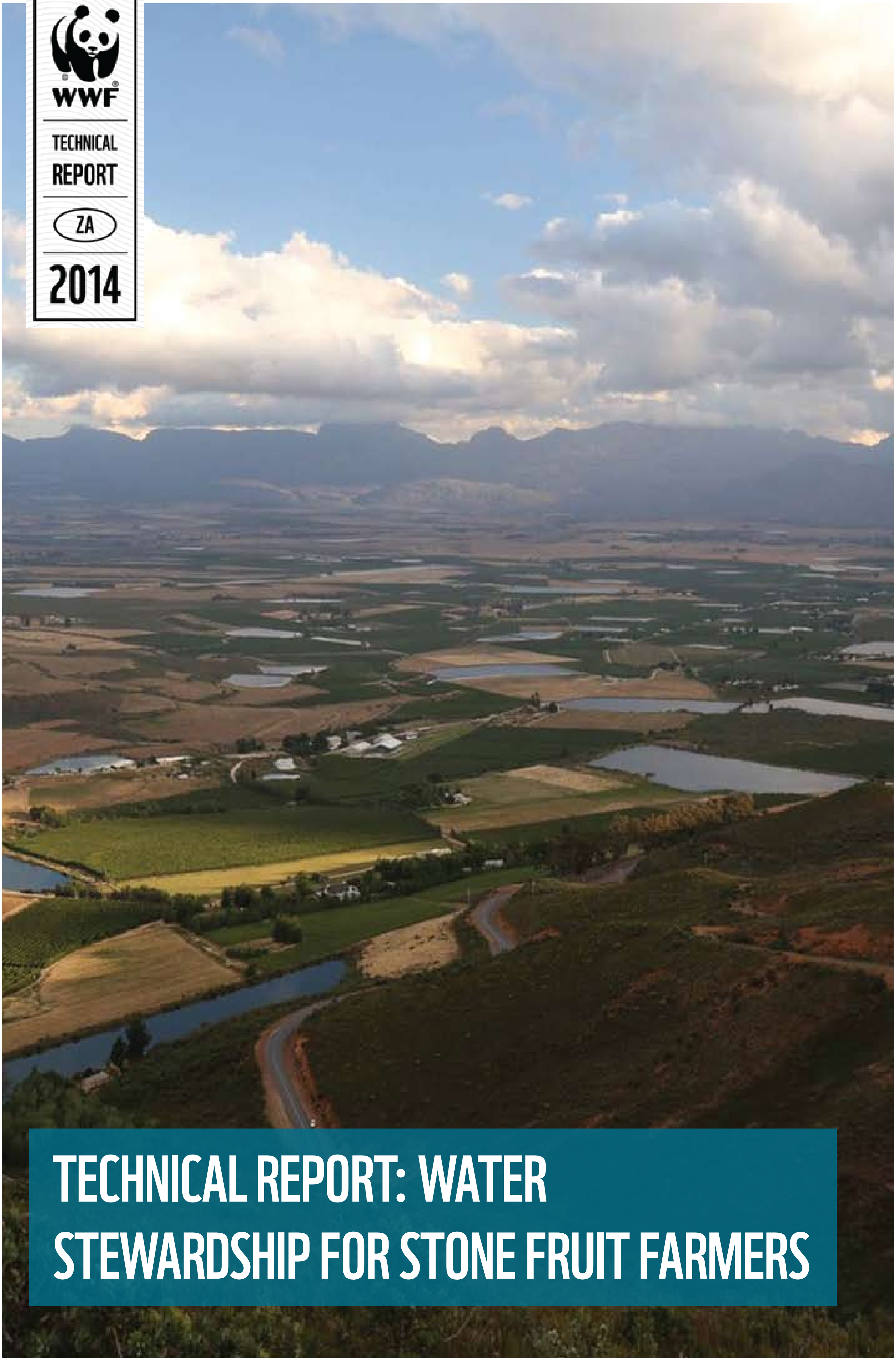
WWF TECHNICAL REPORT ZA 2014



TECHNICAL REPORT: WATER STEWARDSHIP FOR STONE FRUIT FARMERS

Prepared for:
World Wide Fund for Nature – South Africa

Prepared by:
S. Dzikiti1, K. Schachtschneider [1,2]
[1]Natural Resources and Environment, Council for Scientific & Industrial Research (CSIR)
[2]Freshwater Program, WWF-SA
Emails: sdzikiti@csir.co.za
kschacht@wwf.org.za

January 2015

Reviewed by:

C. Bramley (WWF-UK), C. Colvin (WWF-SA), L.Nicolls (M&S) and A. Sym (AWS)
This water stewardship initiative was made possible with the cooperation and support of Marks & Spencers, Woolworths, the Alliance for Water Stewardship and the WWF-UK

Designed by The Media Chilli

Front cover image by Thomas P. Peschak WWF

Published in January 2015 by WWF-SA – World Wide Fund for Nature (formerly World Wildlife Fund), Cape Town, South Africa.

WWF is one of the world's largest and most experienced independent conservation organisations, with over 6 million supporters and a global network active in more than 100 countries.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

This report is printed on cacoon, produced from 100% recycled fibres. FSC™ Recycled Credit).
Published in 2014 by WWF South Africa, Cape Town.

ACKNOWLEDGEMENTS:

Authors:
Sebinasi Dzikiti
CSIR, NRE
sdzikiti@csir.co.za

Klaudia Schachtschneider
WWF-SA Water Stewardship Programme
kschacht@wwf.org.za

Funders:
Marks & Spencers
Woolworths

Collaborators:
WWF-UK
Alliance for Water Stewardship

Citation:
Dzikiti, S. and Schachtschneider, K. 2015. Water stewardship for stone fruit farmers. WWF Technical Report. Available at www.wwf.org.za/freshwater.

Table of Contents

ABBREVIATIONS AND ACRONYMS

AWS	Alliance for Water Stewardship
BGCMA	Breede Gouritz Catchment Management Agency
CSIR	Council for Scientific and Industrial Research
DWAF	Department of Water Affairs and Forestry
E.coli	Escherichia coli
ET	Evapotranspiration
M&S	Marks and Spencer
WRF	Water Risk Filter
WWF	World Wide Fund for Nature

EXECUTIVE SUMMARY

In October 2013, a one-year collaboration between Marks and Spencer (M&S), Woolworths, WWF-SA and WWF-UK and the Alliance for Water Stewardship (AWS) commenced in the upper Breede catchment of the Western Cape. The aims for cooperation differed for the stakeholders. The two retailers M&S and Woolworths had previously applied the Water Risk Filter in order to determine the water risks in their supply chains.

Stone fruit in the Western Cape came up as a hotspot and hence their aim was for their producers to apply water stewardship, in order to reduce supply chain risks. The aim of the AWS was to test the final version of their standard in an agriculture setting. The WWF offices, drivers of water stewardship and holders of local connections, became involved as bridging and communication agents in the process. The CSIR was subcontracted to conduct the research process, focussing both on a detailed orchard-scale water use (for plums and peaches) and for driving the AWS testing process. Nine stone fruit farmers volunteered their cooperation for the year, and together with the CSIR they worked through the AWS standard format, first understanding their own water use, then planning improvements and finally implementing the first water stewardship steps. Over the course of the first year the work focussed on on-site water stewardship actions.

The first part of the report provides a detailed water use evaluation of the peach and plum orchards. The results show that there are opportunities for improved water use. The data suggest that drip, instead of micro jet irrigation is more efficient. The report points out opportunities for further water use efficiency improvements by evaluating irrigation methods around fruit sunburn and by reworking crop irrigation factors. The report predicts potential water savings of up to 20% in certain situations. These results apply at a very localised level, while the report compares Western Cape agricultural water footprints with global averages for four fruit types, showing that Western Cape farmers, compared internationally, show they are two-to nine times more water use efficient during fruit production than what international water footprint averages suggest. The second part of the report focussed on the application of the AWS standard, looking in greater detail at the standard's focus on outgoing water quality, an overall calculation on water balance and a farm-by-farm summary of the planned water stewardship steps and their level of implementation by August 2014. The last section provides feedback on the AWS standard application and feedback from farmers, who each have individual lessons they gained through this participation. The year 2015 be the second phase of this project, where the more catchment-based initiatives will be implemented, in order to address larger-scale water issues in the upper Breede. These include urban water quality issues, alien plant clearing and the provision of more water-related information, allowing easier implementation of water stewardship.

INTRODUCTION

Stone fruit sourced from the Western Cape Province of South Africa is produced entirely under irrigation. Availability of adequate water is therefore critical for sustainable production given that South Africa is the eighth largest exporter of stone fruit (National Agricultural Marketing Council, 2013). A recent study that used the WWF's Water Risk Filter (WRF), commissioned by the UK retailer Marks and Spencers (M&S), indicated that a water risk hot spot lies in the Western Cape, spread across four water management areas namely; the Berg, Breede, Gouritz and Oliphants/Doorn. Stone fruit were identified as a key risk being a high water consuming crop per unit weight of fruit produced.

The goals of this study were firstly to verify the outcomes of the Water Risk Filter (WRF) based on actual measurements of water consumption in relation to fruit yield in case study farms. The second objective was to evaluate the Alliance for Water Stewardship (AWS) standard. The AWS Standard is a single global standard aimed at driving water stewardship, defined by AWS as *"The use of water that is socially equitable, environmentally sustainable and economically beneficial, achieved through a stakeholder-inclusive process that involves site and catchment-based actions. Good water stewards understand their own water use, catchment context and shared risk in terms of water governance, water balance, water quality and important water-related areas; and then engage in meaningful individual and collective actions that benefit people and nature".*

Participating farmers used the 2013 Beta AWS Standard which has since been superseded by v1.0, launched in April 2014. Lessons from this project informed the revision of the Standard (v1.0). Both Beta and v1.0 are structured around six steps of implementation. The duration of this phase of the project was not sufficient to work through all steps of the AWS Standard. Farmers were able to work through steps 2 and 3. Step 2 requires implementers to "*gather and understand data*", at both site and catchment level. This enables an implementer to understand their own water use in the context of the catchment conditions. Step 3 involves developing "*a water stewardship plan*" based on the data collected in step 2. Note that Step 1 (leadership commitment) was assumed to be covered by having farmers volunteer to participate in the project.

Specific questions for which the farmers' views and perceptions of the standard were solicited include: 1) Can farmers in a river catchment meet the requirements of the standard? 2) Is the AWS standard applicable in a South African context? 3) What would it take for South African farmers to implement the standard? **Section 1** of this report summarises biophysical information on actual water use and water use efficiency of selected stone fruit orchards in the Western Cape. **Section 2** attempts to answer the above questions regarding the AWS standard based on one-on-one and group engagements with stone fruit farmers in the Breede Catchment. Nine farms volunteered for the AWS evaluation as summarized in Table 1. An additional five were self-assessing. The self-assessing farms provided valuable insights on the feasibility of South African farmers implementing the standard unaided.

Table 1: Participating farmers receiving either full support or self-assessing.

Area	Farm Name	Participation
Robertson region	Sonskyn*	Yes
	Rosedale	Declined
Ceres region	Lushof	Yes
	Ou Stasie	Yes
	Romansrivier	Yes
	Trevors’	Yes
	Waboomskraal	Yes
	Denou*	Yes
	Esperanto	Yes
	Welgemeen	Yes
	Cascade	Self-assessing
	Verdun Estate	Self-assessing
	Edenville	Self-assessing
	Leeuwenfontein	Self-assessing
	Excelsior	Self-assessing

*Case study site for on-farm water balance assessments.

SECTION 1

WATER USE BY SELECTED STONE FRUIT ORCHARDS

1.1 Description of study sites

Fruit production statistics show that peaches (*Prunus Persica*) are the second largest stone fruit group in the Ceres area of the Western Cape (HortGro., 2013). Plums (*Prunus Domestica*), occupy the second largest area in Robertson. Overall nectarines (*Prunus Persica* var) are the largest stone fruit group in both regions. A previous study by the CSIR (Taylor and Gush., 2014) focused on the water requirements of nectarines in the Breede River catchment. Besides the need to ground truth the WRF, there are important information gaps on the water requirements of peach and plum orchards in this catchment.

Accurate information on the water requirements of stone fruit is important in order to understand the water risk to this sector as a result of the increasing demand for water, increasing government regulation of the water sector, and climate change. For this reason two case study sites were established, one in Ceres on peach, and the other in Robertson on plums.

Key outputs of the case studies are: 1) the seasonal water requirements of stone fruit orchards; 2) information on the amount of fruit produced per unit volume of water used under Western Cape growing conditions, and; 3) guidance on irrigation scheduling.

Irrigation scheduling is the process whereby farmers decide “when” to irrigate and “how much” water to apply during each irrigation event. Efficient irrigation scheduling is a vital part of good on-farm water stewardship in irrigated agriculture. A survey by Stevens (2006) on irrigation scheduling adoption revealed that only 18% of South African farmers use objective scheduling methods while Volschenk et al (2003) noted that over-irrigation was prevalent in the fruit sector in the Western Cape as most farmers do not use scientific tools to make irrigation decisions. The saying “*you can’t manage what you don’t measure*” is especially true for irrigation scheduling particularly in the South African fruit sector which is entirely reliant on irrigation.

Measurements in the peach orchard were done in a four year old Juli Pretty orchard at Denou farm in Ceres (Fig 1a). This cultivar has the longest growing season and therefore it’s water use is close to the maximum for peach in the area. The trees are budded on the 778 rootstock and total size of the orchard is about 4 ha. Trees are planted on ridges with a spacing of 4 m between rows and 1.5 m within the rows. Irrigation is via medium range micro-sprinklers delivering about 32 L/h. The plum trial was conducted in a five year old African delight orchard budded on the GF-677 rootstock at Sonskyn farm in Robertson. Area of the orchard is about 3 ha. The trees are trained on a V-Haag trellis system with 10 wires with dual rows running in an east-west direction on a drip irrigation system (Fig 1b). Spacing was about 5 m between rows and 1.5 m within rows. This plum cultivar is also the longest season cultivar harvested during March-April.

Fig 1. (a) Four year old Juli Pretty orchard at Denou farm in Ceres with Microjet sprinklers. (b) Five year old African Delight plum orchard on V-Haag trellis at Sonskyn farm in Robertson with pressure compensated drip emitters, spaced every 75 cm along the irrigation line delivering water at a rate of 2.0 L/h.

1.2 Materials and methods

1.2.1 Water use and weather measurements

Actual amounts of water used by individual trees (in litres per day) were measured using the heat pulse velocity sap flow system on peach (Fig 2a) and plums (Fig 2b). Six trees were instrumented at each site. The transpiration data was collected at hourly intervals starting on 17 October 2013 (late spring) and continued through the peak water use period in summer ending in winter when the trees dropped their leaves. Weather variables namely air temperature and relative humidity, wind speed and direction, solar irradiance and rainfall were measured at Denou using an automatic weather station (Fig 2c). Data from a nearby weather station operated by the Agricultural Research Council was used at Sonskyn farm. Actual evapotranspiration from entire orchards were measured using equipment known as 'eddy covariance sensors' mounted above the tree canopies on flux towers (Fig 2d) at each site. To minimize the costs associated this equipment, evapotranspiration data was collected over a few days during the peak irrigation period in summer instead of daily.

1.2.2 Irrigation and soil water content

To measure the amount of water applied during each irrigation event, we installed high precision water flow meters (Fig 2e) in each study orchard. The flow meters were connected to data loggers so that flow readings are recorded automatically. Corresponding changes in the soil water content in the root zone of the trees was measured using capacitance soil moisture probes installed at 30 cm depth and beyond the root zone (70 cm depth).

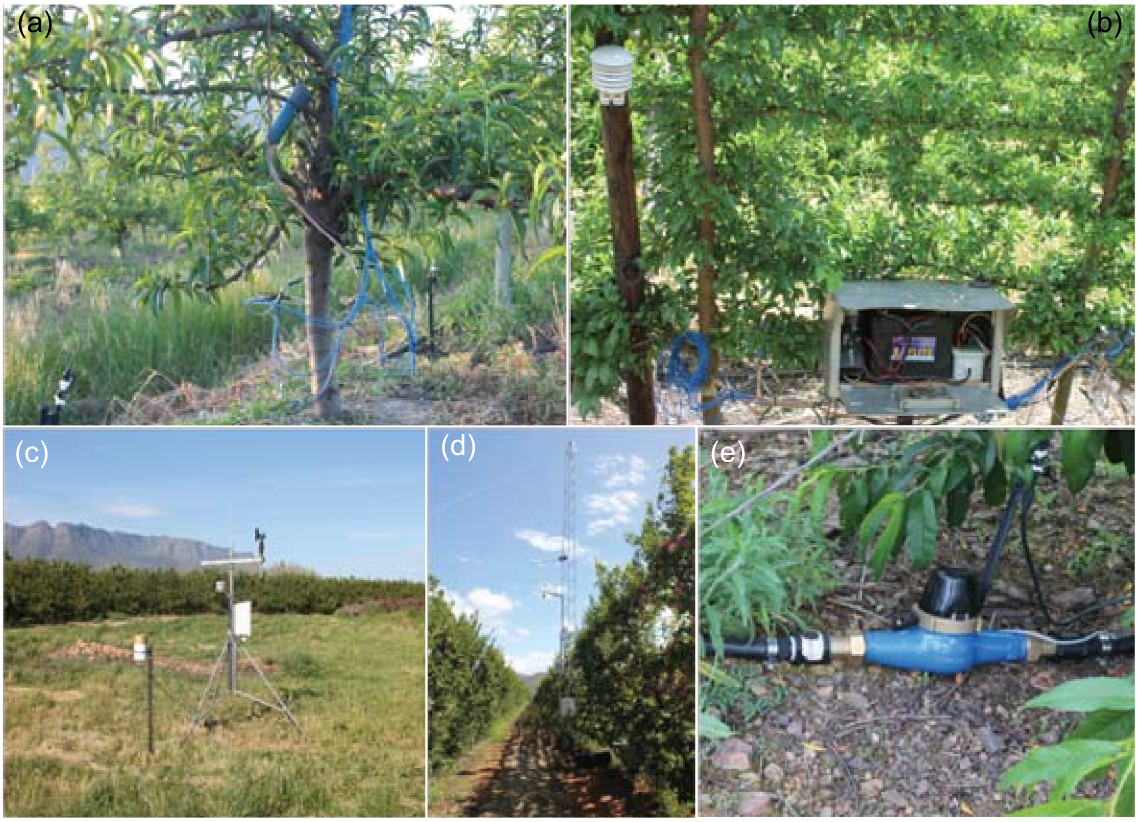


Fig 2 (a) Sap flow system measuring the transpiration rates of peach trees; (b) sap flow system measuring transpiration rates of plums; (c) automatic weather station at Denou; (d) eddy covariance system measuring evapotranspiration of an entire plum orchard, and (e) precision water flow meter measuring irrigation volumes.

1.3 Results and discussion

1.3.1 Comparing water balance – at orchard level

Maximum transpiration during the peak irrigation season exceeded 25 litres per day for a peach tree while that of individual plum trees rarely reached 20 litres per day. This was because of a relatively smaller leaf area index for plum (~1.1) compared with peach trees (~1.7). Both species exhibited midday depression in the diurnal transpiration trend due to partial stomatal closure under conditions of high atmospheric evaporative demand. Seasonal total transpiration by an individual Juli Pretty peach tree was 3 412 litres compared with 6 023 litres of irrigation (Fig 3a). Number of peach trees per hectare was 1667 giving an actual seasonal transpiration of 5 690 m^3/ha compared to 10 022 m^3/ha of irrigation (Table 3). Actual water use under microjet irrigation is relatively smaller than the applied irrigation. This is because of a larger wetted area under micro sprinklers which is necessary for the development of an extensive root system which in turn would support a much healthier tree. This irrigation method has proved to produce high fruit yields, which translates to high economic returns for farms. Hence there is a drive in the deciduous fruit industry to move towards microjet irrigated orchards, rather than drip irrigation, which is not suitable to several soil types and which can produce lower fruit yields, if improperly managed.

Given that measurements started in mid-October 2013 after the irrigation season had commenced, actual transpiration for peaches is likely just over 6 000 m3/ha/season while applied irrigation was over 10 000 m3/ha/season. Seasonal evapotranspiration of the peach orchard determined using the remote sensing Fruitlook product (www.fruitlook.co.za) was 6 240 m3/ha. Actual evapotranspiration therefore accounted for just over 60% of the irrigation applied. Yield for the Juli Pretty peach orchard was 21 tonnes per hectare for the 2013/14 growing season. It therefore took one cubic metre of transpired water to produce 3.5 kg of peach.

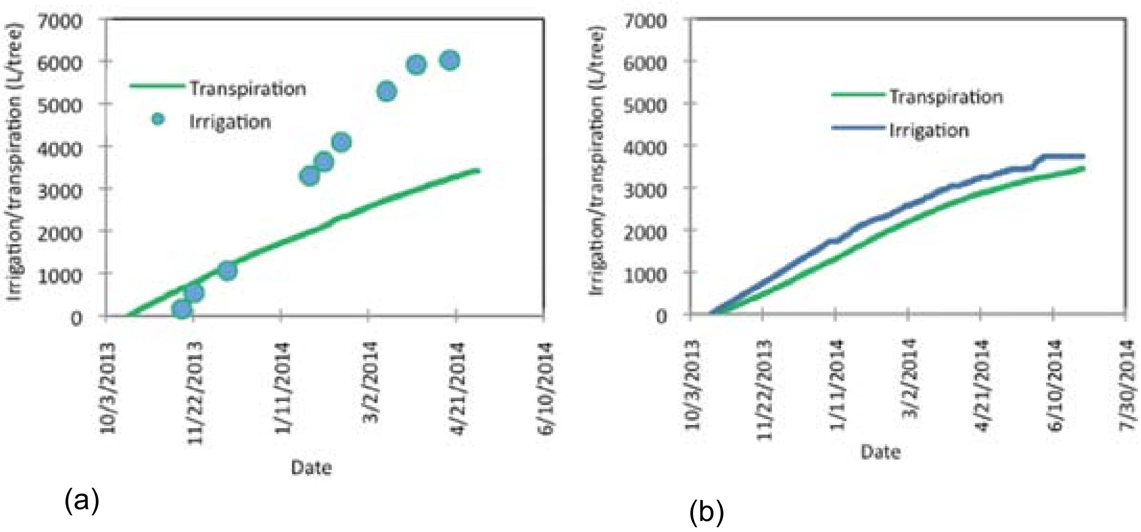


Fig 3. Cumulative transpiration (green line) and irrigation (blue line) given to each; (a) peach tree at Denou farm with manual flow measurements, and; (b) plum tree at Sonskyn farm with continuous flow meter measurements from October 2013 to end of April 2014.

Despite the lower daily transpiration rates by plum trees, seasonal transpiration values by an individual tree was higher (3 450 litres) than that by peach (Fig 3b). This was because plum trees retained their leaves for longer (until mid to late June) than the peach (mid to late May). Total irrigation per tree (3 750 litres) was quite close to the total transpiration and this trend is expected for drip irrigated orchards growing on heavy soils. Seasonal transpiration for the plum orchard was however, much higher being 9 210 m^3/ha because of a much higher plant density (2 667 trees per hectare). Total irrigation was approximately 10 006 m^3/ha (Table 3) which is clearly efficient. Yield per hectare in the plum orchard in the 2013/14 season was 55 tonnes per hectare. Water use efficiency is close to 5.97 kg of plums per cubic metre of water transpired which is greater than the efficiency of peach under micro-sprinkler.

Table 3. Water balance for a microjet peach and a drip-irrigated plum orchard, respectively.

Species	Actual seasonal transpiration (L/tree)	Total irrigation (L/tree)	No of trees per ha	Seasonal transpiration (m^3/ha)	Seasonal evapotranspiration (m^3/ha)	Irrigation applied (m^3/ha)
Peach	3412	6012	1667	5690	6240	10 022
Plum	3455	3750	2667	9210	-	10 006

In summary, it can be said that both orchards had the same amount of irrigation applied, and both peach and plum trees transpired similar amounts of water. However, due to the differences in irrigation technology, the drip-fed plums received far less water per tree (3750 l/tree) than the microjet-fed peaches (6012 l/tree) and it can be concluded that drip irrigation is more efficient. However, aspects such as the density of trees per hectare also influence water use. Hence the debate around crop water use efficiency, as shown here, is neither simple nor clear-cut. The following section attempts to provide a more general angle to the discussion of efficiency, using water footprint results.

1.3.2 Water footprints

A water footprint provides information on the total amount of water used to produce a specific product along the entire production chain. The chain extends from field to farm gate for agricultural products. It is a very effective way for a consumer and a retailer to assess water use between food types, or food types grown in different regions. The results support discussions around sustainable and equitable water use and allocation, forming a basis for a local assessment of water-related impacts (Hoekstra *et al.*, 2009).

The orchard-level water balance calculations were used to determine the agricultural water footprint for peach and plum fruit (Table 4 and 5). The bulk of any water footprint for most commodities lies in the agricultural part of the supply chain, and predominantly through evapotranspiration. South African footprint studies have found that 98.7% of the agricultural water footprint for apples and nectarines is linked to crop evapotranspiration (Gush and Taylor, 2014). Similar trends were found for the production of beer (98.3%) (SAB Miller and WWF-UK, 2009).

Table 4: Juli Pretty peach infield water footprint (green and blue water only)

Variable	Quantity	Units
Seasonal ET of orchard	6240	m^3/ha/season
No of trees per ha	1667	
Average yield per ha	21000	kg
Average yield per tree	12.6	kg
Average mass of one peach fruit	160	g
Average no of fruit per tree	78.7	
Average ET per tree	3.7	m^3/tree/season
ET equivalent for one fruit	0.048	m^3/fruit
Water footprint	47.5	Litres of water to produce one peach

Table 5: African delight plum infield water footprint calculation (green and blue water only)

Variable	Quantity	Units
Seasonal ET of orchard	9210	m^3/ha/season
No of trees per ha	2667	
Average yield per ha	55000	kg/ha
Average yield per tree	20.6	kg/tree
Average mass of one plum fruit	135	g
Average no of fruit per tree	152.8	
Average ET per tree	3.5	m^3/tree/season
ET equivalent for one fruit	0.023	m^3/fruit
Water footprint	22.6	Litres of water to produce one plum

The actual measurement of a water footprint can be a detailed process and it is possible to compare footprints that have been determined through the same measurements. As such, the Western Cape now has the agricultural water footprint for four fruit types (nectarines, apples, peaches and plums), that were determined through the same scientific measurement process (combination of sapflow and eddy covariance measurements), applying the water footprint calculations of Hoekstra et al., (2009). Table 6 provides a comparison between the South African agricultural water footprint and global footprint averages for the same fruit.

Table 6: Global and local water footprint averages for stone and pome fruit

Product	Global water footprint (l/kg)[1]	SA (W Cape) infield water footprint (l/kg)
Apple	694	192
Nectarine	771	350
Peach	771	297
Plum	1758	167

1 Water Footprint Network:http://www.waterfootprint.org/?page=files/WaterStat-ProductWaterFootprints[accessed 14 September 2014].

The table shows that volumetrically, South African fruit production is markedly more efficient than what global footprints suggest. This is a good indication of the overall efficiency, with which the Western Cape fruits are produced, assuming the infield footprint results make up 97.8% of the total water footprint. However, a water footprint cannot measure the severity of the local environmental impact on water consumption.

1.4 Conclusions and recommendations

The orchard water balance results need to be evaluated both at the global and at the local scale. Comparing at a global level, the water footprint results (Table 6) show that South African stone fruit farmers produce stone and pome fruit at a water footprint 2 to 10 times smaller than commonly available values for global average footprints. This alone suggests that Western Cape fruit farming is already quite advanced in its water use efficiency measures, compared to stone fruit farmers world-wide. However, when looking at the orchard data at a local level, it is also clear that there is room for further improvement. This is particularly clear for micro-sprinkler irrigated orchards. The lack of precise irrigation scheduling tools and guidelines is a major factor contributing to inefficient irrigation practices in stone fruit farms. In this study only two of the nine participating farmers scheduled their irrigation based on soil moisture probes and weather data. The rest relied on moisture pits but most often on intuition and experience. As part of good water stewardship, farmers should be encouraged to use objective tools to "*measure*" in order to "*effectively manage*" the scarce water resources.

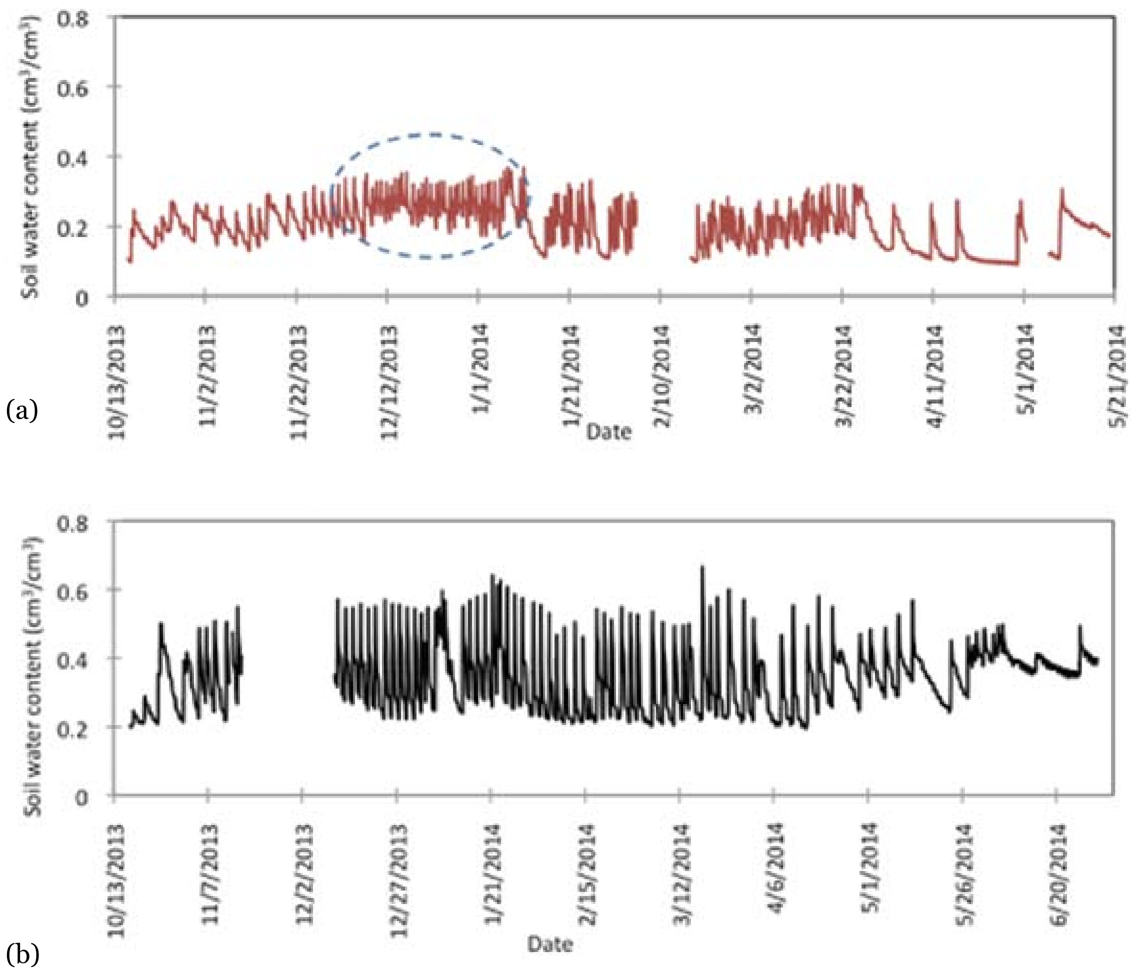
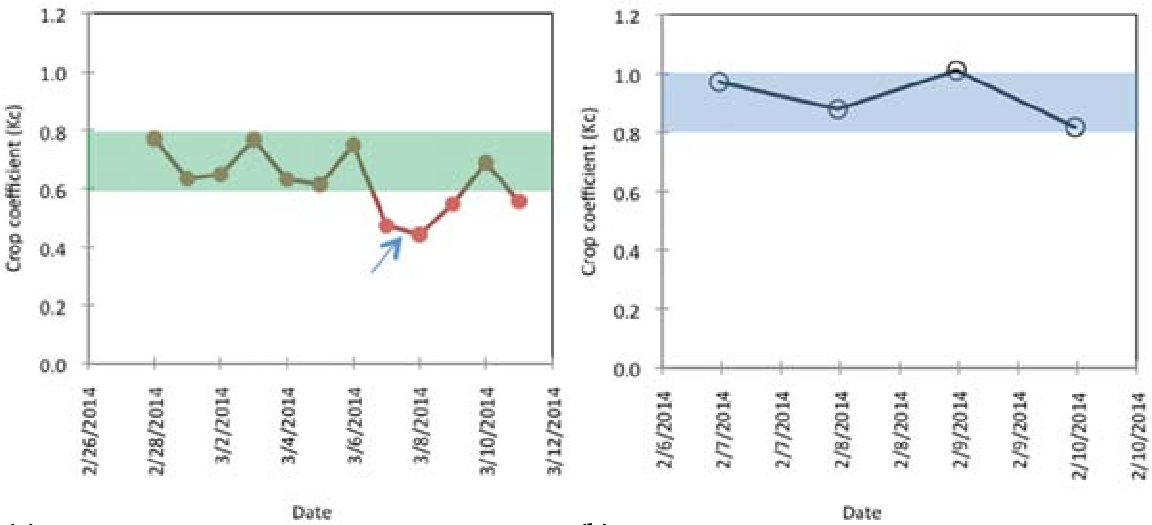


Fig 4. Changes in soil water content in the root zone of (a) micro-sprinkler irrigated peach trees and (b) drip irrigated plum trees during the 2013/14 growing season.

Besides inefficient irrigation scheduling, much of the water in the Western Cape is used to minimize sunburn. Small spurts of extra irrigation cools the trees, creating a slightly cooler microclimate in the orchards Fig 4(a) (area in dotted circle). At least 15% of some fruit types are lost due to sunburn annually. Clearly this represents a substantial loss of income and farmers are indeed justified to take measures to reduce sunburn. Frequent irrigation, usually applied in pulses is the most common practice used to reduce sunburn given that irrigation modifies the canopy microclimate. However, in a water scarce country like South Africa, alternative methods of sunburn control e.g. using shade nets and applying kaoline sprays should be encouraged although the first option is costly and the latter is problematic for some stone fruit types e.g. peach, due to the hairiness of the fruit. Ongoing research at the University of Stellenbosch hypothesizes that sunburn control is linked to the microclimatic cooling effect, created through spray in an orchard, rather than continual wetting of the root zone.



(a) (b)

Fig 5. Crop factors for (a) peach and (b) plum trees during the peak irrigation season in the Western Cape. Actual ET was measured using the eddy covariance system.

Given the expected 10-15% increase in evaporative losses due to climate change in the Western Cape by 2030 (Midgley and Lotze., 2011), efficient irrigation is critical for sustainable farming. The dense network of automatic weather stations in the Western Cape provides farmers in the region with a good opportunity to adopt good irrigation practices. But good guidelines are needed in order to fully utilize the weather data. Farmers often determine the irrigation amounts by estimating the actual evapotranspiration (ET) of their orchards. According to standard FAO guidelines (Allen et al., 1998), ET can be estimated as the product of the reference evapotranspiration (ET_o) and a crop factor/crop coefficient (K_c) for a given crop. Reference evapotranspiration is defined as the evapotranspiration from a short, healthy and actively growing crop that uniformly covers the surface and is not short of water. ET_o is a measure of the atmospheric evaporative demand.

While fruit farmers in the Western Cape have access to good quality ET_o data, they lack appropriate crop factors to accurately determine the amount of irrigation to apply. For example during the course of this study we came across a farmer with a sophisticated network of soil moisture probes and telemetry systems which he uses to determine "*when*" to irrigate. However, to determine "*how much*" irrigation to apply, he then uses his weather station to estimate ET from ET_o assuming K_c=1.0.

While this assumption may be correct for drip irrigated high density plum orchards (Fig 5b) during the peak irrigation season wherein K_c is between 0.9 and 1.0, clearly he will over irrigate his micro-sprinkler irrigated peaches. Fig 5(a) shows that actual ET of micro-sprinkler irrigated peaches during the peak irrigation season is on average 0.7 of ET_o. The farmer can potentially save 20-30% of his water by using the correct crop factors.

Further research, quantifying fruit water use, could lead to an updated list of crop factors for key stone fruit types in the Breede catchment. This could substantially increase the precision of irrigation scheduling in the region thereby saving significant amounts of water and reducing water risk.

SECTION 2

FARM SCALE WATER STEWARDSHIP IN THE BREEDE CATCHMENT

2.0 Introduction

This section focuses on the following two topics which are based on one-to-one and group engagements with the stone fruit farmers listed in Table 1 within the year long duration of the project:

1. Implementing water stewardship in a Western Cape catchment that has been identified as a high water risk basin for the supply chain

Aim: reduce water risk and increase water stewardship in a key catchment of South Africa.

2. Testing the AWS Beta/Final standard

Aim: To test if the AWS standard, in its current format, is suitable for the agricultural sector and ready to be taken up as a tool by corporations like M&S.

2.1 Data gathering for AWS standard

2.1.1 What did farmers regard as a water risk for their operation?

Implementation of the AWS standard commenced with the "data gathering" phase. Information on key risks to stone fruit production in the Breede River catchment was collected for the nine participating farms and this is summarized in Table 4.

Table 4. Summary of risks. L, M and H represent, low, medium and high risk, respectively.

Farm	Risk of flood	Risk of drought	Risk of / to water quality	Reputational risk	Risk to wetlands	Risk to/ of social	Risk of regulation
1	L	M	M	L	L	M	L
2	L	H	L	L	L	M	L
3	L	H	L	L	L	M	H
4	L	L	L	L	M	M	L
5	L	L	L	L	L	L	L
6	L	M	L	L	L	M	M
7	L	M	L	L	L	H	H
8	M	M	L	H	H	M	L-H
9	L	M	L	L	M	L-M	L
Overall	**L**	**L – H**	**L**	**L**	**L-M**	**M**	**L-H**

Most farmers considered drought, social and reputational risk to be the highest risk factors to their operations. Fruit production in the catchment is entirely dependent on irrigation and water allocation can be disrupted in times of drought. Farmers have experienced reductions in water allocation in previous droughts. Social risk was prevalent for farms located close to towns mainly because of high rates of theft and vandalism to irrigation infrastructure. Pumps, taps and electric cables are particularly vulnerable for their copper. Consequently, farmers invest heavily in security to protect their equipment. As such, the social risk was seen as 'a risk by society on the farm water supply', rather than a risk of farm water use on society. Regulatory risk received the most varied responses. Some participants saw no risk, while others considered this risk as high. A frequent comment was that regulatory risk was perceived as worrying because of limited information exchange between authorities and farmers regarding water allocation issues.

2.1.2 Farm-scale water balance calculations

As part of the AWS standard, a whole farm level water balance is required in order to determine if one's operation is water constrained or has excess water. Part A of this report presented the water balance of specific orchards planted to specific stone fruit types. But this section deals with the water balance of entire farms taking into account all the water inputs and outputs from each property. The AWS standard calculation is broader and it looks at the overall operational water balance. The sap flow and eddy covariance measurements on the other hand gave a very detailed and scientifically accurate orchard-scale water balance (in Part A) and this provided insights on the water use efficiency under the current water management practices in the specific orchards.

The farm-scale water balance results (Table 5) provide a rough guide as to whether a farm, under current operation, has water to spare (results are positive), or if it has a water shortage (results are negative).

Table 5: AWS water balance calculation results at overall farm operation-scale

Farm ID	*Water Inputs (m^3/yr)	**Water outputs (m^3/yr)	Water balance (m^3/yr)
1	4 924 770	4 286 760	638 010
2	1 377 000	960 350	416 650
3	2 471 000	2 540 250	-69 250
4	2 162 750	2 118 276	44 474
5	1 885 000	1 422 450	462 550
6	616 000	605 360	10 640
7	542 500	416 325	126 175
8	517 000	492 189	24 811
9	1 095 450	1 073 378	22 073

*Water inputs were calculated using information provided by the farmers;
**Major water output fluxes such as the evapotranspiration were calculated using information from the Fruitlook remote sensing tool.

The results show that three farms (1, 2 & 5) have a very positive water balance. One has a good surplus (7), while four have just enough water (4, 6, 7, 8 & 9) and one farm operates at a negative water balance, with no water to spare (3).

It needs to be noted that these balance calculations are not absolute, but serve as an indicator. Most farmers, when shown the water balance results, concurred with the results, saying that it fitted their overall perception and understanding of the farm-level water availability.

It also needs to be highlighted that this water balance calculation is based on current operations (2012/2013). One of the assessed farms is fairly new and its water balance results showed high amounts of excess water. If this water balance calculation is repeated once the farm is fully established, it will show a less positive water balance.

The water balance calculation was furthermore complicated by the fact that farms do not operate on fully metered systems. Their water allocation is arranged as a set amount of m^3 per hectare of planted land. The amount allocated per m^3 depended on the region, as well as the ratio and type of fruit grown. Typically, the water allocation amounts ranged between 7000 – 10 000 m^3/ha. This lack of reliable input data into the AWS water balance calculation, based on metered flow data, did pose a particular interpretation problem.

2.1.3 Water quality tests and feedback

Water quality was assessed at various strategic locations around participating farms to initiate a thorough water quality monitoring plan required for the implementation of the AWS standard. Water sources, e.g. holding tanks, dams or sometimes a collection of sources were identified and GPS tagged and water samples were collected for testing in the CSIR chemistry laboratory. Discharge point/s as well as potential point sources of pollution e.g. waste water collection points were also identified and sampled. The samples were analysed for chemical constituents e.g. electrical conductivity - EC (general indicator of quality), Dissolved Organic Carbon (DOC an indicator of organic pesticides), Potassium K (indicator of pollution from waste water), Nitrate (NO_3), Ammonium (NH_4) (nutrients, indicators of run-off and possibly waste water) and ortho Phosphates (P).

E-coli and faecal coliforms were measured to give an indication of the microbiological quality of the water. Farmers were also shown the H_2S strip test which is a cheap and rapid test for microbiological pollution and can be used to decide whether a particular sample needs to be analysed or not. Since only one sample was collected in October 2013, the data (Table 5) merely shows a snap shot of the water quality at the respective sites relative to the country's aquatic ecology and irrigation guidelines. Critically however, the process kick started a voluntary annual water quality monitoring plan for outgoing water on each farm. Some site specific water quality targets in the implementation of the standard are based on our on-site water quality tests.

Fig 6: Picture of three bottles, one empty, one positive and one negative result (Genthe and Franck, 2000)

The results were compared to three relevant South African water quality guidelines:
1. The aquatic ecosystem guidelines – (DWAF, 1996a)
2. The agricultural use – irrigation guidelines (DWAF, 1996b)
3. Discharge limits as set out in National Water Act, 1998

The aquatic guidelines were chosen because all farm runoff contributes to the Breede ecosystem, the agricultural guidelines were chosen because downstream farmers use the Breede water for crop irrigation and finally the discharge limits were chosen because the runoff water is technically discharge water from a farm. If a guideline was not mentioned for a particular element in table 5, then no specifications could be found for that particular guideline. Unfortunately it was difficult to calculate the Aquatic ecosystem guideline requirements, as its results are based on a % difference calculation between natural state water and outgoing water. Most farms do not use local water sources, but rather rely on water schemes that are situated kilometres away – and hence do not reflect natural water quality conditions at the local level. Local water conditions would be expected to be far worse than current incoming quality, because the area is known for its high levels of salinity (reflected in elevated EC). Water from irrigation schemes, with a different water quality characteristic, will run through the farm and the soil and is likely to take up water quality characteristics that reflect the local geology as well as human practices. Due to this complication it was decided to place key focus on the agriculture and the drainage guidelines instead.

Farm 1 had the most obvious water quality problems, in that EC levels were raised, as well as K, DOC and total coliforms. The farmer stated that the monitoring coincided with the application of an organic pesticide. Further monitoring was highly recommended.

Farm 3 had a particularly high EC reading and this was ascribed to the local soil conditions and geology. The area is known for salinity issues in the middle catchment.

Farm 4 had raised faecal coliform levels and it was highly recommended to re-evaluate this later in the year, to see if the reading was indicative of a long-term sewage problem, or if it picked up a once-off event.

The nitrate and phosphate levels of farm 6 fell within the agriculture and drainage guidelines, but compared to local fountain water, it did indicate a nutrient increase beyond the aquatic ecological guidelines. A reduction in fertiliser application has already been enacted at the beginning of this growing season.

Both farms 7 and 8 had pH levels that lay beyond guideline levels. Farm 8 was due to a suspected equipment malfunctioning. Further monitoring was advised.

Farm 9 measured the water quality of two outflows – one irrigation drain (going into the Skaap River) and a little wetland, into which the farm piped some of its sewage. The little wetland was well vegetated with reeds and an active bird breeding ground. The elevated phosphate, potassium and DOC levels were the only evidence of this area being an official drainage area, while residence time and vegetation were enough to filter E coli concentrations to acceptable levels. The value of a natural wetland was well-demonstrated in this case. The EC and Ecoli levels in the Skaap river were higher than in farm runoff water. This could be indicative of the localised water conditions that are different to water quality in the dam schemes, but it also reflects the result of farms draining their runoff into the river.

The final measurement was completed for the Skaap River, which is a tributary to the Breede and into which most farms in the area drain their outflows into. The elevated EC levels are likely reflective of the surrounding geology.

Table 5. Water quality summary for outgoing water at the participating farms collected in October 2013

Property name	Comparative guideline ranges	Farm 1			Farm 2	Farm 3		Farm 4	Farm 5	Farm 6		Farm 7	Farm 8	Farm 9			
Type of flow		In flow	Out flow	Out flow	Through flow/Out flow	In flow	Out flow	Out flow	Out flow	In flow	Out flow	Out flow	In & Out flow	In flow	Out flow	Out flow	Through flow
Location		Koekedouw water scheme	Drain	River trib. end of farm	River/ Dam	Holding Dam	Drain	Drain	Drain	Fountain	Drain	Pit	Holding Dam	Holding dam	Drain	Sewage dam	Skaap river
Temp (deg C)			18.3	20.5		20.9	18.2	19.8	18.8	14.4	18.9	17.7	23.1	23.5	18.3	26.4	20.6
pH			7.07	8.04		**8.5**	6.89	7.5	7.21	6.28	7.05	5.45	**9.78**	7.75	7.42	7.33	7.8
Aq eco	Change < 5% from natural																
Irrig	6.5 - 8.4																
Dis limits	5.5 to 9.5																
EC (uS cm-1)		4	**155.6**	136		32.5	**669**	58.3	58.2	24.9	31.2	43.8	73.7	24.5	37.5	77.4	**203**
Aq eco	change <15% from natural state																
Irrig	<20 mS/m																
Dis limits	70mS/m above intake up to 150 mS/m																
Nitrate + Nitrite as N *		0.3	<0.1		<0.1	<0.1		0.5		<0.1	2.7	<0.1	<0.1	0.2	0.2	0.4	0.1
Aq eco	change <15% from natural state																
Irrig	<5mg/l																
Dis limit	15 mg/l																
P ortho Phosphate		0.06	0.46		<0.05	<0.05		0.05		<0.05	0.12	<0.05	<0.05	<0.05	<0.05	5.1	0.05
Aq eco	change <15% from natural state																
Dis limit	10 mg/l																

Potassium as K Dissolved		0.4	**13**		2	2.2		5.3		0.1	11	0.4	1.5	1.3	1.2	**23**	1.2
Dissolved Organic Carbon		2.4	**31**		8	4.4		14		<0.5	13	1	9.4	7.2	8.1	**37**	9.1
Total coliforms		0	**32600**		16580	1950		46110	48800	179	6600	165	1230	11700	613	2600	16700
E coli		0	96		46	2		**1116**	344	9	7	31	1	71	50	200	533
Irrig guide	1-1000/100ml (do not wet fruit)																
•	Results that were above guidelines are highlighted																

Results that were above guidelines are highlighted
KD: Koukedouw, In: Inflow, Out: Outflow; Aq eco: Aquatic ecology guidelines, Irrig: irrigation guidelines, Dis limit: Discharge limit

2.2 IMPLEMENTING THE AWS STANDARD

2.2.1 Water stewardship activities for Ou stasie

CREDIT: K. SCHACHTSCHNEIDER

2.2.1.1 Description of site

Ou Stasie is situated in the Wolseley District and it is one of three family-owned farms that grows stone (peach, nectarine and plum) and pome fruit (apples and pears). Vegetables also occupy a substantial area on the farm. The three-farm enterprise employs a total of 550 permanent staff, of which 40 families live in staff housing at Ou Stasie. The produce of Ou Stasie and its sister farms is roughly divided between the local market (50%) and the export market. Of the exported fruit, about 80% is destined for the UK market, while smaller proportions are sold to wider Europe, Canada, the African Islands and the Far East.

Ou Stasie obtains its water from a complex combination of canalised water pumped from the Breede River, as well as groundwater from boreholes, mountain run off and water that is pumped from man-made seepage pits, in which groundwater collects. Water infrastructure at Ou Stasie is continually being upgraded in order to optimise the irrigation system, given constraints in water quantity, soil, age of infrastructure, budget and timeframe. At the moment emphasis is placed on ensuring that all irrigation methods are suitable for the local soil conditions. The piping is being modernised, replacing old asbestos with PVC pipes. All orchards are irrigated using modern high pressure systems mainly micro-sprinklers and drip.

Ou Stasie subscribes to several standards which include: Global gap, Field to Fork, CISA, Tesco and the BRC audits. Water quality is continually checked for compliance with other export standards, such as Global Gap. All water sources, including river, ground and seepage water are monitored annually.

Environmentally, the farm has agreements with CapeNature to leave areas undeveloped for the protection of a plant species 'Leucadendron lanigerum var. laevigatum'. The farm cooperates with the government programmes to clear invasive alien plant species along the river channel and on the mountain slopes. The farm keeps its own Eucalyptus plantation which it uses for making poles, compost and packing crates. There was an emerging case of suspected infestation of Myriophyllum aquaticum (an aggressive invasive alien plant) in one of the seepage pits of the farm and it was addressed as part of the farm's water stewardship activities.

The farm holds all required water use licenses and it is currently in the process of completing the Validation and Verification of Lawful Water Use process, initiated in 2013 by the Breede Gouritz Catchment Management Agency (BGCMA). In this process it is confirmed whether the volume of water registered coincides with the volume of water required for the crops cultivated. In terms of water risks, Ou Stasie faces the greatest risks from drought, water regulation and social risks (in terms of electric cable thefts and the resulting impacts on pumping).

2.2.1.2 Targets and implementation at Ou Stasie

The completed assessment has led Ou Stasie to set up its own water stewardship targets, which outline the main commitments that Ou Stasie is undertaking with respect to its water. They are:

Targets	Implementation as of August 2014
1. Ou Stasie will have all its outdated asbestos pipes replaced with PVC as part of a 5-year plan.	Some replacements have already happened as per 2014 targets for a 5 year plan
2. It commits to constant cleaning up of its river reaches and its seepage pits. This includes removing weeds and reeds and alien invasives including the recently discovered aquatic invasive Myriophyllum aquaticum in one of the pits.	Clearing is ongoing task to avoid clogging of pipes. Myriophyllum aquaticum could not be found as suggested by CSIR. Possible misidentification?
3. A list of sighted water-bird species will be compiled over the next year.	Bird list is completed and on file of farm. Ou Stasie undertakes to update the list with new sightings particularly of endangered species.
4. Training refresher for irrigation staff	All new staff being trained on-site as part of the pre-season activities

2.2.2 Water stewardship activities for Denou

2.2.2.1 Description of site

Denou is a special-case farm in that it is a Black Economic Empowerment farm which is jointly owned and run by the Goosen family, as well as the farm staff. It is jointly run with 2 other farms belonging to the Goosen family (Ou Stasie and Jagerskraal). Denou is situated in the Ceres District and it grows stone and pome fruit and vegetables. The three-farm enterprise employs a total of 550 permanent staff, of which 40 families live in staff housing at Ou Stasie. The produce of Ou Stasie and its sister farms is roughly divided between the local market (50%) and the export market. Of the exported fruit, about 80% is destined for the UK market, while smaller proportions are sold to wider Europe, Canada, the African Islands and the Far East.

Denou obtains its water from the Koekedouw Irrigation Scheme and it has three boreholes. However, the boreholes are rarely used because of the poor quality of groundwater in the area. Irrigation infrastructure at Denou is being continually upgraded comprising mainly of drip and micro-sprinkler irrigated systems. The piping is being modernised replacing old asbestos pipes with PVC. Envisaged benefits of PVC piping compared to asbestos are lower frictional losses. Ou Stasie subscribes to several standards which include: Global gap, Field to Fork, CISA, Tesco and the BRC audit. Water quality is continually checked for compliance with export standards.

CREDIT: K. SCHACHTSCHNEIDER

Environmentally, the farm has several farm dams, which are populated by various species of water-bird. A reduction and change in fertilisers and pesticides a few years back saw the return of numerous water-birds which had left the area presumably because of deteriorating water quality.

The farm holds all required water use licenses and it is currently in the process of completing the validation and verification of lawful water use processs with BGCMA.

The greatest water risks for Denou are considered to be water regulation, reputational risk and social risks (in terms of electric cable thefts and the resulting impacts on pumping).

2.2.2.2 Targets and implementation at Denou

The completed assessment has led Denou to set up its own water stewardship targets, which outline the main commitments that Denou is undertaking with respect to its water. They are:

Targets	Implementation as of August 2014
1. Long-term goal to install water flow meters at each orchard block and to computerise the system completely.	Recent theft of entire pump-house equipment has necessitated the reallocation of budget thereby delaying implementation of this target.
2. Ongoing change of old asbestos with PVC tubing (bigger tubes to reduce friction).	Moving all taps to safe points on farm to reduce theft – as part of that process all old asbestos pipes are being replaced
3. Regular monitoring of dam (maybe a drain as well) water as part of in-and-outflow water quality checks.	Ongoing as part of annual water quality sampling at end of each year and new sampling points are being added.
4. Wetland to be left alone to allow for further recovery.	Done
5. List of water birds to be maintained and updated.	Bird list is completed and on file of farm
6. Undertake in-house training of 8-10 irrigators per year to increase efficiency.	All new staff being trained on-site as part of the pre-season activities

2.2.3 Water stewardship activities for Esperanto

2.2.3.1 Description of site

Esperanto is a Witzenberg property in the Koue bokkeveld. The farm grows stone fruit (cherries, peaches, nectarine) and pome fruit (apples) and vegetables. The produce is bought by both the local market (most SA chains, including Woolworths) and the UK (including M&S), wider Europe, Africa, the Far East and the US and Canada. The farm has 72 permanent employees and 525 contract workers. A total of 346 people live on the premises, consisting of workers and their families.

Esperanto is located in the upper reaches of the Olifantsdoorn catchment, receiving its water from the adjacent mountain streams. The farm diverts part of this stream water, storing it in 17 dams spread across the farm, from where it pumps water to its 356 hectares of crops. Irrigation on the farm is modern with all blocks under either drip or micro sprinklers. The farm is one of a few with a sound irrigation scheduling protocol via a combination of soil moisture probes, weather data and occasionally remote sensing tools such as Fruitlook.

Esperanto already subscribes to four standards which include: Global Gap, Tesco, CISA and Field to Fork. Water quality is continually checked for compliance with other export standards. All water sources are monitored annually for compliance.

Esperanto is located at the top of the catchment. Several pristine mountain streams run through the farm and merge inside the farm boundaries. This river is seasonally dammed at the bottom end of the farm, due to the dam wall height of the neighbouring farmer which was recently raised. This forms a wetland at which a multitude of wetland bird species congregate.

The farm holds all required water use licenses, but there are no active Water User Associations or catchment management agencies that Esperanto currently belongs to.

In terms of water-related risks, Esperanto faces the greatest risks of environmental damage to the river, as well as reputational risks. Hail and frost are also high risks to crops in the area.

2.2.3.2 Targets and implementation at Esperanto

The completed assessment has led Esperanto to set up its own water stewardship targets, which outline the main commitments that Esperanto is undertaking with respect to its water. They are:

CREDIT: K. SCHACHTSCHNEIDER

Targets	Implementation as of August 2014
1. 5-year plan to change time-based irrigation system to flow-based one. This will be implemented on new developments and re-plantings. Estimate 50-60% of area to be converted in 5 years.	Installed 3 flow meters in 2014
2. Water quality (outflow) is currently fine. Second water quality test scheduled at end of growing season. Special interest to check nitrates and phosphates.	Scheduled for November 2014
3. Looking at irrigation training for production managers. Plan to get 1 person on-site for training of 4 staff.	Training of 5 staff including the farm manager to be done on 21 August 2014.
4. Maintaining wetland at the lower end of the farm is of long-term interest.	Attended discussions on Berg-Olifantsdoorn on downstream fish conservation and fynbos rehabilitation projects
5. Soil moisture probes in more blocks are a long-term consideration.	Remains a long term consideration
6. Farm aims to change to short range micros which save water.	Long term consideration
7. Farm further aims to reduce water use by stone fruit from 6000 to around 5000 m3/ha/season.	Long-term aim that will be end-result of flow-meters and soil probes

2.2.4 Water stewardship activities for Lushof

2.2.4.1 Description of site

Lushof is part of Graaff-Fruit located close to Prince Alfred Hamlet. Currently the farm grows a total of 221 hectares of stone (nectarines, apricots, peach and plums) and pome fruit. The fruit are distributed locally (about 55%) and overseas (45%). Locally, fruit are sold to most supply chains, and juicing companies. Exports are for the UK and EU markets, and increasingly for the Indian and African markets. The farm employs 50 permanent and roughly 200 seasonal workers, of which 90% live off-site.

Lushof subscribes to four standards which include: Global Gap, Tesco Nurture, Field to Fork and CISA.

Irrigation water for Lushof is obtained from three different schemes, namely the Koukedouw, the Rooikloof and the Warm bokkeveld. The farm also has backup boreholes, but they are not used for irrigation due to the local brak water conditions.

Water infrastructure and irrigation scheduling at Lushof is state-the-art and automated. They have flow meters monitoring water applied to all blocks. Irrigation scheduling is done via soil moisture probes rented from an irrigation consulting company and weather data from an automatic weather station on site. The soil moisture probes are linked by a telemetry system to a central PC enabling the farm manager to closely monitor the water status and irrigation of various orchards in real time.

Water quality is continually checked for compliance with other export standards. All water sources, including groundwater are monitored annually.

The farm has one important water related area, namely the Skaap River that runs through the property. The river is very degraded, due to its regulation from the Warm Bokkeveld dam, and the fact that most farms drain their irrigation outflows into the Skaap River. At Lushof, the river is heavily overgrown with reeds.

The farm holds all required water use licenses and the farm manager is part of the Board for the Koukedouw Water User Association.

In terms of water risks, Lushof faces the greatest risks from drought and social risks (in terms of electric cable theft and vandalism).

2.2.4.2 Targets and implementation at Lushof

The completed assessment has led Lushof to set up its own water stewardship targets, which outline the main commitments that Lushof is undertaking with respect to its water. They are:

CREDIT: AVENANT

Targets	Implementation as of August 2014
1. To continually optimise irrigation methods and timing with the aim of having a 20% buffer amount of water left in the main dam at the end of the season.	In 2014 had 15% safety in dam left
2. To install a flow meter on the flush unit of the filters, to assess saving opportunities during the flushing process.	Part of a 10-year plan not yet addressed
3. Include outflow water quality checks annually	Scheduled for late 2014
4. In some cases orchards are planted too close to the river. As part of a long-term plan the idea of an increased riparian buffer zone will be implemented.	Plan remains. Will be implemented during replanting.
5. Investigate 2014 opportunities for training of 10 people in water-related matters.	Completed for 7 people
6. Plan to put their own flow meter at Koukedouw to minimize water theft.	Part of long-term plan
	Bought (R 50 000) and installed another VSD – now all of the farm irrigation is computerised
	Media coverage in Landbou Weekblad has led to Lushof being contacted for irrigation advice. They have entered a Waitrose competition for an irrigation demonstration farm.

2.2.5 Water stewardship activities for Romansriver

2.2.5.1 Description of site

Like Lushof, Romansrivier is part of Graaff-Fruit, growing over 80 hectares of stone fruit (peach, nectarine and plum) and pome fruit. It is situated in the Wolseley District at the foothills of the Mosterstukburg mountain and at the headwaters of the Breede River. Its fruit are sold to local markets (20%), juice companies (10%) and to export markets (70%). Exports go to the Middle East, Canada, the UK and Europe. Of the approximately 100 staff members, 30 are permanently employed and 12 live on-site.

Romansrivier subscribes to Global Gap, Tesco Nature's Choice and LEAF.

Romansrivier obtains its irrigation water from annual runoff and from a spring off the Mosterstukbrug mountain. The entire farm is under modern irrigation systems primarily drip and micro sprinklers. Water is gravity fed from the dam located upstream of the orchards on the foot slopes of the Mosterstukbrug mountain. About 60 ha of fruit are produced under shade nets mainly to minimize wind damage and sunburn. In addition, the farm uses water conservation practices such as mulching quite extensively.

Incoming water quality is checked annually for compliance with export standards. Environmentally, the farm has agreements with CapeNature to invest an annual budget of around R 100 000 into clearing the upstream mountain slopes of invasive alien plants, in order to ensure biodiversity and increased runoff.

The farm holds all required water use and dam licenses and does not belong to any irrigation board or water user association due to its water self-sufficiency.

In terms of water risks, Romansrivier is believed to face mostly low risks from drought, water regulation, water quality and environmental risks. Social risk (in terms of labour strikes and resulting damage) was seen as moderate.

2.2.5.2 Targets and implementation at Romansrivier

The completed assessment has led Romansrivier to set up its own water stewardship plan, which outlines the main commitments that Romansrivier is undertaking with respect to its water. They are:

Targets	Implemented as of August 2014
1. Another 4000 m3 of mulching to be placed on 20 ha. This has previously cut back irrigation frequency from daily to once every 3 days.	Bought (R 500 000) to be added to 40-60ha
2. Reduce application of N back to 150 kg/ha from the current 165 kg/ha	Reduced application by 15kg/ha
3. Annual outflow water quality measurements to be included with other water quality sampling	Coming up at end of year and will include additional sampling points identified during the study.
4. Training of staff	2 people on training course, on-site training ongoing

CREDIT: K. SCHACHTSCHNEIDER

2.2.6 Water stewardship activities for Trevor's Farm

2.2.6.1 Description of site

Trevors' Farm is a small-scale farm and one of the few Black Economic Empowerment farms in the area. It is situated near Prince Alfred Hamlet and grows over 21 hectares of stone fruit (peach, nectarine and plum). Of these, about 40% of fruit are supplied to the local market and 60% are exported to the Middle and Far East, the UK and the rest of the EU. The farm owner employs 18 permanent and 15 seasonal staff and one family living on the farm.

The farm subscribes to Global Gap and Cisa.

Trevor's Farm obtains its water from the Koukedouw Irrigation Scheme. The farm is under modern irrigation systems, mainly drip and medium range micro-sprinkler. Incoming water quality is continually checked for compliance with all export standards e.g. Global Gap. There are no important water related areas like rivers or wetlands within the farm boundaries. The farm holds all required water use licenses for the Koukedouw Irrigation Board. The farm owner is also a board member of the Breede-Overberg Catchment Management Agency (BGCMA).In terms of water risks, the owner felt the farm was at low risk from droughts and floods, from water quality, water regulation and social risks.

2.2.6.2 Targets and implementation at Trevor's farm

The completed assessment has led Trevors' Farm to set up its own water stewardship plan, which outlines the main commitments that Trevors' Farm is undertaking with respect to its water. They are:

Targets	Implementation
1. Annual water quality sample of drainage water sent off for full analysis.	Scheduled for end of year
2. Revisit irrigation allocation per hectare by comparing actual use with the allocation.	Yet to be implemented.
3. Improve irrigation scheduling.	Plans to install tensiometers. Approached a funding organization for assistance.
4. Will take steps to send two staff members on irrigation training at the Kouebokkeveld Training Centre.	One person was trained.

CREDIT: S. DZIKITI

2.2.7 Water stewardship activities for Waboomskraal

2.2.7.1 Description of site

Waboomskraal is a fruit farm situated near Prince Alfred Hamlet, growing over 115 hectares of stone fruit (peach, nectarine and plum) and pome fruit. Most of the fruit is sold to the local market (60%) and 40% is exported mainly to the UK. The farm sells both fresh and dried fruit. Waboomskraal employs 42 permanent and 110 seasonal staff. A total of 25 staff stay on the farm. Waboomskraal subscribes to three standards, namely Global Gap, Tesco Nurture and Field to Fork.

The farm obtains its water from the Koukedouw and Warm Bokkeveld irrigation schemes. The water is stored in 3 dams on site. Irrigation infrastructure at Waboomskraal consists of drip and micro sprinkler systems. Soil moisture probes are currently being used for scheduling irrigation in selected blocks. Quality of all incoming water is continually checked for compliance with other export standards e.g. Global Gap and sampling is done annually.

There are no important water related areas like rivers or wetlands within the farm boundaries. The farm holds all required water use licenses and is represented at the Koukedouw, and the Koue Bokkeveld Water User Associations. In terms of water risks, Waboomskraal thinks it faces moderate risks from drought, water regulation and social risks (i.e. theft and vandalism).

2.2.7.2 Targets and implementation at Waboomskraal

The completed assessment has led Waboomskraal to set up its own water stewardship targets, which outline the main commitments that Waboomskraal is undertaking with respect to its water. They are:

Targets	Implementation as of August 2014
1. Consider installing more soil moisture probes for objective irrigation scheduling.	Tested 1 soil probe successfully and bought 2 extra in 2014 more to follow in 2015
2. Consider reducing water use from the current 7500m3/ha to around 7300m3/ha with improved irrigation scheduling.	Long term, to be achieved with change to more soil moisture monitoring
3. Ensure all water quality parameters are within relevant guidelines.	Test scheduled for end of year
4. Annual monitoring of outflow water quality to be included in samples and analyses	Test scheduled for end of year
5. Checking on 2014 training opportunities, in line with already existing training programme at Koue Bokkeveld Centre (2 staff)	

CREDIT: S. DZIKITI

2.2.8 Water stewardship activities for Welgemeen

2.2.8.1 Description of site

Welgemeen is a fruit farm near Prince Alfred Hamlet that grows over 109 hectares of stone (peach, nectarine and apricot) and pome fruit. The fruit are sold to the local market (30%) and about 70% is exported. Main overseas markets are the UK, the remaining EU, the Middle and Far East, Russia, the USA and Africa. The farm employs about 205 staff in-season and 125 off-season. There are 23 inhabited houses on the farm.

Welgemeen subscribes to Global Gap, Nature's Choice and CISA. Welgemeen obtains its water from the Koukedouw Dam as well as the Warm Bokkeveld scheme. Irrigation infrastructure at Welgemeen is modern with all orchards under micro sprinkler and drip irrigation. Incoming water quality is continually checked for compliance with all export standards e.g. Global Gap and Nature's Way. The farm has one important water related area, namely the Skaap River that runs along its property. The river is very degraded, due to its regulation from the Warm Bokkeveld dam, and the fact that most farms drain their irrigation outflows into the Skaap River. At Welgemeen, the river is heavily overgrown with reeds that require annual control.

The farm holds all required water use licenses and belongs to both the Koukedouw and the Warm Bokkeveld Water User Associations. In terms of water risks, Welgemeen faces moderate risks from drought, the disturbance of important water related areas (Skaap River) and social risks (in terms of theft and vandalism).

2.2.8.2 Targets and implementation for Welgemeen

The completed assessment has led Welgemeen to set up its own water stewardship plan, which outlines the main commitments that Welgemeen is undertaking with respect to its water. They are:

Targets	Implementation as of August 2014
1. To include water quality monitoring of outflow in annual quality tests – and to have all water quality parameters within the levels of irrigation guidelines	Scheduled test for November
2. Training has already occurred. This year 1 extra person (production manager) will be trained at Kouebokkeveld opleidingssentrum.	Two further staff members were trained since the planning stage
3. In order to be more accurate, it is part of 5 year plan to install 4 flow meters in the key irrigation areas of the farm, in order to accurately assess irrigation levels.	One flow meter was replaced, another one in repair
4. Annual monitoring of outflow water quality to be included in samples and analyses	Test scheduled for end of year
5. Checking on 2014 training opportunities, in line with already existing training programme at Koue Bokkeveld Centre (2 staff)	

CREDIT: K. SCHACHTSCHNEIDER

2.2.9 Water stewardship activities for Sonskyn

2.2.9.1. Description of site

Sonskyn is a family-owned farm in the Robertson District that grows over 52 hectares of stone (nectarine, apricot and plum) and citrus fruit, as well as some vegetables. It obtains its water from the Central Breede River irrigation scheme.

Water infrastructure at Sonskyn is modern with all orchards under drip and micro sprinkler irrigation systems. Flow meters are installed at key points to monitor water usage. Staff is regularly trained to ensure maintenance is well-executed. The incoming water quality is continually checked for compliance with export standards, such as Global Gap.

There are no important water related areas, such as wetlands and rivers on the property and there are no invasions by alien plants on the property. The farm holds all required water use licenses and is represented at the Central Breede Water User Association.

In terms of water risks, Sonskyn is perceived to face moderate risks of drought and water quality deterioration. There is a social risk, in terms of theft and vandalism, but security checks are in place in order to minimise these.

2.2.9.2 Targets and implementation at Sonskyn

The completed assessment has led Sonskyn to set up its own water stewardship plan, which outlines the main commitments that Sonskyn is undertaking with respect to its water. They are:

- To look into the pipe layout to staff houses, exploring the option of implementing water meters to staff quarters.
- Minimizing water losses through leakages from the canal and other irrigation infrastructure.

However, the farmer has been unavailable for the final round of engagements.

CREDIT: S DZIKITI

2.3 SCALING UP - CATCHMENT ACTIVITIES

2.3.1 Catchment level workshop overview

A multiple-stakeholder workshop was held in April 2014 to identify key sub catchment water risks and opportunities for co-operation. Key risks identified were related to water quality and resultant reputational risks. Other risks were reputational, due to challenges around institutional transformation.

Areas of potential collective action can be summarized as:

1. Securing the valuable water information being gathered in the project: alignment with BGCMA water quality monitoring.
2. Information sharing and knowledge transfer: Web-based tool in collaboration with BGCMA and the Danish Hydrological Institutie (DHI) with funding from the Danish Embassy South Africa to share the information, rewarding good behaviour (picked up from legal perspective); knowledge transfer among other commercial and informal farmers on e.g. irrigation scheduling.
3. Prince Alfred's Hamlet water quality management: WASH, waste disposal management (in collaboration with the municipality); engagement with the informal farmers (Department of Agriculture).
4. Alien vegetation clearing in the headwaters (in collaboration with CapeNature).

2.4 BRIEF OVERVIEW OF PHASE 2

1. Collective action projects (i.e. the agreed catchment level activities) are initiated, supporting better water stewardship in the upper Breede Overberg Catchment and therefore reducing water risks to farmers, to catchment stakeholders and sourcing retailers
2. The AWS online tool is implemented to establish on-going support for water stewardship activities in the Breede catchment and its application is scaled up to other regions of South Africa by linking it to the Water Risk Filter
3. Guidelines (created in phase 1) are disseminated widely in order to scale-up water stewardship in other parts of South Africa and beyond.
4. The AWS standard is further tested on volunteers, allowing for final recognition of participants of being good water stewards at the end of the engagement period.

3.0 TESTING THE BETA/FINAL STANDARD: AN AWS PERSPECTIVE

As we have only gone through steps 2 and 3 of the beta standard and there has been no validation of conformity (which would only come after full implementation) we cannot say whether the farmers would have met the standard and/or what would have needed to change to meet the standard. What we can say, however, with some confidence is that using the standard as a framework for engagement and as a "safe place" to ask the right questions has led to a much more nuanced understanding of both individual farm water use and the catchment conditions. This has led directly to the identification of major threats, as listed elsewhere in this report, and the beginnings of a platform to address these catchment-level threats.

Key lessons from AWS's perspective:

1. **Public policy support**. The political context in which this project has been implemented have strongly influenced how the AWS Standard v1.0 aims to ensure that water stewardship supports public policy. Two main factors were 1. Worker unrest in 2012 in the Ceres region that impacted project implementation, and; 2. Revision of the National Water Resource Strategy, including proposals to disestablish WUAs and merging of CMAs. Important improvements from the Beta Standard to v1.0 were (step 2) that implementers need to understand not just physical and socio-economic context, but also the "institutional" context (who is doing what?), and (step 3) the site water stewardship plan needs to be shared with relevant authorities, not for approval but to maximize the likelihood that the plan will align with and support public policy objectives.
2. **Alignment with other standards**. The project has re-emphasized the importance of aligning with other standards and initiatives (an explicit objective of AWS) and highlighted GlobalGAP as the most relevant in this context. Note that alignment does not mean "integration". Alignment would likely involve recognition of criteria covered by GlobalGAP (or others) to avoid dual auditing. The AWS Standard taking a catchment level and water stewardship approach is clearly going to go above and beyond GlobalGAP in terms of water. We should not be aiming to do "one or the other" rather to apply the AWS Standard where the needs/risks/opportunities are greatest and in so doing ensure that relevant criteria of GlobalGAP are covered.

3. **Verification**: The project has directly informed the development of the AWS verification system. We have almost finalized a step-wise approach that links awareness-raising, training and verification, emphasizing continual improvement. Importantly, this system will enable recognition of progress as well as recognition of full compliance. This builds directly off the learning from the Ceres project.
4. **Group verification/certification**: the involvement of multiple farmers in a single project has helped us understand the needs when it comes to making AWS accessible to groups, whether farmers, SMEs or others.
5. **Local guidance**: the need for supplementary material and support to effectively implement a global standard shone through in the project. The work to develop the information-sharing tool in the next phase is a (replicable) example of the importance of local specificity married to global consistency.
6. **Support services**: the workshop in November 2013 highlighted the need for training. We have subsequently developed the initial elements of a "core" training program, to be supplemented by locally-specific material. To enhance the development of this locally-specific material and improve access to the locally-skilled expertise, we have launched an accreditation program for training service providers, consultants and conformity assessment bodies.

3.1 Beta AWS Standard Pilot Summary Report

3.1.1 Facilitated testing of AWS standard along assessment of on-site water use

This project facilitated a multitude of objectives simultaneously. Just as M&S was interested in testing and mitigating their supply chain water risk, the AWS tested the Beta and final version of its standard. At the outset of this project in September 2013, the Beta version of the AWS standard was tested on 9 stone fruit farmers in Ceres. By April 2014, the final version of the AWS standard was launched. The adjustment of the standard required a careful review of the standard amendments, which were integrated in the ongoing testing process. The research team found it particularly helpful to be working with the Beta-version MS Excel sheet during the interview process. Such a sheet does not currently exist for the final standard version, but is highly recommended by the research team in this final report.

3.1.2 Quotes from participants about their perceptions of the AWS standard

Christi, JC, Trevor and Derek: *'We all like to be at the forefront of initiatives like these, hence we were keen to get involved.'*
Derek: *'The entire process stimulated a lot of thinking and made us re-evaluate our irrigation scheduling process'.*
Simon: *'As farmers we were not used to think about water at this level of detail and with such focus. It was a great learning curve.'*
Paul-Daniel: *'We installed more soil moisture probes during this year as a result of our engagement in this project. Using this level of technology helped us cut down our irrigation amounts and consequently our pumping costs.'*
JC: *'It is always good to measure ourselves against others. But it is also great to see that our estimates coincided with your findings. It shows us that we are on the right track.'*
Christi: *'We appreciated that this standard looked at outgoing water quality. It was something we never had to do before and we were pleasantly surprised by the outcome. Showing that we are not polluting is reassuring that we are doing the right thing and we are interested in continually monitoring this.'*
Danie: *'We appreciated the local publicity we got through Woolworths World Water Week media initiative. The article in the national Landbou Weekblad showed that we are at the forefront of good irrigation practices, and we have information to give to others. We have had quite some interested by other farmers to come and look at our system.'*
Trevor: *'This standard not only provides an opportunity for farmers to improve their on-site water use, but it has the potential to play an important role at the decision makers' level, providing scientific information on which to base South Africa's water reform decisions on.'*

Frequently raised comments regarding the standard:

- The standard was very thought-provoking, as it made everybody think about water in a different and more focussed way. It sparked the motivation to refocus and improve on several irrigation scheduling and monitoring issues.
- The standard was well-presented by the research team, clarifying concepts with every step (this comment also means that some support may be required for self-assessors. Hence the development of a web-based tool may address this matter)
- Participating in the standard gave many farmers the reassurance that their own practices and plans are on-track and comparable with international levels.

3.2 Streamlining of AWS standard with other standards

As part of the final feedback from participants, they were asked if they preferred the AWS standard as a unique, stand-alone standard, or if they felt that the standard should be integrated into – or aligned to other standards.

All farmers reported that there was considerable overlap between information required for Global Gap and the AWS standard – and the WWF has noted overlaps between the AWS standard and other agricultural standards in South Africa (SuSfarms, Sustainable Fruit Initiative SFI, African Ecolabeling). Marked differences were the water quality measurements of drainage water, groundwater questions, the strong focus on quantified water measurements and technical details, such as the water balance calculation. One farmer commented that the focus on quantification (normal to the water sector) was very new to the agriculture sector, requiring considerable financial and technical input. Several farmers mentioned a concern that the average farmer might not be able to complete and understand the standard on their own. Support would be beneficial.

Seven farmers stated that they were already subscribing to at least 3 to 4 standards and they had little interest in completing yet another standard – and paying for it. Some felt it would be good to integrate the AWS standard into Global Gap, as that is fast becoming the standard acceptable to both international and local supermarket chains. One farmer thought that South Africa should combine all its agriculture standards and make that combined product acceptable by all international standards, like AWS, BonSucro and Global Gap. There was a clear preference to do one standard well, rather than repetitively answering to separate standards, paying for certification each time.

Two farmers told of their experience that standards start simple and grow in complexity over time. They expressed concern that the AWS standard might undergo the same fate.
One farmer, at home in the water sector and agriculture, thought that the standard was too unique and important to be watered down through the integration into another standard. He showed concern that the business model for other standards placed greater emphasis on the increased numbers of subscriptions, rather than compliance and he did not want to see the AWS standard lose impact in such a way.

REFERENCES

ALLEN, R., PEREIRA, L.S., RAES, D. and SMITH, M. 1998. Crop evapotranspiration. FAO Irrigation and Drainage Paper 56. Food and Agriculture Organization (FAO), Rome, Italy.

Department of Agriculture, Forestry and Fisheries (DWAF). 1996. South African Water Quality Guidelines. Vol 7. Aquatic Ecosystems. Department of Water Affairs and Forestry. Second Edition.

Department of Agriculture, Forestry and Fisheries (DWAF). 1996. South African Water Quality Guidelines. Volume 4. Agricultural Use - Irrigation. Department of Water Affairs and Forestry. Second Edition.

Genthe.B and Frank, M. 2000. A field test for assessing the microbial quality of water: an H2S strip test. Wisa Conference. South Africa.

GUSH, M.B and TAYLOR, N.J. 2014. The water use of selected fruit tree orchards. Volume 2. Technical report on measurement and modeling. Water Research Commission Report No.1770/2/14, WRC, Pretoria, RSA. (ISBN 978-1-4312-0575-2).

HOEKSTRA, A.Y., CHAPAGAIN, A.K. ALDAYA, M.M. and MEKONNEN, M.M. 2009. Water footprint manual. State of the Art 2009. Water Footprint Network.

HORTGRO. 2013. Tree census. Available at http://www.hortgro.co.za/market-intelligence-statistics/tree-census-database.

MIDGLEY, S.J.E. and LÖTZE, E. 2011. Climate Change in the Western Cape of South Africa: Trends, Projections and Implications for Chill Unit Accumulation. Acta Horticulturae 2011; 903: 1127-1134.

REPUBLIC OF SOUTH AFRICA.1998. South African National Water. Act No 36 of 1998.

SAB MILLER and WWF-UK. 2009. Water Footprinting: Identifying and addressing water risks and the value chain. Available http://www.sabmiller.com/files/reports/water_footprinting_report.pdf.

STEVENS, J.B. 2006. Adoption of irrigation methods in South Africa. PhD thesis. University of Pretoria.

VOLSCHENK, T., DE VILLIERS, J.F. and BEUKES, O. 2003. The selection and calibration of a model for irrigation scheduling in deciduous fruit orchards. Water Research Commission report 892.

GLOSSARY

Ammonia	A form of nitrogen found in organic materials, sewage, and many fertilizers. It is the first form of nitrogen released when organic matter decays. It can be used by most aquatic plants and is therefore an important nutrient. It converts rapidly to nitrate (NO3) if oxygen is present. The conversion rate is related to water temperature. Ammonia is toxic to fish at relatively low concentrations in pH-neutral or alkaline water. http://www.ecologydictionary.org/RTMYP/EU-Bio-Glossary/leaf_area_index
Coliforms (total)	Total count of bacteria that serve as indicators of pollution and pathogens when found in water. These are usually found in the intestinal tract of humans and other warm-blooded animals. http://www.lenntech.com/water-glossary.htm#Parameter#ixzz3HWMbj5GZ
Crop factor/crop coefficient	The ratio of evapotranspiration occurring with a specific crop at a specific stage of growth to potential evapotranspiration at that time. http://www.ecologydictionary.org/RTMYP/EU-Bio-Glossary/leaf_area_index
Dissolved organic carbon	A measure of the organic compounds that are dissolved in water. In the analytical test for DOC, a water sample is first filtered to remove particulate material, and the organic compounds that pass through the filter are chemically converted to carbon dioxide, which is then measured to compute the amount of organic material dissolved in the water. http://www.ecologydictionary.org/RTMYP/EU-Bio-Glossary/leaf_area_index
Electric conductivity	The amount of electricity the water can conduct and a measure of salinity. It is expressed in a chemical magnitude. http://www.lenntech.com/water-glossary.htm#Parameter#ixzz3HWMOMCRZ
Escherichia coli	Coliform bacterium that is often associated with human and animal waste and is found in the intestinal court. It is used by health departments and private laboratories to measure the purity of water. http://www.lenntech.com/water-glossary.htm#Effluent#ixzz3HWKWyaF8

Eutrophication	Enrichment of water, which causes excessive growth of aquatic plants and increasing activity of anaerobic microorganisms. As a result the oxygen levels in the water quickly decline and the water chokes, making life impossible for aerobic water organisms. http://www.lenntech.com/water-glossary.htm#Effluent#ixzz3HWK2D5DU
Evaporative demand	Evaporative demand is a measure of the extent to which the environment is 'trying' to evaporate water. Farquhar, G. and Roderick, M. 2007. Worldwide changes in evaporative demand. Water and the Environment Pontifical Academy of Sciences, Scripta Varia 108, Vatican City 2007. Evapotranspiration - The loss of water from the soil through vaporizing, both by directevaporation and by transpiration from plants. http://www.lenntech.com/water-glossary.htm#Effluent#ixzz3HWKCn3A
Kaoline spray	a fine white clay produced by the decomposition of feldspar, sprayed onto fruit to avoid sunburn. https://florabase.dpaw.wa.gov.au/help/glossary#L
Leaf area index	The area of one side of leaves per unit area of soil surface. http://www.ecologydictionary.org/RTMYP/EU-Bio-Glossary/leaf_area_index
Nitrate	A compound containing nitrogen that can exist in the atmosphere or as a dissolved gas in water. A plant nutrient and inorganic fertilizer, nitrate is found in septic systems, animal feed lots, agricultural fertilizers, manure, industrial waste waters, sanitary landfills, and garbage dumps. Nitrates in water can cause severe illness in infants and domestic animals. http://www.ecologydictionary.org/RTMYP/EU-Bio-Glossary/leaf_area_index
pH	The value that determines if a substance is acid, neutral or basic, calculated from the number of hydrogen ions present. It is measured on a scale from 0 to 14, on which 7 means the substance is neutral. pH values below 7 indicate that a substance is acidic and pH values above 7 indicate that it is basic. http://www.lenntech.com/water-glossary.htm#Parameter#ixzz3HWLlnUKv

Phosphate	Phosphates are materials containing a phosphate group; sources include some fertilizers and detergents; when wastewater containing phosphates is discharged into surface waters, these chemicals act as nutrient pollutants (causing overgrowth of aquatic plants). http://www.ecologydictionary.org/RTMYP/EU-Bio-Glossary/leaf_area_index
Potassium (K)	Potassium is part of many minerals. Potassium ions are necessary for the function of all living cells. This resulted in potassium first being isolated from potash, the ashes of plants, giving the element its name. For the same reason, heavy crop production rapidly depletes soils of potassium, and agricultural fertilizers consume 95% of global potassium chemical production. http://en.wikipedia.org/wiki/Potassium
Remote sensing	Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object. The term generally refers to the use of aerial sensor technologies to classify objects on earth by means of created signals, e.g. from aircraft or satellites) or passive (e.g. sunlight). http://en.wikipedia.org/wiki/Remote_sensing
Stomata	Stomata are minute aperture structures on plants found on the outer layer of leaves. Their main function is to allow gases such as carbon dioxide, water vapour and oxygen to move rapidly into and out of the leaf http://www.eoearth.org/view/article/156262/
Telemetry	Telemetry is the automated communications process by which measurements are made and other data collected at remote or inaccessible points and transmitted to receiving equipment for monitoring. http://en.wikipedia.org/wiki/Telemetry
Transpiration	The process by which water vapour is released into the atmosphere after transpiring of living plants. http://www.lenntech.com/water-glossary.htm#Parameter#ixzz3HWMFgNie

WWF®

WATER STEWARDSHIP FORSTONE FRUIT FARMERS

100% RECYCLE

8%

land area provides 50% of our surface water

47.5

litres of water to grow 1 peach

66%

of our water is used by agriculture

22.6

litres of water to grow 1 plum

60%

of freshwater ecosystems are threatened, 65% of wetland ecosystems are threatened

WWF

Why we are here
To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

www.wwf.org.za

ZA WWF.ORG.ZA