposium. He added that there should be some incentive for growers who measure their water use accurately.

### 3.1.3 From the perspective of intermediaries

#### *3.1.3.1 How would you rate irrigators' water management practices?*

In answer to this question, intermediaries responded as follows:

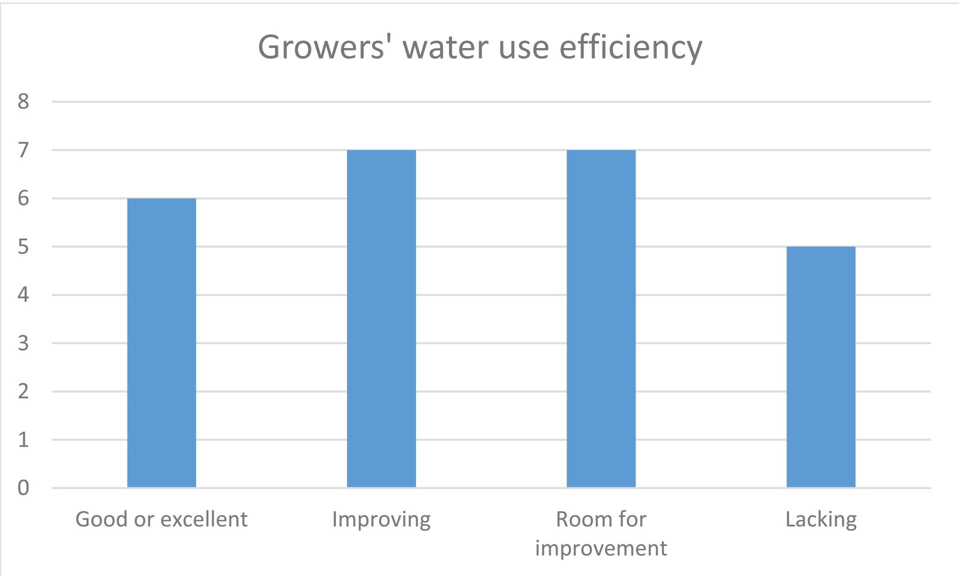



*Figure 18: Intermediaries' perceptions of growers' water use efficiency*

When an intermediary was positive about growers' water management practices or its improvement, but pointed out aspects which could still be improved, they were put in both categories.

The table below summarises the responses[16]:

*Table 13: Intermediaries' perceptions on growers' water management practices*

| Intermediary | Comments on growers' water management practices | | | |
|---|---|---|---|---|
| 1 | Growers are much more efficient than 10 years ago | | | |
| 2 | WUAs are constantly improving controls | Growers: in flood irrigation- there is movement to improve efficiency especially with probes | Controlled irrigation similar movement to use latest tools to become more effective and precise | |
| 3 | A lot of water is wasted along the Orange River | | | |
| 4 | WRC project will give WUAs a more accurate crop factor for citrus | Growers moving toward greater efficiency, WRC project will help | | |
| 5 | Lack of good advisory service on scheduling in WUA4 area | | | |
| 6 | Growers should measure more, especially soil water content | Should be more aware of crop per drop | Critical of way scheduling consultants set probe software up, seldom calibrate | Not sure they are effective with all the tools they have |
| 7 | Growers schedule correctly | But, over-irrigate in early stage of soya | | |
| 8 | Those who use GWK are doing well | Still large area of cotton under flood along lower Orange, opportunities for improvement | | |
| 9 | Improved dramatically over last 3 years possibly because of drought | Oranje Riet and Oranje Vaal are capable WUAs that assist growers to be more efficient | | |
| 10 | Trend to replace flood with drip or micro | Considers growers to be good water managers especially exporters, they measure and keep records | | |
| 11 | Increasing awareness of water use productivity and irrigation efficiency. | A lot of growers converting to drip and micro | | |
| 12 | Water is too cheap and too little pressure to manage it efficiently | | | |
| 13 | Survey found in area from Vanderkloof dam to Prieska 80% apply good water practices | WUA3 is lacking | Estimates about 50% of growers who have probes apply the irrigation recommendations | |

[16] The intermediaries were numbered for anonymity.

| | | | | |
|---|---|---|---|---|
| 14 | They recommend that their clients use some model or equipment for irrigation | The more effectively growers schedule, the better results they get with fertilizers | Trend to use water more productively | Growers are open for it; lack of support from suppliers |
| 15 | Water is managed well along Orange River | WUA4 difficult to monitor return flow, should be improved. Also, a need for automation of canals | | |
| 16 | Not very involved with irrigation but found that nozzle packages negatively affect efficiency | | | |
| 17 | Room for improvements | | | |
| 18 | 75% of commercial growers know how much they use; they measure even if it is not with meters | Does not make financial sense to pump too much water. Electricity is too expensive | | |
| 19 | Some WUAs are doing excellent work | Important to manage precisely because water is scarce resource | 90 members of HTB group are very efficient; they measure and compare efficiency | |

(Two intermediaries did not make a general comment on growers' water management practices and were therefore not added in the table.)

#### *3.1.3.2 The use of water meters*

Six intermediaries commented on the use of volumetric metering to increase water productivity and irrigation efficiency. Their responses echo the growers' and are summarised in the table below:

*Table 14: Intermediaries' perceptions of growers' use of water meters*

| Intermediary 1 | 2 | 11 | 18 | 19 | 20 |
|---|---|---|---|---|---|
| Meters, yes, we want to say with x amount of water we have harvested y amount of tonne. Crop per drop | Under pressure of government to install - WUAs and growers | Good uptake with larger growers, more willing and able to invest in good quality water meters. Small growers using flood cannot afford good quality meters | Commercial growers who measure with meters are more efficient and more profitable | Greater value: Meters on pivots or blocks. GWK calculates per pivot which can be converted to per hectare | Important that the amount applied through irrigation is monitored |

| | | | | | |
|---|---|---|---|---|---|
| Meters on pivots or blocks are needed to do this | Meters are needed for control on river abstraction | | | | Volumetric meters will add more value if they are at distribution to blocks or pivots. But you must calculate total use including losses |
| Growers resist meters because of cost | Use of meters are increasing | | | | Cost is a factor. Growers don't all see the value of meters |
| | On-farm value on pivot and block | | | | |

It was interesting that the intermediaries all said that volumetric meters add more value to precision scheduling if they are on pivots or at distribution pumps to pivots or blocks. On the other hand, as Intermediary 2 said, ''meters are needed for control on river abstraction''. According to the intermediaries, the cost to smaller growers is the main inhibiting factor. They expect the use of volumetric meters to increase, despite the cost, because of the pressure of government and the drive to become more water productive.

### 3.1.4 Extrapolation to other WUAs

Although the actual use of water measuring and metering differs from scheme to scheme, the driving factors and trends found in this study can probably be extrapolated to the commercial irrigators in other schemes. Specifically:

- At scheme level: the driving factors for implementing measuring or metering
- At farm level:
    - the drive to become improve water productivity and irrigation efficiency
    - the trend to use technology to support the above drive
    - the constraints of smaller commercial growers
    - the conflicting interests involved in metering at the farm edge
    - the views and concerns of growers about water meters at the farm edge
    - the need to demonstrate the business value of water meters at the farm edge to growers.

## 3.2 Knowledge sources and knowledge paths

### 3.2.1 WUA management

The table below gives a summary of the knowledge sources that the CEO and Board chairs of WUA1, 2 and 3 use. The management of WUA4 mentioned very few knowledge sources.

*Table 15: Knowledge sources of WUA management*

| Source | WUA1 | WUA2 | WUA3 | WUA4 |
|---|---|---|---|---|
| **Experiential knowledge vs research-based knowledge** | *We developed our own solutions. We were not often in books.* Rely on internal capacity | | They find solutions by observing current practices, analysing the causes and results thereof and finding appropriate and site-specific solutions | Not mentioned |
| **Knowledge networks** | Informal knowledge networks | Informal knowledge networks, e.g. Tokyo Keiki water meter from Jan Raadt (Atlanta Instruments) | Experts | Dries Visser, previously from DWS |
| **Own research** | Internet not always sufficient. Supplement with best practice research: need knowledge of successful practices - study visits to Joburg Water, Tshwane and Kalahari-Oos for SSE telemetry and to Central Breede WUA for FloCheck meters | Internet and internet forums, e.g. Stack overflow | Internet | Not mentioned |
| | Did own research on algae with fish | | | |
| **Other WUAs** | See above | Talk to the more advanced ones, Oranje-Riet, Oranje-Vaal and sometimes Boegoeberg | Talk to colleagues at other WUAs. Oranje-Riet is considered as the leading WUA in area | Talk to Jean from Boegoeberg about due diligence report |
| **Universities** | No contact | Not mentioned | Not mentioned | Not mentioned |
| **WRC** | See success stories | Not mentioned | Not mentioned | Not mentioned |

When questioned about their relationship with DWS and DAFF, WUAs responded as summarised in the table below:

*Table 16: Relationships with DWS and DAFF*

| Source | WUA1 | WUA2 | WUA3 | WUA4 |
|---|---|---|---|---|
| DWS | Regular contact with DWS in Bloemfontein; they pay subsidies; and attend WUA meetings | Engages with official from DWS Bloemfontein regional office. DWS attends about 50% of meetings held at the WUA | DWS occasionally assists with funds for improvements and repairs to the infrastructure | Under scrutiny from DWS |
| DAFF | *We have no contact with DAFF.* | No relationship with DAFF | Good relationship, but DAFF does not provide any funding | No contact with DAFF |

The CEO of WUA1 said that there are 17 emerging growers; of whom 5 are successful growers, in the area of the WUA. The management offered to share cost of an extension officer, but there was no interest from DAFF. *The extension services of DAFF are at this stage non-existent. (CEO, WUA1)*

### 3.2.2 Growers

#### *3.2.2.1 10 most mentioned sources*

The graph below illustrates the 10 most mentioned knowledge sources across the study area:

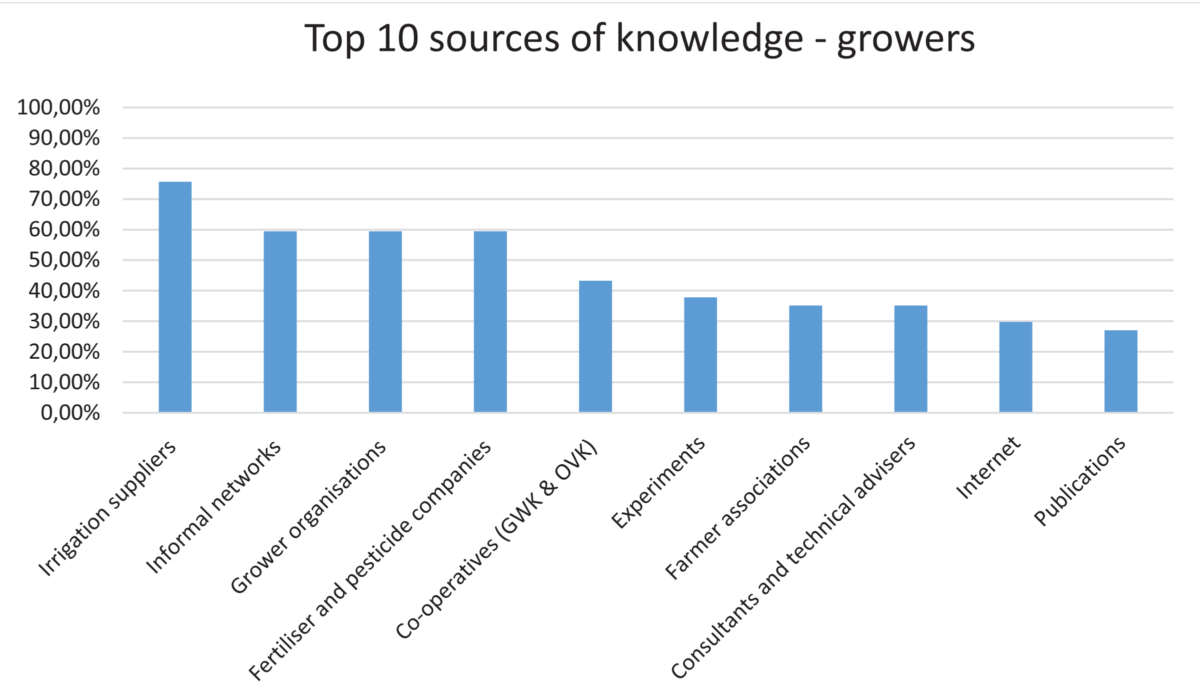



*Figure 19: Top 10 knowledge sources of growers*

The top growers in these areas are information seekers and gatherers. They surround themselves with a network of expertise and experience, they experiment, they evaluate, and they select what works the best for them. They acknowledge that you make mistakes in the process, and then you pay *skoolgeld* (school fees), but they are prepared to learn and improve:

*You surround yourself with knowledgeable people. (WUA1, grower 3)*

*I've gained knowledge by looking, listening and by asking questions. (WUA2, grower 1)*

*My father always said one must steal with your eyes and ears open and that is what I do. (WUA4, grower 8)*

*We are continuously learning. You learn by making mistakes. (WUA2, grower 4)*

Advisers include agricultural cooperatives such as GWK and OVK, and grower organisations like the South African Table Grape Industry (SATI), Dried Fruit Technical Services (DFTS), the Citrus Growers Association (CGA), Vinpro, the Protein Research Foundation, the South African Pecan Nut Producers Association (SAPPA), Orange River Wine Cellars (OWK), and Cotton SA.

These organisations do their own research, often in cooperation with the relevant university departments. They fund the research, inter alia, from members' contributions. Commercial irrigators as members of these organisations contribute therefore to the research.

The leader growers in each area not only contribute to water research; they also participate in experiments for grower organisations, seed or cultivar suppliers or they do their own experiments on, for example, soil enrichment or water retention. Although the experiments are time-consuming, the benefit of getting first access to the results is perceived to make the effort worthwhile.

Grower 4 of WUA2 regards himself part of an international community that shares and exchange knowledge. For example, the day before the interview, he had a visit from Danish people; a British team was expected in two weeks' time.

In WUA1 and WUA2, many growers rely heavily on the 1-stop advisory service of the local cooperatives, GWK and, to a lesser extent, OVK. In addition to GWK's general advisory service, growers in these areas can belong at a fee to, what is called, a group of HTB growers. This group of currently 90 growers get hands-on personal advice and product support on all aspects of their irrigation farming business. (See success stories in section 3.4 below)

*Advisers are essential in the farming business. I rather talk to someone than read about the topic.*

*We cannot really do without them (GWK). (WUA1, grower 7)*

This is evident in the two word-clouds below that depict the relative size of the respective knowledge sources of the growers from WUA1 and WUA2.


*Figure 20: Knowledge sources of the growers of WUA1*

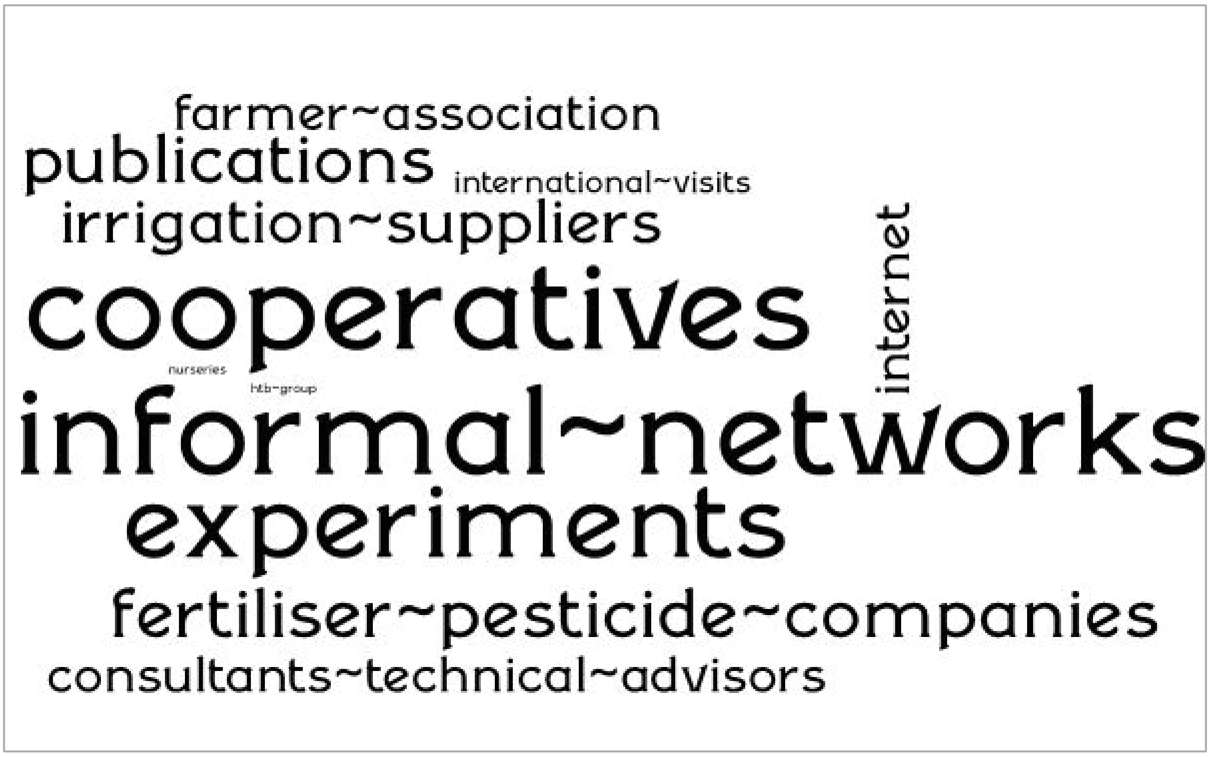



*Figure 21: Knowledge sources of the growers of WUA2*

In WUA3, on the other hand, growers find themselves in a no man's land regarding this type of advisory service. GWK is not particularly active in the area. Kaap Agri, which is active in the area, does not provide a comprehensive advisory service to growers. As a result, growers have less support and have to rely on individual consultants. This is evident in the word-cloud below.


*Figure 22: Knowledge sources of the growers of WUA3*

The word-cloud below reflects the knowledge sources of WUA4.

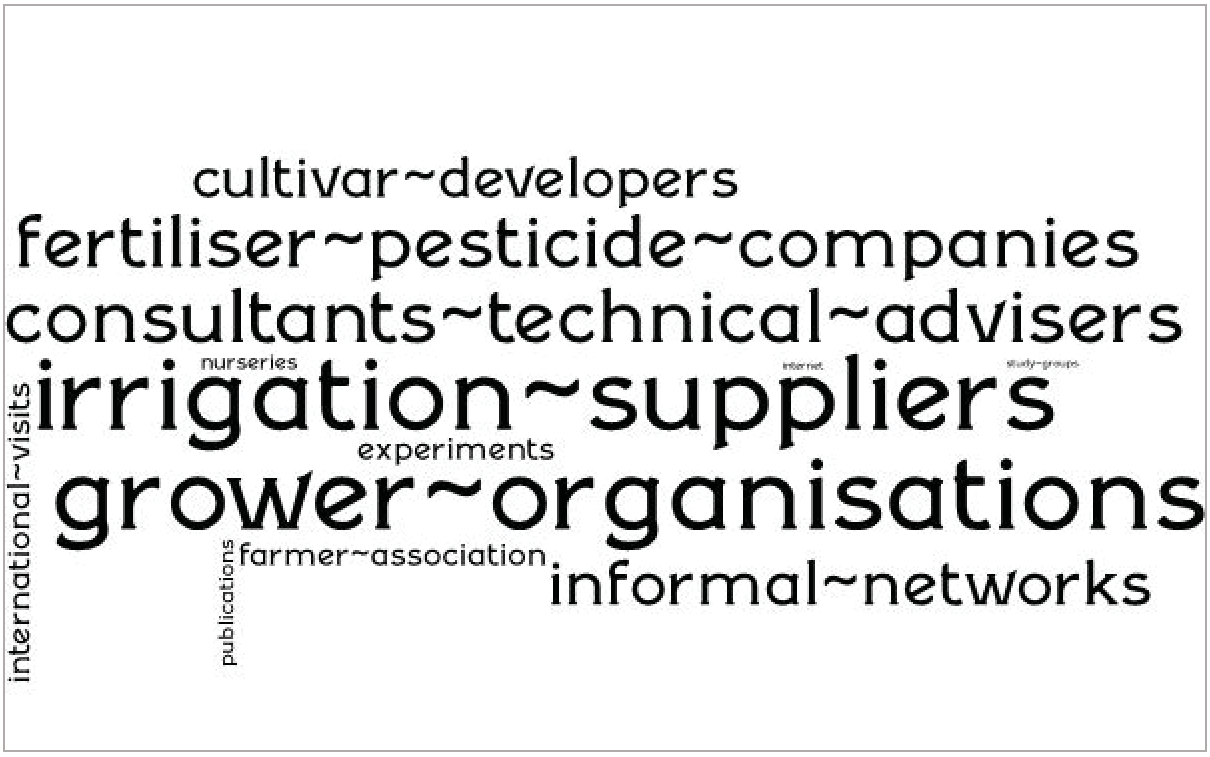



*Figure 23: Knowledge sources of the growers of WUA4*

There is no 1-stop service in WUA4 that compares with GWK. This explains the higher figure of different advisers and consultants in this area. Growers who do not (or who cannot) make use of a 1-stop solution, make use of crop-specific or product-specific experts and advisers. Grower organisations like SATI, SAPPA, DFTS, Vinpro, OWK play an important role to provide growers with information. Two of the growers interviewed in WUA4 have in-house technical advisers.

Growers who export have expanded knowledge networks to include the international community, which they consult for expertise and best practice. Several growers visit leader growers and companies in other countries.

Grower 5 of WUA4 said:

> *We have people across the world whom we ask for advice on different aspects of agriculture. For example, the Alte group in Mexico, group from Chili, Greece, Morocco, across the world.*

Because their operations include the full value chain, the export growers of WUA4 compete directly against each other for shelf space in international markets. For this reason, it is more important for them than growers in the other WUAs to develop, in collaboration with their advisers, their own, unique success recipe. On the other hand, or perhaps for the same reason, they value Frudata as a knowledge source. Frudata did an economic survey in which growers were benchmarked anonymously against their peers.

Growers did not mention their dependency on advisers as a risk. Although the study did not investigate this, there were a few comments from growers without tertiary education that indicated that their dependency on advisers could be a risk.

To summarise the use of other top knowledge sources:

> Fellow growers and informal networks are very important sources of information. Growers talk to each other; they know what their neighbouring growers are doing, and they know whose opinions they value and whose practices they could copy.
>
> For fertilizers and pesticides, growers tend to buy from a variety of suppliers, mostly the cheapest. Many are sceptical of supplier advice; they are concerned that they might be over-applying. They tend to prefer experts for advice.
>
> 14 growers said that they participate in formal experiments with new types of seed or cultivars.
>
> Not all growers are active in farmer associations: some attend meetings regularly; others said they seldom or never go. The same mixed result was found for study groups or WhatsApp groups. Six growers said that they belong to active study groups.
>
> The internet was less frequently mentioned than expected. Growers tend to find the information on the internet overwhelming, and they don't always know how to select information on farming practices. They find the internet more useful for product information. Some growers mentioned specific websites that they return to. For evaluative information and decision-making, they rather use their interpersonal networks mentioned above.
>
> Publications mentioned include the Landbouweekblad, Wynboer, SATI's Technical Bulletin and Statistical Booklet, and the newspaper.

#### *3.2.2.2 Less mentioned sources*

Five growers said that their own experience is an important source of knowledge.

Other knowledge sources that were not widely mentioned or that growers found less useful than expected include WUAs, government departments, research organisations and universities:

> Only one grower, Grower 5 of WUA1, mentioned the WUA as a source of information, in this case it was information sessions on water meters. One grower from WUA2 said that the WUA sent information, but that it was very basic. The WUA does not seem to be a good channel to get research-based knowledge to growers, because there are usually too many water management issues to be communicated. Growers also did not mention SAAFWUA as a knowledge source.
>
> An emerging commercial grower from WUA3 got support from DWS and DAFF in the form of subsidies, tractors, water and land, but most of the technical support and knowhow he needed he got from fellow commercial growers. Only three growers mentioned universities as currently being a source of information.

Commercial irrigators, amongst others, contribute to the research of the Water Research Commission through the water research levy that they pay to DWS. However, awareness of the WRC and its research products was disappointing. **75% of the respondents were not familiar with the WRC or its research products. Not one grower said that they have seen or used the WRC-funded knowledge products on water measuring and metering.**

Growers were unfortunately quite negative about the quality of research in South Africa, as the quotes below illustrates.

> *It is a pity that much of the support that government previously gave to agriculture has fallen away. I believe in capitalism, but capitalism favours the strong. Our previous system in farming assisted weaker farmers with subsidies and loans, services and information. Previously, there were three government agricultural experts in town; today, even in Kimberley, there is not a single government agricultural expert. The same is true about government research organisations. You are on your own. You have to go overseas for your knowhow. (WUA2, grower 4)*

Another grower voiced his scepticism about South African research organisations as follows:

> *The most they have to offer is how to apply new technology in local conditions. Our best researchers have anyway left the country. (WUA4, grower 4)*

The full details on the knowledge sources of growers in each WUA can be found in Appendix A.

### 3.2.3 Intermediaries

The figure below depicts the knowledge sources that the 21 intermediaries who were interviewed mentioned (more than one mention was possible).

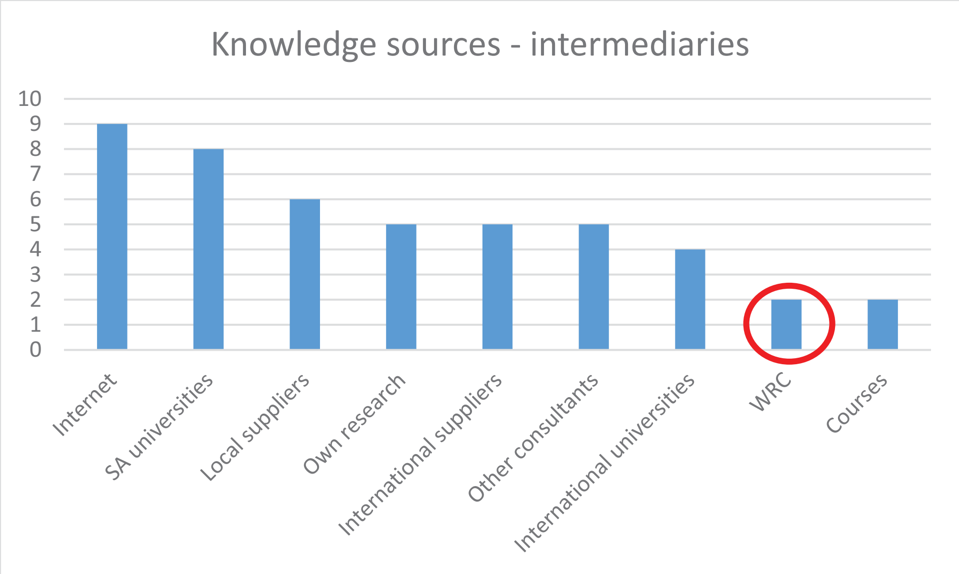



*Figure 24: The knowledge sources of intermediaries*

The distribution shows why it is more likely that these intermediaries have had contact with the WRC and its research than growers.

In contrast with the growers, the internet is the most mentioned knowledge source for intermediaries. One intermediary had the same criticism as some of the growers: he said that information on the internet is not always applicable for South African conditions.

Academic sources, such as publications and personal contact with local and international academic researchers were mentioned by 12 intermediaries. One intermediary was critical of academic sources and said university research is too theoretical.

Two intermediaries use the WRC as a knowledge source. Intermediary 14 said that the Water Wheel gives him a list of new publications and research, and as such, is a valuable source.

Local and international suppliers of irrigation infrastructure are important knowledge sources for these intermediaries. Some intermediaries have their own international knowledge networks that they consult to bring the latest technology to their South African clients, e.g. 'filter banks' – that Agrico brought in or the Spanish technology that Hanno Smit brings in through Rhino Agrivantage, (WUA5, grower 5). Intermediary 19 said that they visit universities, research organisations and major growers, and hold workshops, in countries like Brazil, Australia, Mexico and the United States.

Five intermediaries said that they share information with other consultants. If you add this figure to the 11 who said that local suppliers are a knowledge source, it shows that there are dense knowledge networks among these intermediaries. Many of them know each other personally.

### 3.2.4 Extrapolation to other WUAs

Although there were major differences in knowledge networks between the studied WUAs, the differences could be explained, and it was a matter of more of the one and less of the other. We would therefore expect to find a similar networks of knowledge sources and knowledge paths in other schemes. However, for each type of crop, one can expect in each area a unique set of individual consultants, relevant grower organisations and supplier firms.

The low awareness of, and negative perceptions about, state-funded research organisations were found across WUAs. It is therefore likely to occur in other WUAs as well, unless an individual or individuals from an organisation has built up a reputation as a knowledge source for commercial growers in a specific farming community. We suspect that might be the case with intermediary 20.

## 3.3 COMMUNICATION CHANNELS AND MEDIA

### 3.3.1 Communication channels between the WUA and growers

#### *3.3.1.1 From the perspective of the WUA*

The four WUAs use the following communication channels to communicate with their members.

*Table 17: Communication channels between WUAs and growers*

| WUA1 | WUA2 | WUA3 | WUA4 |
|---|---|---|---|
| Member meetings in all sub-areas. Low attendance if all is well; attendance improves when there are issues. WUA uses meetings as platform to give feedback on operational status of sub-area | Member meetings in all sub-areas | Member meetings in all sub-areas | Member meetings in all sub-areas |
| Management meetings (well attended) | Management meetings | Management meetings | Management meetings |
| Emails for agendas and minutes; bills are sent directly from the WAS<br>SMS and WhatsApp messages.<br>Farm visits | Email and SMS. They also visit members on their farms | Cell phones, and SMS<br>Farm visits | Email (but they must be short to be read) |
| SMS to request water | No system to request water | Paper-based system (cards) to request water | Paper-based system (cards) to request water |
| Website, but never mentioned | No website | No website | In process of building a website (the website has since gone live) |

#### *3.3.1.2 From the perspective of the members*

Members were generally positive about their WUA's communication. Growers from WUA2 were the most vocal about the WUA's communication; growers of WUA4 the least.

*Table 18: Growers' perceptions of WUA's communication*

| | |
|---|---|
| **WUA1** | Growers are satisfied with the communication, they appreciate the personal communication and they find it easy and comfortable to contact the WUA management |
| **WUA2** | The WUA took four years to get everything under control and regulated. Initially it was tough and the untactful manner in which it was done gave rise to a lot of unhappiness. But, the main culprits were identified and with time attitudes changed (grower 2). This grower also feels that information sessions are needed to explain to growers how a WUA works; one cannot assume that they know, hence the misconception that the WUA is DWS.<br><br>Grower 3 said that the WUA representatives should speak directly to growers.<br>Grower 6: Emails work reasonably well. She does not always go to meetings.<br>Grower 7: Believes that SMS and WhatsApp groups work better than emails because you always have your phone with you. The Board is on a WhatApp group; thinks all sub-regions members should also be part of a group.<br>Grower 11: Communication is very important so that all water users know what the rules of water use are and what is expected from them. |

| | |
|---|---|
| **WUA3** | Growers are positive about the improvement in communication. Grower 2 explained that he receives an SMS to keep track of his water use and that he is also on the WUA's WhatsApp group for emerging irrigation growers. |
| **WUA4** | Growers do not have issues with the WUA's communication. Several commented that the WUA sometimes runs the canal dry for maintenance, but that they are informed well in advance and adapt their schedules accordingly.<br>Grower 2 commented that they complain if something is not right; the WUA is responsive. |

### 3.3.2 Grower channels and media

The growers that we interviewed spend their days in their fields and their offices. They all have laptops/desktops and smart phones, which is their primary communication channel. Cell phone reception in WUA1, WUA2 and WUA3 is not very reliable.

In our communication with the growers, the growers were much more responsive to personal messages on WhatsApp and phone calls than to emails. It was clear from the nature of the interactions that these growers value personal relationships; hence the preference for channels that put them in personal contact with their knowledge sources.

Respondents mentioned that they use the following channels to connect to knowledge sources:

- Phones (calls, Apps)
- Formal visits (advisers or fellow growers come to their farms and they visit local and international best practice sites)
- Informal personal interactions
- Meetings and workshops (farmer association, study group in-field meetings, information days)
- Local and international expos
- Email (several mentioned PDF attachments that they receive from advisers and suppliers)
- Printed media (trade magazines and newspaper)
- Google and YouTube
- Specific websites (for example, supplier websites)
- Social media: WhatsApp groups; Facebook group (one grower mentioned the Young pecan growers' Facebook group).

Radio was surprisingly not mentioned. The research team found radio reception of RSG very weak in the area, which is probably the reason. One of the growers said that farmers no longer get up when the cock crows (sic).

## 3.4 Uptake of WRC research - success stories

In each WUA, the research team found at least one success story of WRC research uptake:

### 3.4.1 WUA1

WUA1 has mechanical or electrical (FloCheck) meters at all abstraction points. The decision to install FloCheck meters was made because of the CEO’s involvement in a WRC project. He served on the Reference Group of Mr Francois du Plessis’ study (WRC Report No 1190/1/04) on electric supply measurement. *We took the principle of electrical meters from the WRC project*. The study led to the development of the FloCheck meter.

#### 3.4.2 WUA1 and WUA 2

Many of the growers from WUAs 1 and 2 rely heavily on GWK's knowledge transfer model.

> *I honestly don't think we would have been able to manage our farms without them (GWK). (WUA1, grower 7)*

These growers belong to GWK's HTB group, which was started in 2006. GWK offers them a holistic, 1-stop service, which has integrated several facets of WRC research.

> *We created a mechanism within GWK to serve the growers with precision farming methods. We implement facets of WRC research that I have learnt over the years. (Dup Haarhoff, Head of Agricultural Services)*

The 1-stop service to the HTB growers include:

- Irrigation scheduling;
- Remote sensing and satellite images;
- Soil and water analysis;
- Advice on fertilising and diseases, etc.;
- Comparison of farming activities and production figures of growers in the same area;
- Seasonal discussion on what to plant and how to improve productivity.

#### 3.4.3 WUA3

Mr Alvin Archer is a grower, a consultant and the Director of Research at SAPPA. He is one of the pecan pioneers of the Northern Cape. Archer is involved in a WRC project (WRC project K5/2814//4 titled "Quantifying water use of mature Pecan nut trees and orchards in selected irrigation areas of Northern Cape") on the water use of mature pecans in Vaalharts irrigation scheme and the area between Boegoeberg and Upington.

The research need emerged when GWK held workshops on irrigation scheduling for pecans. At the time, there were many rumours and different opinions about the water needs of pecans.

GWK therefore approached the WRC, and the WRC contacted SAPPA. The WRC and SAPPA have a Memorandum of Agreement and will split the project budget 50-50. The project will be undertaken by the University of Pretoria with Dr Nicky Taylor as project leader.

The project will be completed in 2023 (according to the Terms of Reference found on the WRC website).

#### 3.4.4 WUA4

Mr Teunis Vahrmeijer previously worked for Citrus Research International (CRI) but is now with Villa Crop. CRI funds and distributes citrus research in South Africa. He worked on a WRC project under Dr Sylvester Mpandeli. The final report was published in early 2019 (TT 772/1/18 (Volume 1) and TT 772/2/18 (Volume 2)).

The project investigated the water use of citrus for different cultivars and at different stages of the plant's life. They measured the actual water use of the citrus trees (transpiration). *We looked at the basic principles; for example, if I can measure the WPD of a plant in a particular region, I will know how much water the plant uses. What was new, was that we worked it out for our practices, our circumstances, our cultivars. It was also a long-term study, with very comprehensive data – readings taken every hour for two years. There are very few such comprehensive data sets available.*

Vahrmeijer is very proud of the work that they have done. *It was ground-breaking research.* The research will give WUAs a more accurate 'crop factor' for citrus. The water management based on the crop factor for citrus will therefore be more accurate, but it will also help individual growers with more accurate irrigation scheduling for their citrus trees.

The project team has given through the results of the research on the water use of citrus trees to the relevant organisations and also to consultants, including organisations and consultants along the Orange River through the CRI study groups. The study groups consist of 25 to 30 growers from the same area.

## 3.5 FEEDBACK WORKSHOPS

After the data was analysed, two feedback workshops were held as planned.

### 3.5.1 The structure of the workshops

Several changes were made to the planned workshop structure as a result of the findings of the case study and contextual change.

The findings of the case study indicated that growers' opinions on the methods, application and value of water measuring and metering were too complex and diverse to address in a short workshop activity. On the other hand, the findings indicated wide support for precision farming (even though not practised by all) and highlighted the frontrunner role of leader growers in this regard. The research team therefore decided to include an activity in the workshop programme that would showcase local best practice in water management.

With the regulations of February 2018 coming into effect, the scenario format was no longer appropriate for the workshops. It was decided that a Participatory Action Research methodology will be followed for the workshops. The participatory approach was incorporated into the workshop programme at different levels:

- Leader growers from the researched WUAs participated as presenters in the workshop. They shared with the attendees their own water management practices and gave an opportunity for questions and discussion.
- A farm visit was included in the programme to give the presenters the opportunity to demonstrate practices and answer questions on practical, day-to-day issues.

The revised structure of the workshops and the underlying messages are depicted in the table below:

*Table 19: Structure of the feedback workshops*

| Activity | Underlying message |
|---|---|
| Feedback to irrigators on the results of the study | The WRC values your input and our relationship with you |
| A dialogue on water measuring devices | The WRC provides you with topical and relevant information and we answer your questions |
| A presentation by a leader grower about their water management practices | The WRC values your expertise and recognises your innovativeness |
| An overview of relevant items on the WRC's research agenda | The WRC has listened to your needs and will be developing knowledge products that are relevant for you |

| | |
|---|---|
| Farm visit | Let's go and see some best practice and learn from it |

In Workshop 2, the participatory approach was strengthened by asking the chairperson of the Board of one of the participating WUAs, a grower himself, to facilitate the workshop. This change resulted in significantly more discussion and participation from the floor.

Lessons learnt for the structure of future feedback workshops include the following:

- Involve the target audience in the workshop programme. It creates a sense of ownership and stimulates discussion.
- Involve WUA management in the workshop programme.
- Include practical, hands-on information and experiences, for example demonstrations and a farm visit.
- Consider the practical needs of the target audience. For example, a venue that is central for all participants and a programme schedule that growers can fit into a normal day's activities. The feedback workshops ran from 10:00 until 15:00 (including lunch and farm visit).

### 3.5.2 Marketing the workshops

A personal approach was followed to invite WUA management, growers and intermediaries to the workshop:

- The research team phoned the CEOs of the WUAs, and their secretaries where relevant, to explain the purpose of the workshop and to set a date that would suit them best.
- The phone call was followed up with a personal email and a WhatsApp message that invited the growers who participated in the study to the workshop. The programme was attached to the mail. A few days before the workshop, the growers who did not respond to the email or the WhatsApp message were sent a reminder.
- All the intermediaries who participated in the study received a personal email with an invitation and the workshop programme.
- The WUAs invited their members to the workshop:
    - WUA4 sent emails to all their members.
    - WUA3 sent emails to all their members. Knowledge of the workshop also spread by word-of-mouth. For example, one of the growers invited his friends from Oranjerivier Landbou-unie. The CEO arranged transport to the workshop.
    - WUA1 sent emails and SMSs to all their members. They also sent reminders.
    - WUA2 sent emails to all their members. They also sent reminders.
- The research team also invited water meter suppliers of the area personally to the workshops. The suppliers displayed their products and answered questions.
- A phone call was used to contact the growers who were asked to present at the workshop. The call was followed up by a confirmation email and WhatsApp messages. It is important to remind presenters the day before the workshop – growers are busy people!

The personal approach worked very well and the attendance for both workshops was good: 38 people attended Workshop 1 and 39 Workshop 2.

It is recommended for future feedback workshops that the research team draft an email and WhatsApp/SMS message for WUAs to make sure that the communication is clear and accurately reflects the purpose of the workshop. The use of cell phone calls and WhatsApp messages are also recommended as they offer valuable opportunities to establish relationships.

### 3.5.3 Workshop evaluation

The workshop attendees completed an evaluation form to give their feedback on the workshops. The feedback was enthusiastic and positive; it is summarised below.

The feedback confirmed that the workshop approach was appropriate. It also gave valuable guidelines for the activities and channels suggested in the communication strategy that is discussed in Part 4 of this report.

**Workshop 1:**

The evaluation form was completed by 27 attendees. Twenty-five (25) attendees said that the workshop lived up to their expectations. One attendee said that he wanted more practical solutions, and another said that there seems to be no real advice for canal systems.

The attendees found the following aspects the most useful:

- Different ways of measuring water
- Precision farming
- *The readings that I can get from water meters and the different types of water meters*
- Other growers' success
- How the WRC works
- Research that has already been done and what is being planned. *We struggle to get reliable information*
- The aim and background of the project and the feedback on the work done.

Eleven (11) attendees said that the workshop changed their opinion about something, for example:

- How to use water more efficiently (1)
- Precision farming (2)
- Probes (1)
- To measure is to know (1)
- Soil differences (1)
- Use of technology (2)
- Water measurement (1)
- Water meters (2).

Twenty-five (25) attendees learnt something new, for example:

- Probes
- Precision farming
- How to apply the data that you get from precision farming
- Soil differences
- Water meters. *I got more factual information instead of hearsay*
- Information systems that growers use
- Metering on open canals
- WRC research agenda and funds available.

The attendees gave the following suggestions on how to improve the workshop:

- Send out regular information
- Hold it regularly so that we always know what is on the horizon
- Make it bigger and in more areas to reach more growers
- Research on wastewater treatment, re-use and how much water is wasted
- Information on water policy

- More often
- Send us the electronic versions of the presentations.

**Workshop 2:**

The evaluation form was completed by 24 attendees. All the attendees said that the workshop lived up to their expectations.

The attendees found the following aspects the most useful:

- Different ways of measuring water
- Water meters. *I knew nothing about water meters*
- Nozzles
- Friction tests
- How to increase your yield, efficiency and productivity
- Networking, conversation and feedback of other growers
- The grower presentations
- Useful information and practical application
- Feedback on WRC's work
- *I now know more about the activities of the WRC and what research has been done.*

Sixteen (16) attendees said that the workshop changed their opinion about something, for example:

- How to use water more efficiently (1)
- Precision farming (1)
- To measure is to know (2)
- Water costs money/saving water (2)
- Basis on which decisions are made (1)
- Keep contact with WRC and build relationship (1)
- Water measurement (2)
- Water meters (3)
- Water has to be measured (1).

Twenty-two (22) attendees learnt something new, for example:

- Water meters
- New ways of measurement and nozzles
- Experiences of other water users
- Practical examples and applications
- Understand water measurement better
- Technology needs to be used to drive efficiency
- Water use of pecan nuts.

The attendees gave the following suggestions on how to improve the workshop:

- More often
- Keep the user informed
- More about scheduling
- Marketing can be better
- Adapt to needs
- More frequent communication like today and talks at farmer associations.

The presentations were emailed to all the workshop participants.

# 4 Conclusions of the communication-based assessment

## 4.1 Map of knowledge paths and triggers

The figure below depicts the knowledge system of growers as found in the research. The depiction is loosely based on an interpretation of the dynamics of the agricultural innovation system (AIS) (Inter-American Institute for Cooperation in Agriculture, 2014:13).

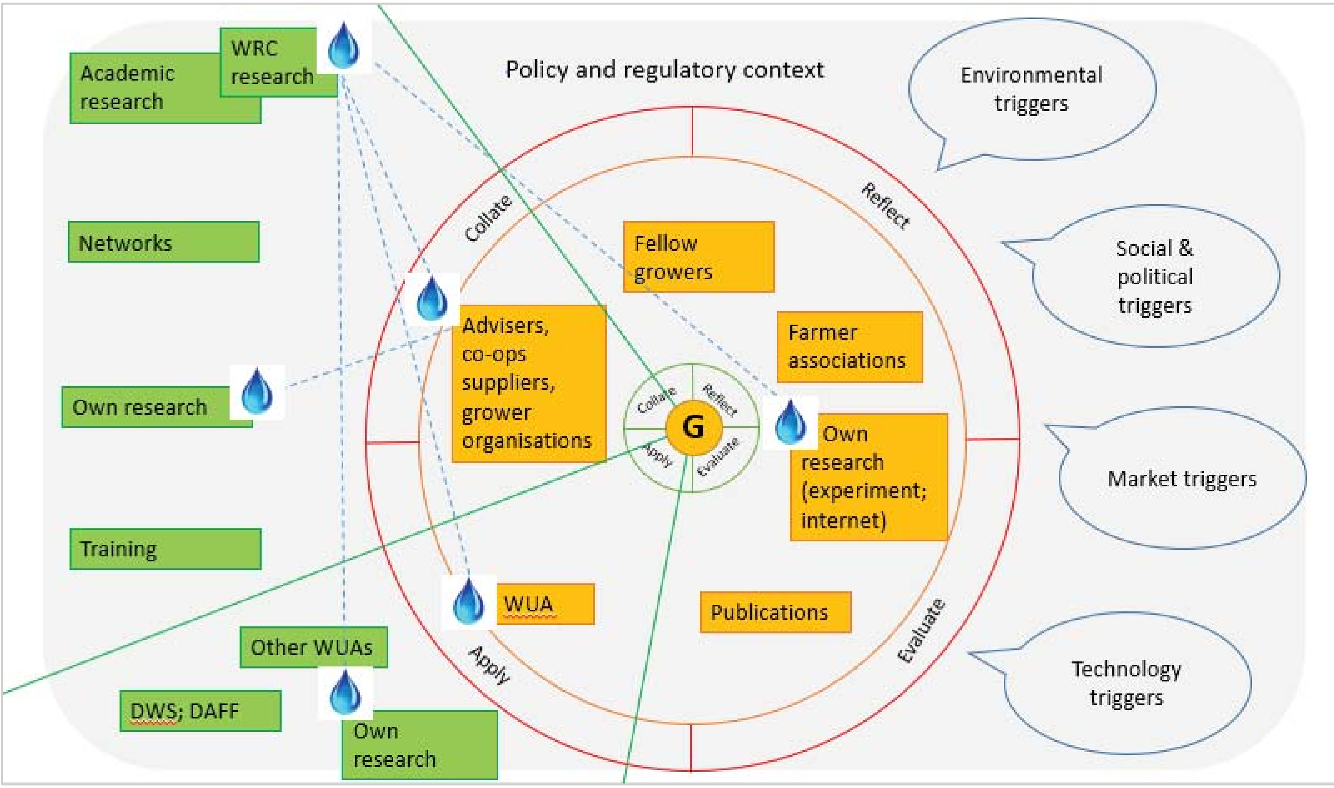



*Figure 25: Growers' knowledge system*

In the decision-making process, individual growers (G in Figure 25) draw on a range of knowledge sources which they collate, reflect on, evaluate, and reject or apply.

Two of these knowledge sources, the intermediary category of irrigation advisers, consultants, product suppliers and grower organisations, and the WUA to which the grower belongs, have been further analysed in this study. The WUAs and intermediaries, in turn, draw from their own knowledge sources, which they collate, reflect on, evaluate and reject or apply, when they inform or advise the grower.

These processes or interactions operate in a policy and regulatory context and are influenced by environmental, socio-political, market and technology triggers.

The figure shows why the research has found low awareness and uptake of WRC research by growers and WUAs, in comparison with the much better awareness and uptake by intermediaries.

The gap between science and decision-makers has been widely discussed in the literature (Knox et al., 2012; Levidow et al., 2014). Growers are decision-makers who need practical and affordable business solutions that they can implement with immediate effect. The intermediaries fill the gap between science and application. For the WUAs as well, practical application value and relevance are key requirements when they source information.

## 4.2 Opportunities to strengthen current pathways and create new pathways

The findings indicate opportunities (marked in Figure 25 as a water drop) for a research organisation like the WRC to leverage knowledge networks by entering into strategic partnerships with growers, grower organisations, cooperatives, universities and water research companies. Srininivasana et. al. (2019) refers to 'a co-innovation approach' in this regard.

Strategic partnerships as depicted in Figure 26 are powerful mechanisms to coordinate water research in agriculture in South Africa. Coordinated research is needed to address sustainable agriculture water use in the face of climate change and the increasing demand on our water resources.

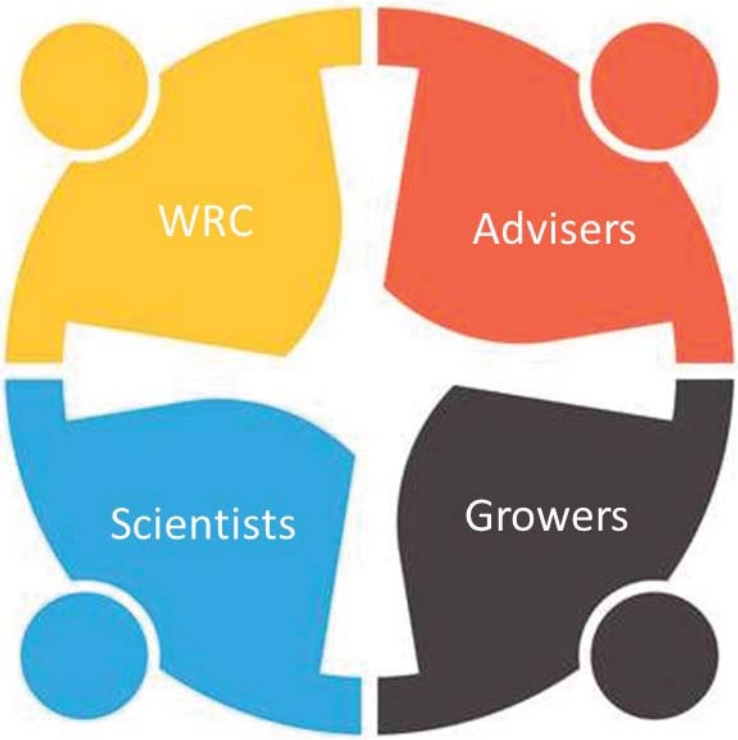



*Figure 26: Strategic partnerships for water research in agriculture*

Such co-innovation partnerships will draw on the strengths of each partner:

1. Grower organisations and cooperatives have close relationships with their members. They have their fingers on the pulse and know and understand knowledge needs as they emerge. Grower organisations and cooperatives have their own grower advisers or work closely with advisers who can interpret and translate research findings into workable solutions. They also have communication networks to keep growers informed on *who* is doing *what* research

*where* to answer questions such as: Who can I contact if I have questions? And when will the results be available?

2. The Water Research Commission has funding capacity and it has the expertise and many years of experience in managing research projects.
3. University departments and private research companies have the scientists and the research expertise.
4. Involving growers as partners in the experiments and tests of water research will contribute to findings and solutions that are practical and applicable in field conditions.

The map of knowledge paths and triggers (Figure 25) also captures opportunities for the WRC to engage with growers, WUAs and intermediaries to improve awareness of the WRC and its knowledge products and to create an enabling environment for uptake.

They are:

- Communication to create and improve awareness of the WRC for growers, WUAs and intermediaries
- Engagement with intermediaries to ensure that
  - they are updated and informed of the latest WRC research that is relevant to their field of expertise
  - the WRC remains in touch with relevant knowledge needs in the field
- Engagement with WUAs to ensure that
  - they are updated on the latest WRC research that is relevant to them
  - the WRC remains in touch with current issues and the relevant knowledge needs of WUAs
- Partnerships with WUAs to assist them with their own research
- Engaging growers to involve them in WRC research projects of which they are the target group. The grower networks found in the study have the potential to spread awareness of the WRC and the knowledge that a grower has gained from involvement in a WRC research project.

Growers and intermediaries were keen to know more about the WRC and to cooperate with the WRC in co-research projects:

- Grower 10 of WUA4 is a large empowerment farm. They said that they are ideally set up for experiments and would like to cooperate with the WRC.
- Grower 9 of WUA2, for example, suggested a partnership between the WRC and GWK, and also between the WRC and the Protein Research Foundation.
- Some of the intermediaries indicated that they are keen to cooperate with the WRC and would like to know more about the WRC's research reports.

## 4.3 THE CASE STUDY AND THE OBJECTIVE OF A COMMUNICATION STRATEGY

The case study on water measuring and metering in commercial irrigated agriculture confirms the criticism against uptake as an objective that was referred to in Part 1 of this report:

- If uptake is the objective of research, it implies that uptake is *per se* in the interest of the target group. This could be constructed as condescending and denying the right of the target audience to decide what their own interest is.

  The report has described the complexity of decisions to measure or meter irrigated water use. Different interests, different methods and different purposes are involved in decision-making processes. Plus, growers, and WUAs, have to make these decisions currently in a perceived uncertain policy environment and an unfavourable economic climate.

- If uptake is the objective of research, it also implies that research organisations can control uptake. Innovation systems theory has shown that research organisations are just one of the players in a complex system. They have no or little control over, for example the policy environment, demand organisations or triggers.

At best, research organisations can aim to create an enabling environment for uptake by establishing effective knowledge paths through which they can engage with the target audience.

Enabling environments take time to establish. Cash et al. (2003) observe in their article that:

> "...building more effective knowledge systems for sustainability takes time and patience. Strategies to promote such systems require a sufficiently long-term perspective that takes account of the generally slow impact of ideas on practice, the need to learn from field experience, and the time scales involved in enhancing human and institutional capital necessary for doing all these things".

The communication strategy which is developed in Part 4 therefore aims to create such an enabling environment to improve awareness, acceptability and application of water metering by irrigation schemes and in commercial irrigated agriculture.

## 4.4 A SUITABLE PARADIGM AND COMMUNICATION MODEL

The research findings indicate that communication framed in a participatory paradigm and a transactional communicational model will have a better chance to reach and be considered by commercial growers.

The conclusion is guided by the following aspects of the knowledge networks of commercial irrigators interviewed in the research:

1. Scientists (researchers), policy advisers and commercial growers have vastly different perspectives on the concept 'water use efficiency'.
2. Commercial growers operate on business principles in a high-risk environment, which is unfamiliar terrain for research organisations and most scientists.
3. Growers are sceptical of state-funded research organisations.
4. Growers demand real-time knowledge for decision-making that is suitable for their unique needs and circumstances.
5. In the digital space, the research-based knowledge produced by the WRC competes with all other available research products. This is an incredibly noisy space to make yourself heard.

## 4.5 KEY PRINCIPLES

The six principles of the WHO framework for effective communication (WHO, 2017) translates as follows for the commercial irrigators from the studied WUAs:

- Accessible
  - Reach them where they search for knowledge and when they do so, in other words, cross their knowledge paths
  - To do this, the WRC must understand the knowledge networks of the target audience and its mechanisms
- Actionable
  - Provide them with practical and useful solutions through their intermediary network
- Credible and trusted
  - Market the WRC brand; focus on credibility
  - Engage leading WUAs, irrigators and intermediaries as research partners
  - Leverage the credibility of partners and their multi-plying power
- Relevant
  - Listen to the target audience to understand their decision-making behaviour and their research needs
- Timely
  - Be sensitive of the right moment
  - Develop mechanisms to be responsive to changes in the policy environment and the effect of triggers
- Understandable
  - Talk the language of the target audience: Commercial irrigators produce and sell crops to make a living. Therefore, an investment in innovation only makes sense if it a) is affordable, b) reduces costs, c) increases yield, or d) decreases risk.

These principles will be applied in the communication strategy set out in Part 4 of this report.

# Part 4: The way forward: A communication strategy

## 1 INTRODUCTION

The objectives of the communication strategy that is discussed in Part 4 were defined in Aim 4 as "to improve awareness, acceptability and application of water metering by irrigation schemes and in commercial irrigated agriculture''.

The impact of contextual factors on the objectives of a communication strategy was clearly illustrated in the course of this project. The objectives captured in the quoted aim got a new significance after the publication of Government Notices 131 of 2017 and 141 of 2018. The discourse on water measuring and metering by irrigation schemes and commercial irrigators shifted from acceptability to the practicalities of application (types, cost, installation, maintenance, risks). In addition, a new application objective emerged, namely the value that real-time volumetric data at withdrawal points could add to irrigation efficiency and on-farm water productivity.

The communication strategy that is set out below has integrated these changes.

In the first section of the communication strategy, the objectives of improving awareness, acceptability and application will be unpacked for the different target audiences in terms of SMART objectives and the current context. The focus of the strategy, target audiences and approaches are then discussed, followed by activities and channels proposed for each objective and target audience. The selection of activities and channels is based on the findings of the study, also taking into account previous communication activities that were not successful. Suitable message frames are also discussed and guidelines for monitoring and evaluation are given. Part 4 concludes with a summary of the strategy and remarks on implementation.

## 2 OBJECTIVES


*Figure 27: SMART objectives (Mefalopulos, 2012)*

Mefalopulos (2008) requires that the overall objective of a communication strategy be translated into SMART objectives (see the figure on the left).

This raises the question: How would one translate the objectives of this communication strategy into SMART objectives, given the findings and conclusions discussed in Parts 1-3 of this report, and the contextual changes and subsequent shift in the discourse mentioned above?

The subsections that follow will do this exercise for each of the three objectives. In subsection 2.4, a new objective that emerged from the research will be added and translated into SMART objectives.

## 2.1 Objective 1: To improve awareness

Interpreting 'improving awareness' in terms of SMART objectives looks like this:

1. What does it mean for irrigation schemes and irrigators to improve their awareness of water metering? Whose awareness of what?
2. Is the improvement in awareness measurable? How?
3. Who must create the awareness?
4. Is it relevant?
5. By when must this awareness be improved?

The communication-based assessment done in Parts 1-3 of this study found four types of awareness that can be improved:

A. The regulator, scheme management and irrigators having a clear and shared understanding of terminology, definitions, and each other's perspectives, interests and intent relating to water measuring and metering. The lack of shared understanding has a negative impact on trust and creates uncertainty on the part of scheme management and irrigators, which is not conducive to successful or sustainable implementation of measuring and metering.
B. WUA members/irrigators' understanding of the differences between their respective roles, responsibilities and interests as members of a local water resource management (WRM)[17] organisation versus being a commercial grower.
C. Scheme management and irrigators' understanding of the technical aspects of the different types of water metering devices, including cost, lifespan, maintenance, accuracy, and appropriateness for specific circumstances.
D. Irrigators and advisers' awareness that volumetric data from the farm edge can be used to improve their water productivity on the farm.

The SMART objectives for each of these types of awareness are summarised in the table below (the proposed activities are described in section 6 of Part 4):

*Table 20: SMART objectives to improve awareness*

| | A | B | C | D |
|---|---|---|---|---|
| **Target group** | Regulator, scheme management, irrigators | WUA members | Scheme management and irrigators | Irrigators and advisers |
| **Objective (purpose)** | Shared understanding | Understand different roles and interests | Understand technical aspects of metering | Understand that withdrawal data can be used to measure and improve water productivity |
| **Measurable? Indicator?** | Yes. A document that captures the shared meaning | Difficult to measure. The number of local WRM organisations that did the proposed activity | Yes. The number of schemes, advisers and irrigators reached through the proposed activities | |

[17] The W&SMP refers to local water resource management institutions (WRMI) as the generic term. This report refers to organisations; hence the term local WRM organisation.

| | A | B | C | D |
|---|---|---|---|---|
| **Assignable?** | Yes. WRC | SAAFWUA<br>Local WRM organisation (WUA) | Yes. Service provider | Yes. Advisers/Intermediaries |
| **Relevant?** | Yes, based on case study findings | | | |
| **How long to achieve?** | 12 months | Once-off activity, but could be repeated annually | 12 months | 12 months |

## 2.2 Objective 2: To improve acceptability

Translating 'improving the acceptability of water metering' in terms of SMART objectives looks like this:

1 What must improve? What does it mean for irrigation schemes and irrigators to accept water metering?
2 Is the improvement in acceptance measurable? How?
3 Who must create the acceptance?
4 Is it relevant?
5 By when must acceptance be improved?

With the publication of Government Notices 131 of 2017 and 141 of 2018 schemes and irrigators became obliged by law to install water metering devices to measure withdrawal volumes.

We propose to define 'acceptance' to mean buying into the value proposition.

1. **At scheme level**, it would mean that the local WRM organisation buys into the value proposition that metering will empower them to account more accurately for their water use to the regulator and their members.
2. **At farm level**, it means that irrigators buy into a dual value proposition: Metering will mitigate the risk of water availability and metered data can be applied on-farm as input data to measure and improve water productivity.

For the irrigators, awareness of the value proposition and accepting its value are closely linked.

The SMART objectives for each group are summarised in the table below (the proposed activities are described in section 6 of Part 4):

*Table 21: SMART objectives to improve acceptance*

| | At scheme level | At farm level |
|---|---|---|
| **Objective (purpose)** | The on-scheme value of metering is accepted | The on-farm value of metering is accepted |
| **Measurable? Indicator?** | Yes.<br>Metering incorporated in scheme regulations | Yes.<br>Growers support and participate in project to integrate withdrawal data into water productivity monitoring and benchmarking |
| **Assignable?** | Yes. | Yes. Advisers/intermediaries |

| | | |
|---|---|---|
| | Management; SAAFWUA in a coordinating role | |
| **Relevant?** | Yes, based on case study findings | |
| **How long to achieve?** | 12 months | 2-5 years as it involves R&D |

## 2.3 Objective 3: To improve application

Interpreting 'improving the application of water metering' in terms of SMART objectives looks like this:

1 What must improve? What does it mean for irrigation schemes and irrigators to apply water metering? For what purpose?
2 Is the improvement in application measurable? How?
3 Who must drive the application?
4 Is it relevant?
5 By when must application be improved?

In terms of Government Notices 131 of 2017 and 141 of 2018, the application of water metering means installing water metering devices to measure withdrawal on-scheme and at the farm edge. But installing meters is rather a useless exercise if the volumetric data is not applied for a specific purpose. The purpose is therefore the true objective.

The SMART objectives for each group are summarised in the table below (the proposed activities are described in section 6 of Part 4):

*Table 22: SMART objectives to improve application*

| | At scheme level | At farm level |
|---|---|---|
| **Objective (purpose)** | Improve accountability to regulator and members | • Mitigate risk of water availability<br>• Improve water productivity |
| **Measurable?**<br>**Indicator** | Yes.<br>Number of meters installed, and data submitted to DWS | Yes.<br>• Compliance<br>• Growers monitor and measure water productivity; use benchmarking results to improve |
| **Assignable?** | Yes. WRM organisation | Yes.<br>Growers<br>Partnership of WRC, advisers and growers |
| **Relevant?** | Yes, based on case study findings | |
| **How long to achieve?** | Regulator's time frame | • Regulator's time frame<br>• 2-5 years as it involves R&D |

## 2.4 Additional objective: To improve awareness and credibility of the WRC

This objective does not feature in the aims of the project; it is added as a response to the findings of the study, which are discussed in this report.

Interpreting 'improving the awareness and credibility of the WRC' in terms of SMART objectives looks like this:

1 What must improve? The target audience's awareness of the WRC and their trust in the credibility of the research-based knowledge that the organisation produces.
2 Is the improvement in awareness and credibility measurable? How?
3 Who must drive the improvement?
4 Is it relevant?
5 By when must awareness and credibility be improved?

The SMART objectives are summarised in the table below (the proposed activities are described in section 6 of Part 4):

*Table 23: SMART objectives to improve awareness and credibility of the WRC*

| Target groups | Irrigators, advisers and local WRM organisations |
|---|---|
| **Objective (purpose)** | Improve awareness and credibility of the WRC |
| **Measurable?**<br>**Indicator?** | No, because there is no baseline. The findings discussed in this report are based on qualitative research. (If a survey is used to establish a baseline, the answer would be 'Yes'.)<br>Workshop evaluations can be tracked, but the participants will differ from workshop to workshop, so results would not be comparable |
| **Assignable?** | Yes. The WRC |
| **Relevant?** | Yes, because lack of credibility undermines trust and, in turn, application |
| **Time-based** | Long-term (more than 5 years) |

# 3 FOCUS OF THE COMMUNICATION STRATEGY

The communication strategy is focused on the case study topic: water measuring and metering by irrigation schemes and commercial irrigation.

Although the communication strategy has a narrow focus, it would also be applicable to other aspects of commercial irrigation and other schemes in South Africa. The wider applicability of the research findings was discussed in the report.

# 4 TARGET AUDIENCES

The primary target audiences of the communication strategy are commercial irrigators, their adviser networks and local WRM organisations (WUAs in the case study).

To facilitate engagement and knowledge flows between the WRC and these target audiences and between the target audiences themselves, a database of Communities of Practice will be useful. For water measuring and metering in commercial irrigation it could be structured as in the table below.

*Table 24: Table of key primary target audience contact groups*

| Target audience contact groups | Details |
|---|---|
| **Management of schemes with large commercial irrigation** | Organisation, position, name and contact details |
| **Leading growers in these areas** | Scheme, name, contact details, speciality |
| **Technical advisers of mega-growers** | Scheme(s), grower, name and contact details, speciality |
| **Farmer association chairs** | Scheme, name and contact details |
| **Meter suppliers** | Company, types of meters that they supply, area in which they operate, name, contact details |
| **Metering experts** | Name, organisation, contact details, area in which they operate |
| **Water productivity experts** | Name, organisation, contact details, area in which they operate |
| **Irrigation efficiency experts** | Name, organisation, contact details, area in which they operate |
| **Cooperatives (coordinator of technical services) and consultants** | Name, type of service, contact details, area in which they operate |
| **Grower organisations (research manager)** | Name, organisation, contact details, area in which they operate |
| **DWS official(s) responsible for implementation of Notices 131 of 2017 and 141 of 2018** | Name, position, contact details, area in which they operate |

The WRC could use the database of this project as a starting point for creating the database of Communities of Practice. Unfortunately, databases are expensive to establish and maintain. See the proposed activities and channels below for suggestions how such a Community of Practice could be established.

# 5 APPROACH

A hybrid communication model is recommended with the approach and activities ranging from collaborative learning/construction of meaning to knowledge dissemination. The figure below depicts the range of approaches within which the proposed communication activities fall.

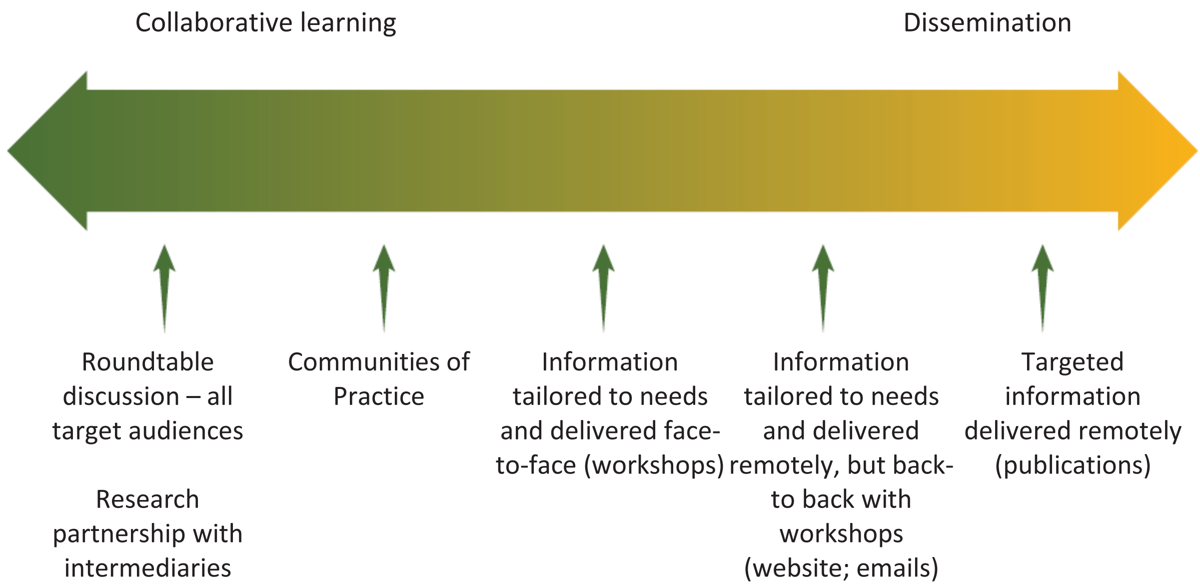



*Figure 28: A range of approaches and activities*

Collaborative learning involves the co-production of knowledge (Roux et al., 2006). Roux et al. (2006) note that this approach "requires a shift from a view of knowledge as a 'thing' that can be transferred to viewing knowledge as a 'process of relating' that involves negotiation of meaning among partners".

The proposed approach and associated communication activities and channels will be linked in the next section to the identified objectives and target audiences.

# 6 PROPOSED ACTIVITIES AND CHANNELS

## 6.1 IMPROVE SHARED UNDERSTANDING

A roundtable discussion forum involving the representatives of DWS, DAFF, scheme management, irrigators and intermediaries and the science community is proposed. The objective of the discussion forum will be to create a clear and shared understanding of terminology, definitions, and each other's perspectives, interests and intent relating to water measuring and metering.

The roundtable discussion format is selected as a mechanism where participants can hear each other's perspectives, build trust relationships and construct shared meaning. Roundtable discussions could be organised at the level of a water management area or at national level, or both.

The table below suggests practicalities to consider:

*Table 25: Objective 1A: Practicalities to consider*

| | |
|---|---|
| **Venue** | Preferably on-scheme or on-farm so that the discussions could include visits or demonstrations |
| **Facilitator and organiser** | Water Research Commission |
| **Outputs** | • A report that captures the shared meaning, distributed to all stakeholders<br>• A press release/conference |
| **Risks** | Participants are unable to achieve common meaning |
| **Sustainability** | Proposed that the roundtable is repeated every year and includes report back on progress on Objectives 1-4 and showcasing best practice |

## 6.2 IMPROVE UNDERSTANDING OF RESPECTIVE ROLES AND INTERESTS

The activity described below aims to make growers aware of the different roles that they play in water management, on-scheme and on-farm; it also addresses the perception found in the research that the WUA is run by DWS.

It is proposed that the activity is first included in the programme of a national SAAFWUA conference. SAAFWUA could make the presentations available to local WRM organisations (WUAs), who could then replicate the activity in one or more of their member meetings and adapt it for their circumstances.

The activity comprises the following:

- A short presentation on the roles and responsibilities of local WRM organisations (WUAs) as set out in the National Water Act (36 of 1998).
- Discussion point: Who is the CEO of a WUA accountable to? To members or to DWS?
- A short presentation based on subsections 3.1.2.6 and 3.1.2.7 of Part 3 of this report.
- The chair sketches three scenarios for discussion or debate. The scenarios outlined below are illustrative only. Each local WRM organisation will have its own relevant scenarios.
    - The WUA asks you to keep the sides of the canal grass-free where it runs past your farm. What is the advantage for the scheme? What is the advantage for you as a grower?

- The WUA asks you to submit a crop plan for the next season. What is the advantage for the scheme? What is the advantage for you as a grower?
- The WUA Board asks you to help to develop regulations for the WUA that will set out the rules for the use of water metering devices at withdrawal points. What is the advantage for the scheme? What is the advantage for you as a grower?

*Table 26: Objective 1B: Practicalities to consider*

| | |
|---|---|
| **Venue** | WUA office |
| **Facilitator and organiser** | WUA Board and management |
| **Outputs** | Two presentations, which could be re-used in subsequent meetings |
| **Risks** | Growers are unable to understand the different roles that they play |
| **Sustainability** | The activity could be repeated as and when relevant |

## 6.3 IMPROVE AWARENESS OF TECHNICAL ASPECTS OF WATER METERING

The following activities and channels are proposed to improve growers' understanding (and that of their advisers) of the technical aspects of water measuring and metering:

- A national roadshow on water measuring and metering at selected schemes, with supplier exhibitions
- Brief guides (hard copy and online) for WUAs, growers, suppliers and advisers. The guides should be based on the WRC's guidelines for water measuring and metering and questions asked at the workshops that were part of this project
- A restructured website (www.watermeter.org.za) with additional features and content like a chat forum, supplier advertisements, short technical video clips, a dashboard of implementation, a blog, news and latest updates and a literature tab with reports, articles, guidelines and presentations.

Both the roadshow and the restructuring of the website should focus on the knowledge needs of commercial irrigators and their advisers, and facilitate dialogue and interaction. Evaluation forms, user testing and Google Analytics can be used to keep track of user needs and satisfaction.

It is proposed that the roadshow and the website operate back-to-back. For example, the attendance register of the roadshow can be used to register growers and intermediaries on the website and create Communities of Practice, either on the website, on email groups or on social media (e.g. Facebook groups or YouTube channels). The attendance lists can also be used to communicate content alerts and news from the website. Questions at the roadshow can be taken up in the blog posts.

It is anticipated that the activities would generate content and stimulate participation that specifically address key questions of commercial irrigators and local WRM organisations as identified in the research, such as:

- Which meter(s) must I/we buy? When must I/we buy it?
- How must I/we deal with water measuring at sluice gates?
- What is best practice for installing each of the different types of meters?
- What value will the volumetric data add to on-scheme and on-farm management?

- How are DWS and the WUA going to use the data? Is the metering going to affect my/our water allocation and payment?
- How must I/we maintain water meters to make sure they are accurate?

*Table 27: Objective 1C: Practicalities to consider*

| | |
|---|---|
| **Funding** | Water Research Commission |
| **Implementation** | Appointed service provider(s) |
| **Outputs** | • A national roadshow and discussions<br>• Brief guides for implementation<br>• A restructured website with new content and mechanisms to engage scheme management, irrigators and advisers |
| **Risks** | • Low traffic on the website<br>• Low attendance of roadshow |
| **Sustainability** | An exit strategy will outline how the proposed actions could be sustained beyond the duration of the project. |

It is expected that the proposed activities will also help to create an enabling environment for Objectives 2 and 3 to improve acceptance and application.

(The activities described in this subsection will be implemented as part of a new WRC project K5 2957//4.)

## 6.4 IMPROVE ON-FARM AWARENESS, ACCEPTABILITY AND APPLICATION

Three findings from the case study research are integrated in the proposed activity and channel:

1. The research found that the growers interviewed do not agree about, or do not understand, the value that metering at the farm edge can add to on-farm water management and water productivity. When they meter water use on-farm, the meter is usually put on pivots (WUA1 and WUA2) or distribution pumps to blocks (WUA4).
2. The analysis of the grower's knowledge sources indicated that the WRC's research-based knowledge has a better chance of reaching growers if it is channelled through intermediaries. This could involve a spectrum of activities and channels, for example:
    a. Formal agreements with grower organisations, e.g. SATI, DFTS, citrus growers, Protein Research Foundation, SAPPA
    b. Collaborative projects, e.g. SAPPA project
    c. Formal agreement with cooperatives like GWK, OVK
    d. Regular, personal contact and relationships with key intermediaries: what do you need and what do we have to offer?
    e. Publishing relevant material in industry publications that the growers and intermediaries of these WUAs read.
3. The HTB project and growers' feedback on Frudata indicated that large growers appreciated opportunities to benchmark their performance.

To stimulate awareness and acceptability, it is proposed that the roadshow discussed above includes the integration of withdrawal data into on-farm water management as a discussion point. A popular article on the topic in, for example, Landbouweekblad, will further stimulate awareness and acceptability.

To improve application, collaboration between the WRC, DWS, SAAFWUA, NB Systems and the relevant scientists is proposed. The outcome of the collaboration would be a project to apply the metered volumetric data from the farm edge in the calculation of water productivity and to develop a benchmarking tool where growers can track and evaluate their own performance and compare it with peers on their smart phones and their computers. The service should also provide a breakdown of the water balance and suggest actions to improve water productivity.

The project could involve an agribusiness such as GWK, which offers a 1-stop advisory service. GWK has the advantage that they have an established network of growers as suitable clients (the HTB group) and they operate in an area where growers already meter their withdrawal at the farm edge.

Once the tool is in full operation, it could be extended to other schemes and other advisory services. This activity could also be strengthened with awarding and showcasing best practice through publications and dialogues, and on the radio.

*Table 28: On-farm awareness, acceptability and application: Practicalities to consider*

| | |
|---|---|
| **Collaboration** | Water Research Commission to initiate and facilitate |
| **Funding** | Water Research Commission |
| **Project implementation** | Appointed service provider(s) |
| **Outputs** | A benchmarking tool for on-farm water productivity that uses the metered withdrawal data collected at the farm edge |
| **Risks** | • Data integrity<br>• Cost<br>• Too much reliance on a single advisory service |
| **Sustainability** | Once developed, an implementing agent will be needed to roll it out to other areas and services. |

## 6.5 Improve on-scheme acceptability and application

The case study found scheme regulations to be a critical success factor for the successful implementation of metering water use at scheme level. These regulations should have been signed by all members and state clear rules and penalties.

The study also found that local WRM organisations seek the advice and assistance from leading peers.

We propose therefore a partnership between the WRC, DWS and SAAFWUA to capacitate and support local WRM organisations with the implementation of Government Notices 131 of 2017 and 141 of 2018. We propose further that leading WUAs be involved.

WUAs will find the following capacity building activities useful:

- Guidelines for implementation with FAQs
- Capacity building: a short course on negotiating strategies to reach consensus on regulations and penalties. WUAs that have already implemented on-scheme metering successfully or an external expert on negotiating strategies could assist with this
- A portfolio of sample regulations
- Capacity building: courses on data management
- Capacity building: calibration courses

- A dashboard of implementation: how do we compare with other WUAs?
- An incentive for compliance, for example an amount for scheme maintenance work.

Ideally, the information should be hosted on the DWS website, but it is difficult to find information on the website and it has lost credibility because browsers identify it as unsafe. Diffusion of information will have to be supported by face-to-face interaction. We propose a special member meeting as channel for dialogues and farmer associations as channel for short courses.

*Table 29: On-scheme acceptability and application: Practicalities to consider*

| | |
|---|---|
| **Funding** | DWS |
| **Implementation** | WRC as facilitating agent |
| **Outputs** | Capacitated WRM organisations (WUAs) |
| **Risks** | • Course quality and relevance<br>• Cost |
| **Sustainability** | As local WRM organisations implement metering, some of these services will become less used. Others, like calibration courses, address a long-term need and will have to be integrated into FETWater curricula and qualifications. |

## 6.6 Improve awareness and credibility of the WRC

The two feedback workshops that the research team conducted proved to be an excellent marketing vehicle to improve commercial irrigators' awareness of the WRC and to build trust relationships.

The format of the feedback workshops (see section 3.5 of Part 3) would be suitable for other WRC research projects in commercial irrigation. It is proposed that all research projects with commercial irrigators as the target audience include similar feedback workshops in their deliverables.

Other proposed activities to increase awareness of the WRC and its research are:

- A public relations strategy that gives the WRC visibility in main stream and social media
- Marking the levy that growers pay towards water research clearly on bills; indicate significance
- Publish annual call for proposals Landbouweekblad and Farmers' Weekly
- Annual interaction with WUA management, for example, an email to each WUA CEO and Board chair about relevant issues and the available research-based knowledge. Include the contact details of the researchers
- Search engine optimisation (SEO) of WRC website. At the time when this report was written, it was still very difficult to find WRC reports on the WRC website if you did not know the TT number or the exact title.

# 7 Message framing

Goodwin et al. (2018) refer to Dolnicar et al. (2010), Dewulf et al. (2009) and Mankad (2012) when they state that the way that people react to information is thought to depend on the way that they process the information, and that, in turn, is affected by message framing. Message framing is defined as "the careful selection of emphasis''.

The literature, for example Knox et al. (2012) and Annandale et al. (2011), has pointed out that communication between scientist and growers fail because they process information from a different perspective.

The following message frames are proposed for communication on water measuring and metering that is aimed at commercial irrigators:

- It is likely that commercial irrigators will be more susceptible to messages about water measuring and metering that are framed in commercial terms that make business sense for a farmer.
- On the other hand, commercial irrigators are also members of local WRM organisations. As members, they share the responsibility of a scarce resource and their accountability to the regulator and each other. Messages for acceptability and application can therefore also be framed to emphasise these roles.
- The commercial irrigators interviewed in this research are independent decision makers who deal every day with huge financial risks that they do not control, such as the weather or market prices. Participatory messages, which encourage dialogue or invite them to participate in decision-making are therefore more likely to appeal to them. In addition, messages that reflect empathy with the risks associated with commercial farming are likely to be well-received.

# 8 GUIDELINES FOR MONITORING AND EVALUATION

There are two types of evaluations of a communication intervention. The one is formative, in other words, the evaluation takes place as the intervention is rolled out to check if implementation is on track and still aligned to the objectives. In development communication, formative evaluations are normally called 'monitoring'. The other type is summative; it occurs at the end of a communication intervention.

Both are based on indicators that have been identified in the defining of objectives. They typically measure the difference in knowledge, awareness, attitude and behaviours between the situation before the intervention and the one after the intervention (Mefalopulos, 2008:135) to establish if the communication has had any impact.

Evaluation methods are quantitative or qualitative, or a combination of the two. Baseline information is often absent, or in a format that makes it impossible to quantify the change that took place.

The indicators of change for each of the proposed interventions and the proposed evaluation instruments are summarised below:

*Table 30: Objective 1 – indicators and evaluation instruments*

| Objective 1: improve awareness | Awareness A | Awareness B | Awareness C | Awareness D |
|---|---|---|---|---|
| **Indicator** | Good participation<br><br>A document that captures the shared meaning | The number of local WRM organisations that did the activity | The number of schemes and irrigators reached through the proposed activities (attendance register) | |
| **Evaluation instruments** | Analyse discussions and document<br><br>Participant evaluations | Feedback from WUAs to SAAFWUA | Participant evaluations | |

*Table 31: Objective 2 – indicators and evaluation instruments*

| Objective 2: improve acceptance | WRM organisation | Irrigators |
|---|---|---|
| **Indicator** | Metering incorporated in scheme regulations | WUA members have signed scheme regulations<br><br>Collaborative project in place<br>Growers and advisers participate in collaborative project |
| **Evaluation instruments** | Calculate % of WUAs with regulations that govern metering | (Same as for WRM organisation)<br><br>Collaboration report<br>Project inception report |

*Table 32: Objective 3 – indicators and evaluation instruments*

| Objective 3: improve application | Local WRM organisation | Irrigators |
|---|---|---|
| **Indicator** | Number of meters installed, and data submitted | • Compliance<br>• Withdrawal data incorporated in tools that monitor and measure water productivity |
| **Evaluation instruments** | Local WRM organisation annual report | DWS dashboard<br><br>Benchmarking results for water productivity is available |

*Table 33: Additional objective – indicators and evaluation instruments*

| **Additional objective: improve awareness and credibility of WRC** | **Irrigators and local WRM organisations** |
|---|---|
| **Indicator** | No, because there is no baseline. The case study findings are based on qualitative research. (If a survey is used to establish a baseline, the answer would be 'Yes'.) |
| **Evaluation instruments** | Workshop participant evaluations<br>Grower surveys |

# 9 SUMMARY

The proposed communication strategy is summarised in the table on the next two pages.

*Table 34: Summary of communication strategy*

| Objective | What does it mean for whom? | Communication activities to make it happen | How do you measure success? |
|---|---|---|---|
| Improve awareness | **Regulator, WUAs, growers:**<br>Have a shared understanding of terminology; respective roles; goals; concerns | Roundtable discussion forum at WMA and national level (annually) | Good participation<br>Report that captures shared meaning<br>Press release<br>Conference |
| | **WUA members/growers:**<br>Understand differences between their on-scheme and on-farm roles & responsibilities | WUA activity:<br>Two short presentations<br>Scenario discussion | The majority of WUAs have done the activity |
| | **Growers:**<br>Understand technical aspects of metering devices | National roadshow<br>Brief guides for implementation<br>Content and mechanisms on website to establish Communities of Practice | Good roadshow attendance<br>Google analytics of the website indicate traffic and lively participation in website and social media activities |
| | **Growers:**<br>Understand value of using withdrawal data in on-farm water management | Include as a discussion point in roadshow<br>Feature on website<br>Popular article in Landbouweekblad | Good roadshow attendance |
| Improve acceptability | **WUAs:**<br>WUAs have incorporated measuring and metering in scheme regulations | Partnership between WRC, DWS and SAAFWUA to capacitate and support WUAs to implement GN 131 & 141<br>• Guidelines for implementation<br>• Portfolio of sample regulations | Scheme regulations of WUAs include measuring and metering withdrawal |
| | **Growers:**<br>Interact and exchange knowledge on challenges and best practice of measuring and metering | National roadshow<br>Website and associated activities | Good participation at roadshow<br>Google analytics of the website indicate traffic and lively participation in website and social media activities |
| | **Growers:**<br>Support and participate in project to integrate withdrawal data into water productivity monitoring and benchmarking | Collaborative project between WRC and partners to develop a benchmarking tool for water productivity that uses metered withdrawal data | Collaborative project in place<br>Growers participate in collaborative project |

| Objective | | What does it mean for whom? | Communication activities to make it happen | How do you measure success? |
|---|---|---|---|---|
| Improve application | → | **WUAs:**<br>Metering devices are installed at withdrawal points and data submitted to regulator | Support activities from partnership:<br>• Course on data management<br>• Calibration courses<br>• Dashboard of scheme implementation<br>• Showcasing best practice<br>• Incentive for compliance | Statistics in WUA annual report |
| | → | **Growers:**<br>Comply with GNs 131 and 141<br><br>Monitor and benchmark water productivity on-farm | Dashboard of implementation<br><br>Withdrawal data is used in the measuring and monitoring of water productivity<br><br>Publication of benchmarking results | Dashboard of implementation; DWS reports<br><br>Growers benchmark their water productivity |
| Improve awareness and credibility of WRC research | → | **Growers, advisers, local WRM organisations (WUAs):**<br>Know who and what the WRC is; they regard the WRC as a credible source of knowledge | Feedback workshops that involve the target groups<br>Other:<br>• PR<br>• Clearly mark water research levy on bills; indicate significance<br>• Annual call for proposals in Landbouweekblad/ Farmers Weekly<br>• Annual interaction with WUA management<br>• Search optimisation of WRC website | Workshop evaluations<br><br>Grower surveys |

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# 10 TOWARDS IMPLEMENTATION

The success of a communication strategy to achieve its objectives is determined by a range of factors, of which not all are controllable. Changes in the political, regulatory, economic or technological context can have a profound effect on objectives and the relevance and appropriateness of channels, activities and message framing aimed at a target audience.

For this reason, the implementation of a communication strategy should be sensitive to contextual changes and it should have a clear monitoring and evaluation strategy so that the communication strategy can be revised and improved as necessary. Some communication endeavours will be more successful to reach a target audience than others and there is no point in continuing with activities that do not achieve their objectives. The timing of a communication activity is also critical for success and implementation must be sensitive to the right moment.

It is recommended therefore that the proposed communication strategy, summarised above, is implemented bearing these remarks in mind.

The case study and the communication strategy affirm the important role that the WRC has to play as a bridging organisation between all stakeholders in the agriculture sector to create an enabling environment for sustainable food and water security in South Africa.

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# Appendix A: Details of knowledge sources

## 1 WUA1

### General

Three growers actively take part in the activities of their farmer associations. Grower 3 said the chairperson of his farmer association, Andre Coetzee, is also an irrigator and he arranges with different people to address them on current issues. Grower 7 and 8 both said that they are not very active because it is easier to find information somewhere else.

Six growers identified GWK as an important source of knowledge:

- Grower 2 visits information days arranged by GWK twice a year.
- Grower 3 is a director of GWK and has travelled to New Zealand. There he first saw variable rate irrigation.
- Growers 4, 5, 7 and 8 get a lot of support from the advisers of GWK.

Five growers are part of GWK's HTB group*. GWK makes suggestions of what I should plant (grower 4). I learn about new cultivars and also see what works for others (grower 2). I am spoilt by GWK that brings the information to me (grower 8).*

Grower 1 said that the younger farmers have a study group. Grower 2 is part of an informal group of growers who exchange information and advice. Grower 4 is part of a group called Douglas Jongboere. They share knowledge about diseases, theft and safety issues.

Three growers identified their fellow growers, family and friends as sources of information. *You have to surround yourself with knowledgeable people (grower 3)*. *My wife supports me all the way (grower 5).*

Grower 2 and 8 said they use the internet as a source of information. Grower 8 visits suppliers' websites and uses search words on Google.

### Irrigation

Grower 2 and 7 use the agents from Valley to get information on irrigation. Grower 7 also uses Agrico. Grower 3 mentioned that agents of Valley (Cobus Myburgh in particular) spoke to them about pumps and irrigation at one of the farmer association meetings.

Agrico provides Grower 5 with after-sales service for the pivots and VSDs that he bought from them.

The consultants of IrriCheck give Grower 6 advice on probes and scheduling. The consultants from Hartswater visit the farm every two weeks to give advice on his pecans.

### Water meters

Grower 3 was advised by Hennie Posthumus to install electromagnetic meters on one of his farms. Grower 5 heard about FloCheck meters at information meetings that were arranged by the WUA.

### Land preparation

Grower 2 does his own experiments with tilling methods.

### Seed and cultivars

Grower 2 does 50-60 experiments for seed companies, such as Ayers and Hydrotec, on various cultivars of onions per year. He specifically wants to see what the results are on his own farm. What works for someone else might not work for him.

Grower 3 contacts GWK if he needs information on seed. They do experiments on various farms in the district and advise him on what would be suitable for the conditions on his farm.

Grower 7 relies on GWK for advice on which seeds to buy. *I don't ask the seed guys for advice. The independent consultants like GWK give much better information.*

### Crops

Grower 1 mentioned that the consultant, Frank Lawrence, GWK and Agrico give good advice on cotton.

Pecans have become a popular crop to plant. The growers use different sources to get information on pecans:

Grower 1 gets information on pecans from the following sources:
- Harry Whelm, his supplier
- SA Pecans
- Leading growers such as Alfonso Visser from Hartswater and other growers in the area
- Bester Fruit and Nuts. They organised a visit to the major pecan producers in the United States.

Grower 3 got advice from his cousin and a nursery in Douglas when he wanted to plant pecans.

Grower 6 is a member of SAPPA. Research done in the United States were shared at a symposium arranged by SAPPA. He also attends SAPPA's annual meeting at Hartbeespoortdam where they discuss topics such as new cultivars and marketing. He also did an online course conducted by professors in the United States. He is a member of the Facebook-group called "Pekanneutboere SA".

### Fertilizer

Grower 3 buys fertilizer from Omnia. Once a week the rep visits him to inspect his crop. Grower 4 relies on GWK and agents of fertilizer for advice. He is involved in experiments that are being done by various fertilizer firms. Grower 6, on the other hand, does not consider sales agents to be valuable sources of knowledge. *They only want to sell their products.* He also does his own experiments on organic versus chemical fertilizers.

### Pesticides

Grower 4 trusts the advice of agents.

The agent that advises Grower 5 on pesticides visits him regularly on the farm.

Growers 4 and 6 are familiar with research done by the University of the Free State on insects and fungus. Grower 6 told the research team about the research that the University of the Free State was doing, in collaboration with a German firm, Agraforum. They do research on diseases that potatoes can get.

### Labour issues

Grower 3 is a member of CESA who advises him on all labour-related issues.

# 2 WUA2

### General

Four growers are actively involved with the farmer associations in their area. Grower 1 is not active because he thinks the themes that they present are not relevant and he does not have the time to attend the meetings. Grower 6 said: *We don't make time to go.* Grower 8 would rather attend the growers' days of John Deere, Grundfus and KSB pumps.

Eight growers said that their fellow farmers, family and friends are sources of knowledge. *I phone my father first (grower 8)*. The CEO of WUA2 mentioned that Grower 5 is a source of knowledge for fellow growers.

The growers read the Landbouweekblad (three growers), Graan SA (one grower), Irrigation Agri (one grower), publications of the co-ops and Kleingraan-sentrum (one grower), and instruction manuals (one grower).

Three growers identified the internet as a source of knowledge. Grower 5 said that suppliers refer him to relevant websites. Grower 6 and 8 use search words and ask specific questions on Google.

Grower 1 and 4 said that they learn by looking, listening and asking questions. *We are continuously learning. You learn by making mistakes (grower 4).*

Grower 2 said that suppliers play an important role to spread information and knowledge.

Four growers said GWK is a source of knowledge. Grower 6, for example, relies heavily on their advisory services. *They are very good.* Grower 9 and 11 is part of GWK's HTB group.

Grower 4, 7 and 11 have visited leader growers and companies in other countries. Grower 4 has become part of an international community that shares and exchange knowledge. He gets a lot of international visitors on his farm.

### Irrigation

The growers use the following knowledge sources for irrigation scheduling:

- GWK (grower 1, 6, 8, 9 and 10)
- OVK (grower 3, 6 and 7)
- Sales agent from Irritech in Kimberley (grower 3)
- Bertus van der Westhuizen (IrriCheck) (grower 4, 7 and 10)
- Johan Malan (grower 4)
- Joe Coetzee (Agrico) (grower 7)
- Precision (from the United States) (grower 5).

### Land preparation

Grower 1 said that he compares different methods of land preparation to the results in the area. According to him, there is no evidence that the no-till method is better.

### Seed and cultivars

Seven growers take part in experiments for various seed companies, including Monsanto (United States), Zanger (United States) and Nataïs (France).

Grower 10 buys wheat seeds from GWK. He finds their advice more trustworthy than those of the seed companies themselves.

### Crops

Grower 9 is involved in a research project run by the Protein Research Foundation. All growers who produce soy beans, pay a levy to this Foundation. Agronomists from the Foundation visit his farm every two weeks to check on the crop that he planted for them.

One grower mentioned that he is a member of Grain SA, but he does not feel that he gets much value from them.

The growers get information on pecans from different sources:

- A friend who farms with pecans near Modder Rivier (grower 3)
- The owner of a nursery in Orania (grower 3)
- Pecan expert from Vaalharts (grower 6)
- The internet (grower 9)
- Gideon van Zyl from Hartswater (grower 9)
- Textbooks from the United States (grower 9).

### Fertilizer

Grower 1 and 10 said that they are not bound to a supplier and will buy the cheapest fertilizer.

Grower 7 uses fertilizer from Omnia. They also do bio and soil analyses. *Omnia is excellent. They use top of the range technology.*

Grower 8 uses different suppliers (Profert, CP, Vitas, etc.), but he uses the knowhow of GWK to do the soil and leaf analysis.

Grower 3 takes part in experiments for fertiliser companies. He does not like it much, but the information that he gets, makes the effort worthwhile.

### Pesticides

Four growers mentioned Louis Olivier (Nulandis) as a knowledge source for pesticides. GWK and Johan de Lange were also mentioned.

# 3 WUA3

### General

Four growers said their fellow farmers and family are a source of knowledge:

- Grower 2 gets help from larger, commercial growers such as Johan Marshall and Johannes Fourie.
- The first grower that Grower 5 worked for helped him to get off his feet.
- Grower 7 phones his contacts, for example Chris Malan.
- Grower 3's father is the chairperson of DFTS's board and often visits growers in other countries such as the United States.

Grower 5 identified the government as a source of knowledge and help. As a young black grower, he used local politicians as an entry point. His extension officer at DAFF, Boitumelo Thukubi, helped with land, water and machinery. He also said that Lebogang Lekatsani from Rural Development helped him.

Two growers said that they take part in the activities of the farmer associations. They have a topic and a speaker (often from a supplier). The topics are usually about machinery and chemicals.

Growers 3 and 6 have tried to get study groups off the ground, but people don't seem to be interested. Grower 2 said that all the emerging growers are on a WhatsApp group, but they have more problems than solutions.

Grower 7 is a director at SAPPA. He said that industry organisations disseminate the progress and research results to their members via email, quarterly magazine, and presentations at annual meetings. Grower 3 said they take part in industry organisations by making themselves available for management structures. *We listen.*

Grower 8 said that GWK is not active in their area. There is no other institution that delivers a similar service. Grower 6 feels that they are lagging behind in terms of the type of service that GWK offers in the Prieska area: *guys who specialise in probes, weather stations and integrating it with ET and the crop factor*.

Three growers said they use the internet as a source of information. *I search on the internet for new ideas (grower 5).* Grower 3 uses the internet for information on equipment and machinery; not really for irrigation methods. Grower 6 uses Google Earth, and DWS's website for flood information. *I give it through to the other growers.*

### Irrigation

Grower 2 uses Agrico from Upington for advice on micro irrigation.

The local agent of DFM, Andre Jordaan (Agrijor) helps Grower 3 with his irrigation.

Grower 8 said DAFF advised him on the incline for his flood irrigation. They gave tables, but these were incorrect. Someone else, another grower, advised him to go flatter. He experimented with different inclines until he found the optimal incline. He uses Agrico for his drippers.

Grower 4 said that she does not really use technical advice for her scheduling.

### Soil

The fertiliser agents and the agent from DFM help Grower 6 with the improvement of the soil. He also finds information on new products to improve the soil and counter salt build-up in SATI publications. The grower showed the research team an article written by Erik Adriaanse of Sasol as an example.

### Seed and cultivars

Grower 3 does his own experiments on cultivars to determine what works in their climate.

### Crops

Grower 4 gets information on cotton from Nico Swart at GWK. GWK also sends her the Cotton Board's booklet, Cotton, and Communique.

The growers get information on pecans from the following sources:

- DWS (assisted grower 1 with the water needs of pecans)
- Other growers:
  - Johan Coetzee (grower 1 and 8)
  - Andre Coetzee (grower 1 and 5)
  - Johann Marshall (grower 3)
  - Heinrich Weidemann (grower 3)
  - Alvin Archer (growers 5 and 8)
- Atlantic Organic (grower 3)

- SAPPA (grower 5)
- American research on irrigation and water needs (grower 7).

Five growers use Orange River Wine Cellars' advisory services for wine grapes. Grower 1 and 4 specifically mentioned that Henning Burger helps them with cultivars.

The growers identified the following sources of knowledge for raisins:

- Other growers (grower 1)
- DFTS (grower 3, 4 and 8). *They come through and give us information on cultivars*, present findings at the farmer association meetings; send newsletters with email (grower 4). Grower 8 mentioned that their services have deteriorated.
- Carpe Diem (grower 3).

Grower 6 uses the experts of JW Seed for advice on vegetable seed.

### Fertilizer

Grower 3 has a long-standing relationship with Omnia for his fertilizer programme. He believes in sticking to one supplier. Grower 6 switched from Omnia to Nexus. *They organise information sessions.* Grower 5 said his extension officer has organised courses on fertilizers.

### Pesticides

Stefan Jordaan gives Grower 3 advice on pesticides. Grower 5 said his extension officer organised courses on pesticides.

# 4 WUA4

### General

The large growers of WUA4 surround themselves with a network of experts on irrigation infrastructure, cultivars, equipment, fertilisation, pesticides, soil preparation and management, etc. The expertise comes from industry organisations and suppliers who access the latest research and technology from all over the world; some do research and local experiments to ensure applicability to local circumstances. The expertise network interprets and translates the information in a format that is directly applicable to the grower.

Eight growers are large commercial irrigators and also exporters. Each of these growers has their own expert or advice model. Growers 1 and 5, for example, have their own technical team who does their own desktop research to advise the business. Grower 9's personal network of advisers includes Klaus Orth and Chris Ferrande, who was previously with Frudata. The agronomist, Hanno Smit, advises Grower 5 on precision farming. He works for Rhino Agrivantage and has links with Spaniards.

As these growers also compete with each other, they have an interest in comparative information and longitudinal data:

> *The Chileans publish every year a book with all the stats of the major growers. It is not anonymous – it includes planning, yield, spraying programme, exports and markets. It would be useful to have a similar publication in SA, but it will have to be driven by the private sector although they could use information that government makes available, such as PPECB (Perishable Produce Export Control Board). It will have to address the full value chain. (WUA4, grower 7)*

Grower 9 of WUA4 said that they like to compare themselves with the other growers in his area, and they find the data analysis of Frudata good value for money. Vinpro does a similar comparative study for wine grapes.

*Vinpro does a national study across all wine producing regions, which gives us cost analyses, for example, production cost*. (WUA4, grower 7)

Grower 10 is a large empowerment business. Both managers believe strongly in practical experience.

Five growers identified their fellow growers and friends as a source of information:

- Grower 1 said that they have contact with other mega growers in the country.
- Grower 2 is part of an informal group of seed growers.
- Grower 3 believes strongly that one should not try to re-invent the wheel. His motto is to check out what others do and follow the best practices. *We talk to each other – it is a small world.*
- Grower 4 talks to other growers. *There are very competent people here. Sometimes I am surprised that farmers near the cities know less than we do.*
- Grower 8 said that his father always said he must steal with eyes and ears, and that is exactly what he does. He also has a knowledge network of friends in the Western Cape.

Grower 6 and 10 are part of study groups. The two managers representing Grower 10 said they are part of a 15-member study group that meets once a week. They go into the orchards, dig holes, classify the soil, look at berry sizes and inspect and discuss it.

Four growers said they participate in the activities of the farmer associations. Grower 10 said that the information they get from the farmer association is not very useful for farming practices as they focus more on policy issues.

Grower 1, 4, 7 and 8 have visited other countries. Grower 1 travels across the world (Spain, Peru, Australia, Israel, Brazil, etc.) to source new technologies, innovative practices and to look for new cultivars. Grower 7 visits countries that produce table grapes to scout for new cultivars and other innovations, such as South America, Spain, Italy, India, China, and California in the United States. California is also very focused on mechanisation. Grower 8 said they visit countries like Australia (for mechanisation) and Chili and Italy (for cultivars and practices) every year.

The growers read the following:

- Landbouweekblad and Die Burger (grower 4). He also watches the news on TV.
- Wynboer, SATI's Technical Bulletin and Statistical Booklet, and Landbouweekblad (grower 7)
- Farm Biz, Wineland, ProAgri, and literature from Orpa (Orange River Producer Alliance), and SAPPA (grower 8).

Two growers identified the internet as a source of information.

Irrigation

Eight growers said that they use Agrico (the consultant is Rudi Horn) for advice on their irrigation systems. Grower 7 also gets information on scheduling and the water needs of table grapes from them.

Two growers mentioned Gariepbesproeiing (the consultants are Bennie Oppel and Bernie Jonker).

Grower 10 uses IrriCheck for their probes.

Grower 1 said that the consultant, Philip Myburgh, helps him with irrigation scheduling.

### Water meters

Grower 3 said that if he has to install meters, Agrico will find the most appropriate meters and will install them.

### Soil

Grower 3 uses Nem Consult through Intelligro to help him with a biological approach to soil management.

Grower 5 uses SGS for their soil analysis and mapping. They previously used Omnia.

Grower 7 uses an independent lab in the United States for his soil management. He is trying to go biological.

Grower 8 said that they use Omnia and Bemlab for their soil analyses. The results have a major impact on their irrigation scheduling.

### Seed and cultivars

Four growers said they do their own experiments with new cultivars. Grower 1 said that the experiments give them a one-year advantage until the other growers have caught up. Four growers stated that they don't do experiments and would rather wait until they have seen proven results from other growers. *I let other people make the mistakes. (grower 3).*

Grower 4 does experiments and tests cultivars before going commercial. Heidi de Villiers from International Fruit Genetics (IFG) also gives him advice on ‘mother’ stock, plants and tests. He goes to other countries with the exporters to look at new cultivars.

Three growers said that they get information on new cultivars from Lelienfontein in Wellington. The consultant is Marco Blom.

Grower 6 mentioned Henning Burger from Orange River Wine Cellars as a knowledge source.

Grower 7 said that cultivar research by government is no longer active. It has been taken over by SATI and Vinpro (table and wine grapes), and DFTS (raisins).

Grower 8 mentioned that their in-house cultivar expert, Jacomien Mouton, as well as SFNL, IFG and Capespan do experiments. Grower 10 identified IFG, SNFL, CRI, Hoekstra and Topfruit as sources of information. The cultivar companies have a WhatsApp group where they share photos; they also send emails with attachments on new technology and research.

Grower 5 invests in a cultivar programme run by the Volcani Institute from Israel.

### Crops

Grower 1 said that the citrus and new cultivars bring them in contact with new networks. *There’s always someone who will dream up a plan.* Grower 10 said CRI is a source of information for citrus, as well as Laeveld Agrochem and Agrimotion.

For pecans, Grower 7 identified SAPPA as a source of knowledge. Grower 8 mentioned Alvin Archer.

Grower 1 and 7 said SATI is a source of information for table grapes, especially for cultivar research.

Three growers mentioned DFTS as a source of information for raisins. Grower 4 also mentioned Dirk Burger from Sunworld. Grower 7 said that DFTS is lagging behind, for example they do not have a publication.

Grower 2 grows vegetable seed on a relatively small scale. Her sources of knowledge include:

- Schalk van der Colff, who told her about vegetable seed
- JW Seed from Oudtshoorn. They send her emails with PDFs, for example they send a curve on how the plant's potassium requirements change over time
- The carrot seed people from Indonesia visit her once a year.

Plant diagnosis

Grower 7 and 8 use the plant clinic of the University of Stellenbosch for plant diagnosis.

Fertilizer

The growers have a wide range of knowledge sources for fertilizer:

- Omnia (grower 1)
- Nem Consult through Intelligro (grower 3)
- Grower 4 uses flow meter readings to know how much fertilizer should be applied
- Hannes Kruger from Nexus (grower 6)
- Intelligro and Viking (grower 7) because they are moving towards a more biological approach. Omnia still sticks to chemicals.
- Nulandis (grower 8)
- Intelligro (grower 10). They also give advice on irrigation scheduling.

Pesticides

The growers get information on pesticides from the following sources:

- Viking (grower 1 and 7)
- Nem Consult through Intelligro (grower 3)
- Grower 4 follows the strict guidelines from EurepGap, it applies to all growers
- Nexus (grower 6)
- Intelligro (grower 7)
- Nulandis (grower 8).

Solar power

Grower 3 mentioned Sonfin as a knowledge source for information on solar power.

Markets

Grower 4 said RMB and FNB give good talks about market trends.

Comparative data

Grower 4, 7, 9 and 10 participate in Frudata. Grower 7 also mentioned that Vinpro does a national study across all wine producing regions, which give them cost analyses, for example, production costs.

# Appendix B: Capacity building report

The research team had a sub-contractor agreement with the School of Languages and Communication Studies at the University of Limpopo.

Honours student, Frans Mehale (student number 201504921), conducted a research project to research and develop a workshop format best suited to share the findings of the WRC study and find common ground on ways to measure water use that serve the interests of irrigators, WUAs and the regulator.

His study leaders were Dr Ian Sauderson, Mr Mahlatse Baloyi and Mr Isaac Riba.

Mr Mehale accompanied the research team to one of the workshops to observe his proposed workshop format in action. The workshop was recorded. The recording and Deliverable 4 (report on the knowledge sharing activities including the workshops) were made available to him for analysis.

Mr Mehale completed the research project and submitted the final report to the University in December 2018. He received a distinction for his report.

The workshop approach and findings are discussed in Part 3 of this report.

# Appendix C: Contact details

Readers are welcome to contact the project leader, Dr Sarah Slabbert, if you require any further information on this report or any of the project deliverables.

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