Runoff farming : responding to smallholders diverse agricultural water needs

Jonathan Denison

26 September 2013

Dr Backeberg
Dr Sanewe
Prof van Averbeke

WATER RESEARCH COMMISSION

UMHLABA CONSULTING GROUP

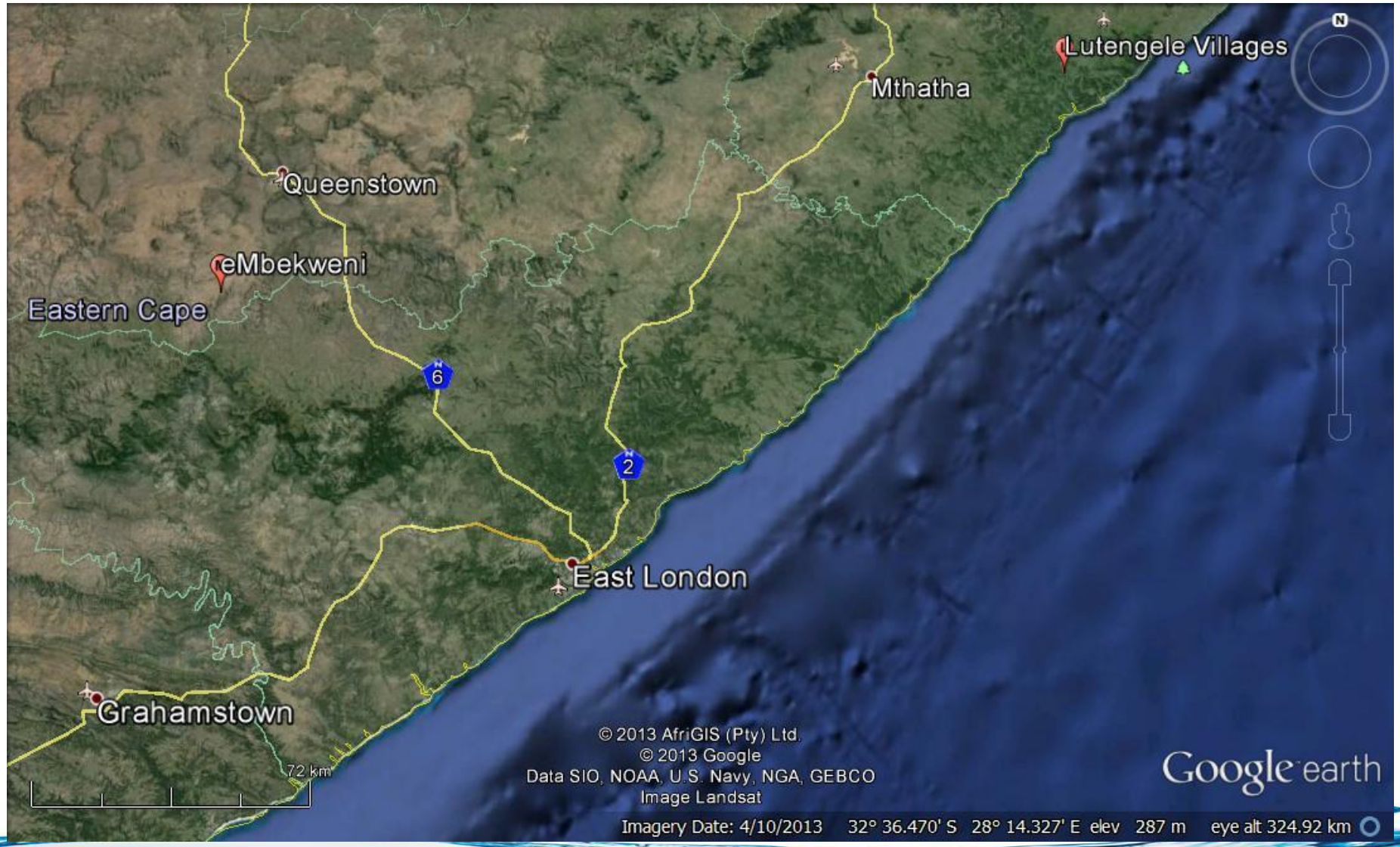
Water Research Commission Symposium 2013

LOCAL SOLUTIONS - GLOBAL IMPACT

Quick perspectives on smallholder agricultural water use

- Snapshots of development realities and potential in an illustrative village setting
- Research-generated solutions currently on the table with reference to international uptake
- Making the NDP, WAR and IWRM work at local level

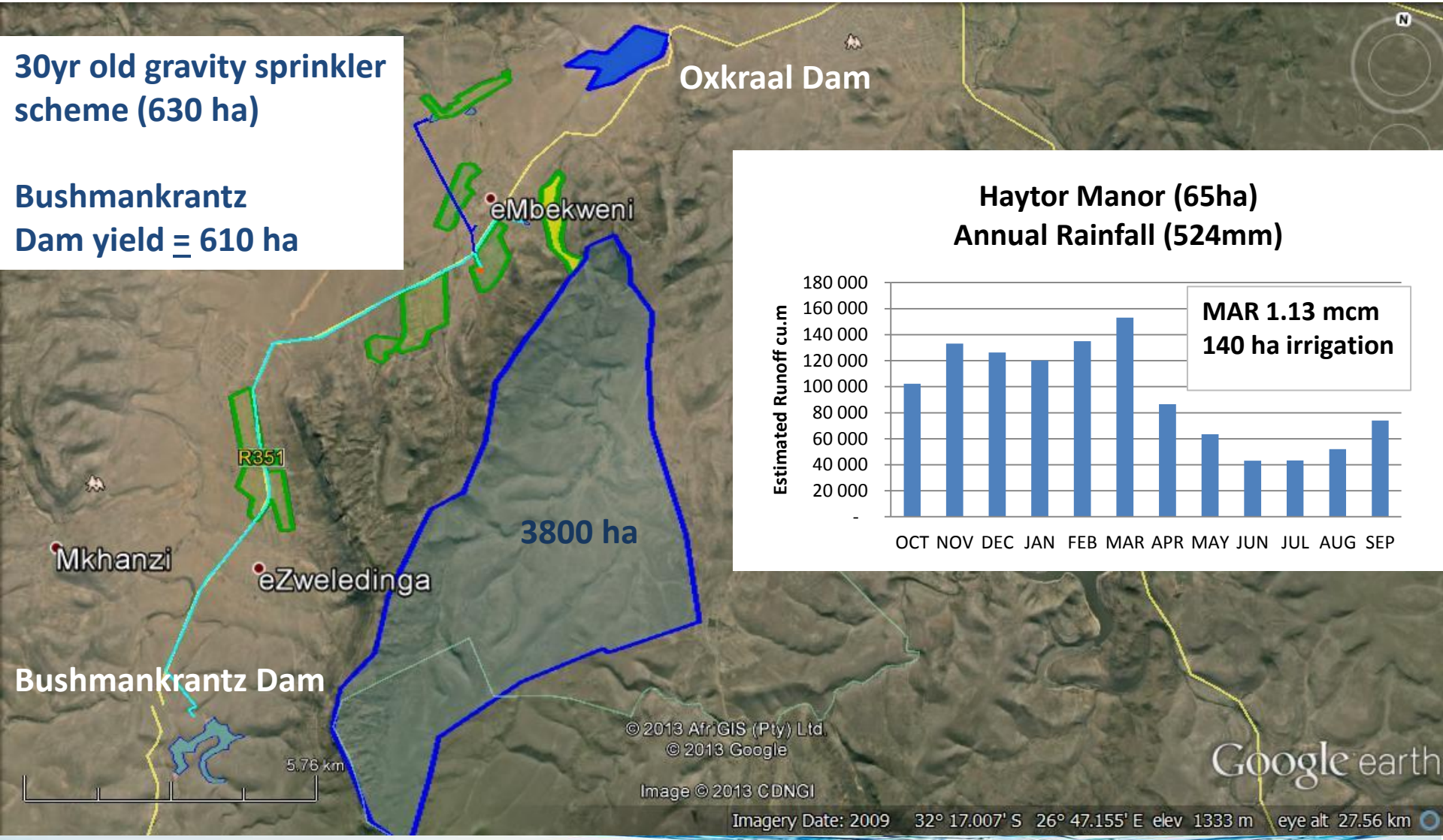
Mbekweni & Lutengele Villages



Mbekweni village - land and water

30yr old gravity sprinkler scheme (630 ha)

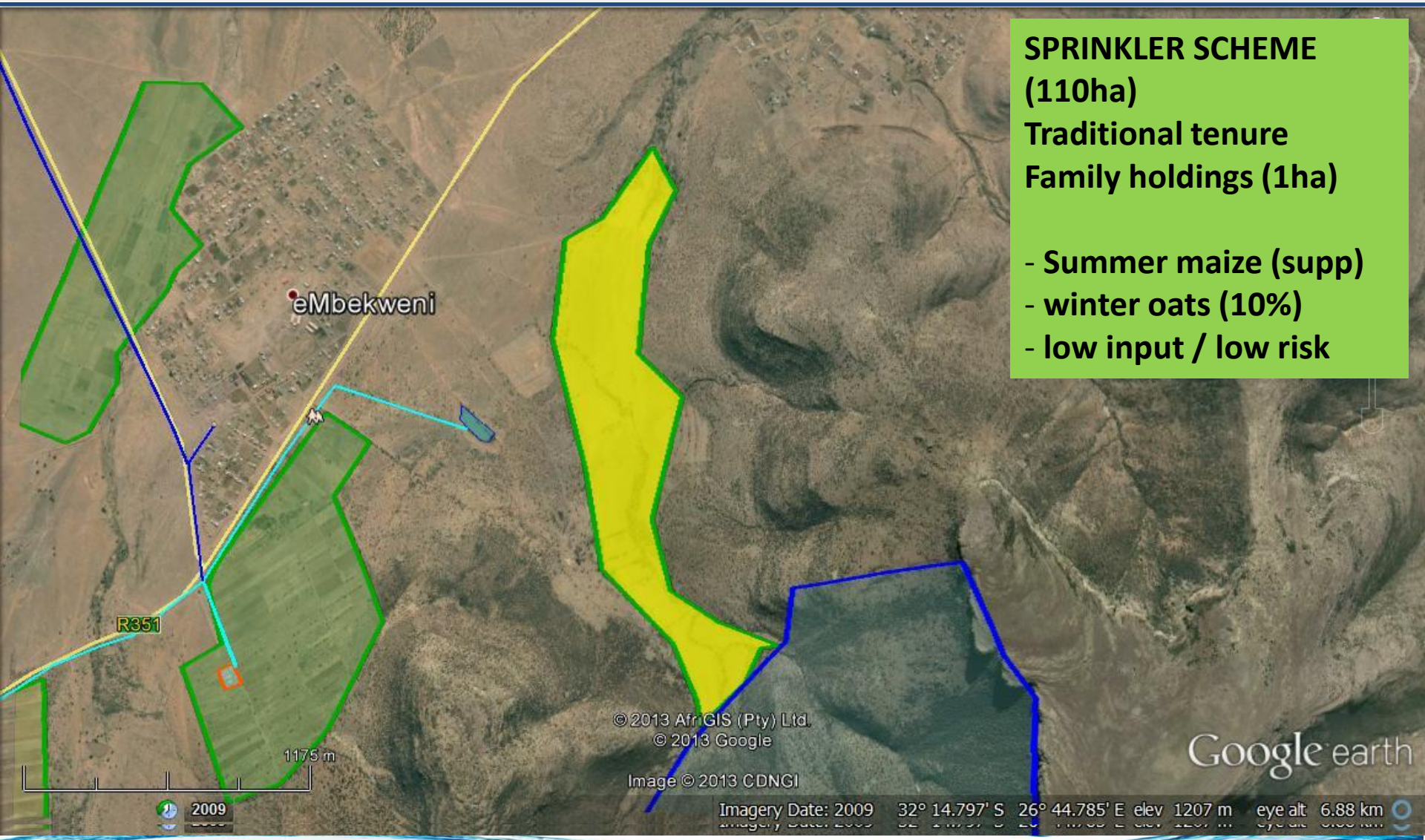
Bushmankrantz Dam yield = 610 ha



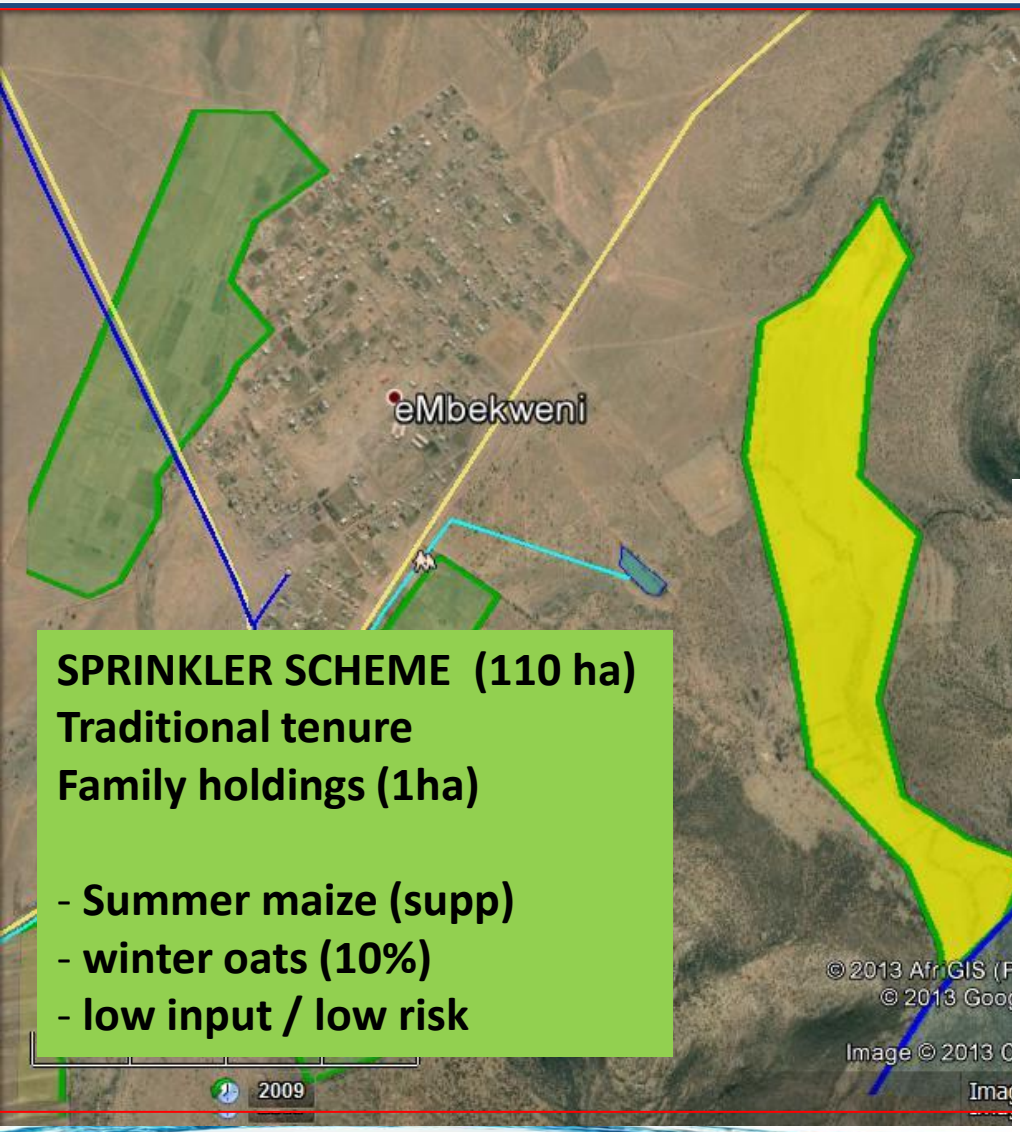
Haytor Manor (65ha)
Annual Rainfall (524mm)

Another project sponsored by the Water Research Commission

Mbekweni close-up on land-use



Mbekweni close-up on land-use



HAYTOR MANOR (65ha)
Tribal Trust land
(ie. no individual rights)

- **deep alluvial soils**
- **no irrigation infrastructure**
- **no activity since Gqozo rebellion**

SPRINKLER SCHEME (110 ha)
Traditional tenure
Family holdings (1ha)

- **Summer maize (supp)**
- **winter oats (10%)**
- **low input / low risk**

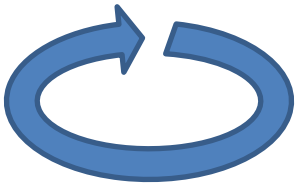
Very low utilisation of available land and water resources (10-15%)

- **WHY ?**
- **ASPIRATIONS?**
- **WHAT OPTIONS?**

Participative agric water-use planning

Another project sponsored by the Water Research Commission

Farming approaches - framework

Farming systems  **livelihoods.**

peasant farming, income one motivation; also own consumption, social linkages, resource reproduction.
- limited appetite for risk
- reduced dependence on external markets

entrepreneurial farming - full market engagement to generate profits. Volatility of markets = risks.

corporate farming – large scale, within a web of interlinked agri-enterprises.

Denison and Manona (2007) (amended)		Van Averbeke and Mohammed (2006)	
Typology	**Purpose of farming**	**Purpose of farming**	**Farming style**
Food plot farmer	Mainly for own consumption with some local marketing. Low external input approaches to production	At least 50% of their gross farm income as food for home consumption with weaker gross …n't sell maize.	**Food farmer Type 1**
Low-risk part-time farmers	Diverse purposes in line w… diversified livelihoods of plot holders and diverse approaches to production reflecting risk appetite. Local (urban) markets dominate but with assistance distant markets can be accessed.	…% of their gross farm income as …ood for home consumption with better gross margins. Market extra maize.	**Food farmer Type 2**
		Characterised by low profitability and employed at least one full-time farm worker	**Employer**
Business farmer	Full-time, commercial farming that includes enga… markets. High… systems that r… finance.	Market-oriented production with the	**Profit-maker**
Equity-labourer	Commercial farming with strategic partner who m… whilst plot hol… receiving a sh… providing the land.		

Peasant farming

entrepreneural farming

corporate farming

Diversity on the ground

Embekweni is a microcosm that reflects across smallholder agriculture contexts in South Africa

In the same locale we have different …..

- **land-tenure/size realities**
- **water infrastructure conditions and costs**
- **resource availability**
- **aspirations vis-à-vis crop and animal production**

Local strategies

HEWU DALUBUZWE

WATER USERS ASSOCIATION

BUSINESS PLAN

FOR 2013 – 2015

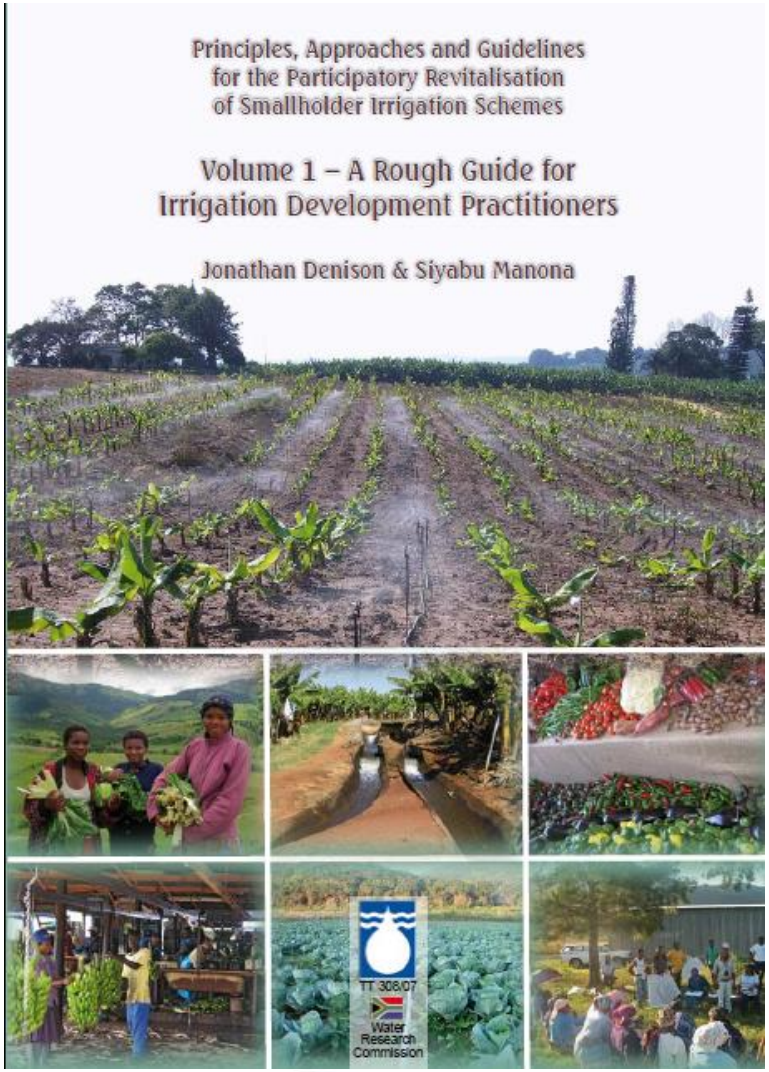
EXPANDED TASKS FOR OBJECTIVE No 3 :
Identify agricultural water potential and develop project concept plans to facilitate funding

Steps	Target date
1. **GET INFORMATION ON IRRIGATION AND WATER-HARVESTING FOR CROPS** (see Appendix B for examples) a. Establish links with Universities and Agricultural Colleges (Fort Cox, Dohne, University of Fort Hare, Agricultural Research Council, Water Research Commission). b. Get information on types of agricultural water use (irrigation, rainwater harvesting, floodwater harvesting etc.) - books, videos, presentations, visits to other sites c. Get information from the Dept of Agriculture on projects in the area d. Identify technical resource people who can assist with concept planning in DoA and DWA, or other organisations and mobilise these.	March 2013
2 **IDENTIFY POTENTIAL WATER-USE PROJECTS** a. Identify areas with agricultural water potential e.g.: i) Possibility of dairy at Mtha (200 ha) ii) eMbekweni old irrigation scheme (possible flood-water harvesting) iii) Bold Point – small irrigation development iv) All maize lands – tied ridge method ('amadanyana' or 'in-field' RWH) v) others for garden production (trenchbeds, swales)… b. Mark these potential areas for future development on a map c. Consider feasibility on the basis of common sense (water availability, likely costs for infrastructure, land-tenure realities, who is likely to be a driver of such an initiative) and then attempt to prioritise. d. Consider what could be done as a pilot by interested WUA members while waiting for Government funding.	2013 All villages outline plans
3 **COORDINATE TECHNICAL STUDIES** a. Do soils investigations / get available soils information (Dept of Agric) b. Do water investigations (DWA, consultants or university involvement) c. Decide on system type (irrigation, rainwater harvesting or flood-water harvesting) d. Do simple engineering design and initial cost estimate e. Decide on likely cropping pattern and sources of inputs and advice f. Decide on likely crop outputs or possible markets and likely prices (could include lucerne for local sheep feed, or vegetables for sale locally, or other crops for sale), g. Assess costs vs returns and see if viable.	2014 2 projects detailed 2015 Another 2 projects detailed
4 **CONSOLIDATE PROJECT PROPOSALS and Motivate for Funding** a. Identify what can be done NOW with available resources b. Take plan to funders	2014

10

Another project sponsored by the Water Research Commission

Research on the table



Irrigation revitalisation guidelines along with …

- ***Bembridge (systems)***
- ***Van Averbeke (typologies, systems)***
- ***Machete (agric-economics)***
- ***de Lange (participative methods)***
- ***Manona (land exchange)***
- ***Sanewe (food security and dev)***
- ***Backeberg (water pricing/history)***
- ***De Stoep (irrigation technology)***
- ***Reinders (technology, WRM)***

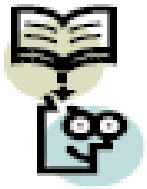
Principles, Approaches and Guidelines

The Volumes

There are two volumes to the Guidelines:

- **The Rough Guide (Volume 1)** is a quick reference guide for the more action-oriented and is written to allow easy access to the main principles, approaches and methodologies to support and guide implementing teams. Revitalisation activities cover new ground for every case and only one thing is guaranteed - the ride will be rough and you'll have to improvise as you go.

- **Concepts and Cases (Volume 2)** contains the theoretical rationale for the guidelines based on a set of arguments developed through academic review, action research and case study investigation. This includes a review and comparison of South African and international revitalisation approaches as well as case studies on commercial partnerships and other support strategies.



Principles of engagement

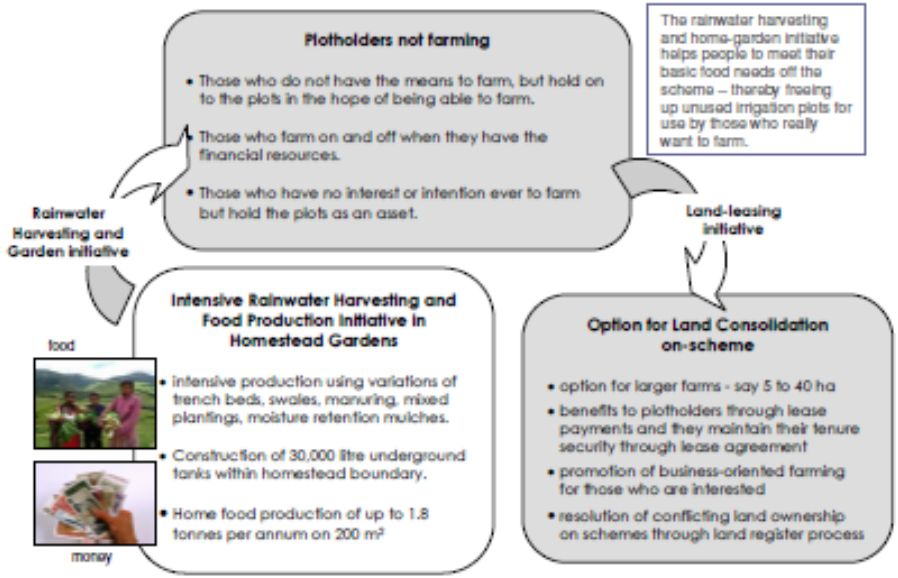
- respect of farmers knowledge
- profitability / economic viability
- participative planning
- community control of processes
- inclusion
- embrace diversity
- expand beyond scheme boundaries
- realise transformation
- scheme's are live entities – learning
- drive towards sustainability

Easy to use (*flip n dip n skim*)

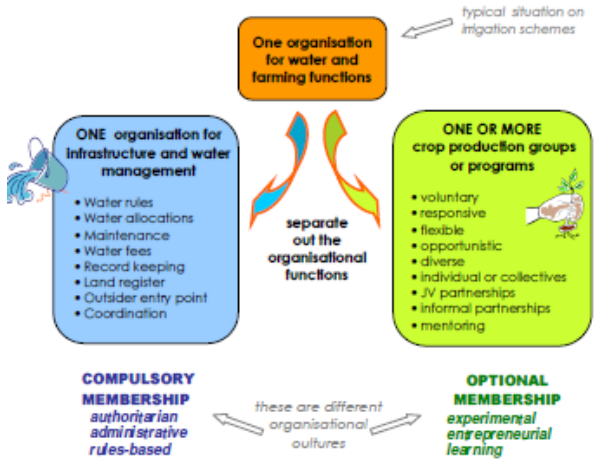
2.3 Catalyst for the land-leasing process

Experience shows that many people who have irrigation plots don't want to engage in irrigated farming on the scheme because of limited resources, skills, interest and the high risks of farming. However, they are often reluctant to lose their access to the irrigated plot given their poverty status and the potential the land holds for production perhaps at a later stage. **These people can have their basic food needs met an intensive home-garden initiative and this frees up the irrigated plots for land-leasing.**

Intensive diversified home food production underpinned by rainwater harvesting and grey-water re-use present a valuable opportunity for breaking out of the limiting cycles posed by small plot sizes on many schemes. The inter-relationship is shown schematically below:



The Rough Guide to Irrigation Revitalisation 19 challenge your thinking



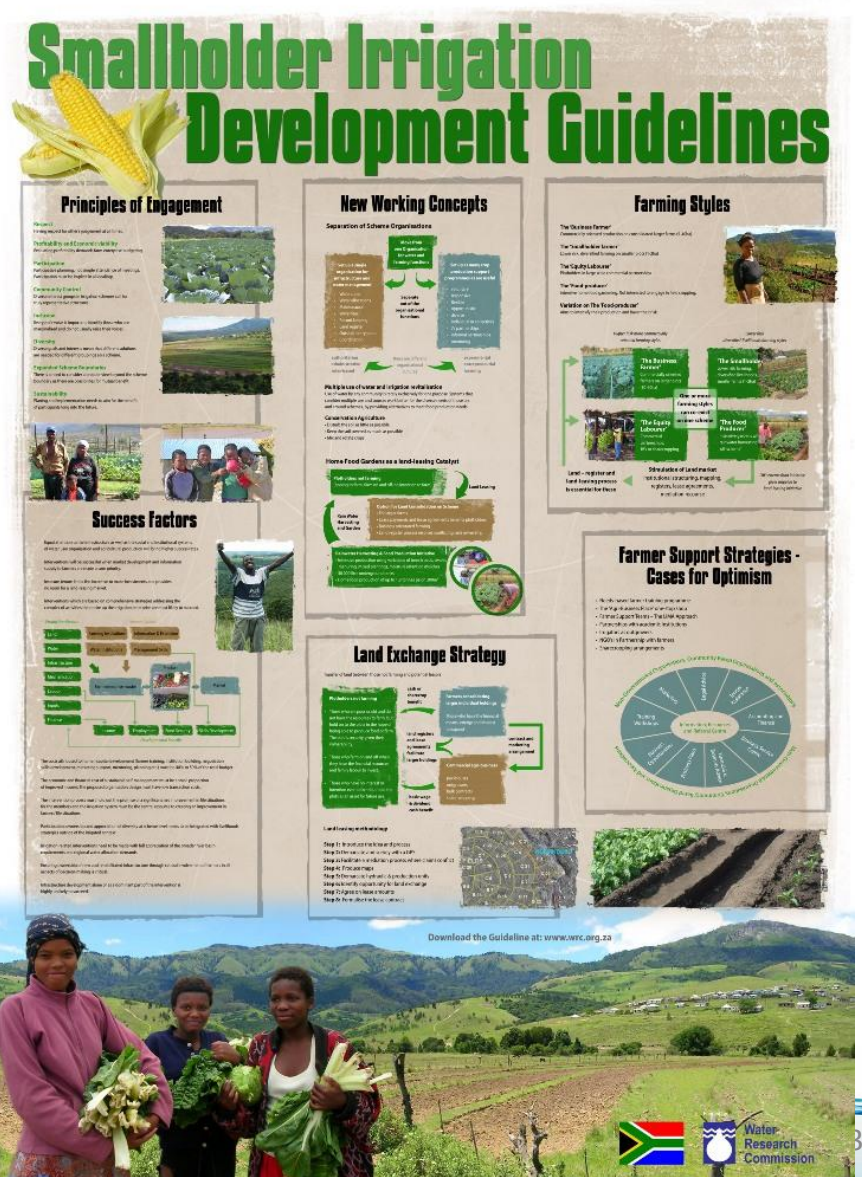
3.5 Success and failure factors

There are many lessons that can be learned from review of successful and failed schemes in South Africa and abroad. A list of success and failure factors that provide context and depth to how irrigation revitalisation planning can proceed is summarised below. The derivation of the success and failure factors is presented in some detail in Volume 2 (Chapter 3 and Appendix D).

success factors

Whole scheme and farm system plans
Experience is clear that **infrastructure development alone or as a dominant part of the intervention is highly unlikely to succeed.** Farmers in smallholder schemes need support systems that go far beyond just the irrigation system if they are to improve their livelihoods significantly. Narrow sectorally isolated engineering and infrastructure driven programmes have substantially increased risk of failure.

International uptake more than RSA



Where …

- **Ghana** Irrigation Reform Agenda (FAO/WB) - GIDA
- **Nigeria** USD 400 Million NIWRMP (WB/FAO)
- **Malawi** USD 146 Million SRBMP
- **Mozambique** USD 70 M PROIRRI
- To be translated into French for WA
- Prescribed reading at **Wageningen**

WHY ? Multi-discplinary / participative / farmer-centred approaches / builds on local and international best practice / practical responses to variable realities

Irrigation responses not sufficient

Need to shift thinking to agricultural water interventions in line with international trends a decade ago: ie. Irrigation + WHC

IN RSA THIS IS NOT NEW:

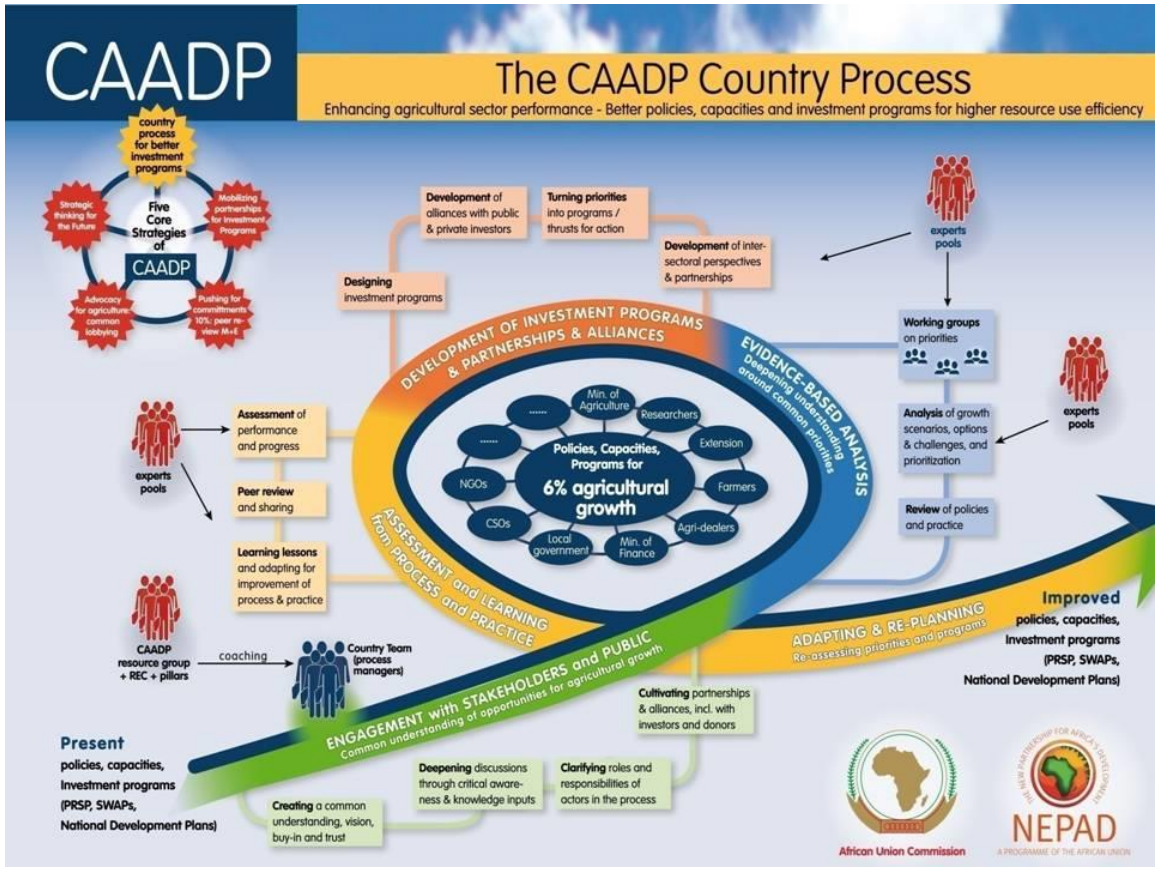
10 years ago: CCAW's – Coordinating Committees for Agricultural Water

Similarly: The DWA Subsidy for Resource Poor Farmers covers six categories:

1. Grants on the capital costs of bulk water distribution infrastructure including canals, weirs, pipelines, pump stations, storage dams and related water metering
2. Subsidy for operation and maintenance of water works , water-resources management and depreciation. This subsidy is phased out over Phased out in five years by scaling down by 20% annually.
3. Grants on acquisition of water entitlement for irrigation which includes the purchasing of water rights for RPF from willing sellers
4. Grants for socio economic viability studies and investigations, project planning & proposals, technical feasibility studies and hydrological studies
5. Grants for the training of WUA management in water use efficiency and management, dispute management and related technical issues
6. **Grants on rainwater harvesting tanks for food security through family food production and other household productive**

RPF Subsidy – WHC implemented

Across Africa … AWM is used



IWMI

FAO

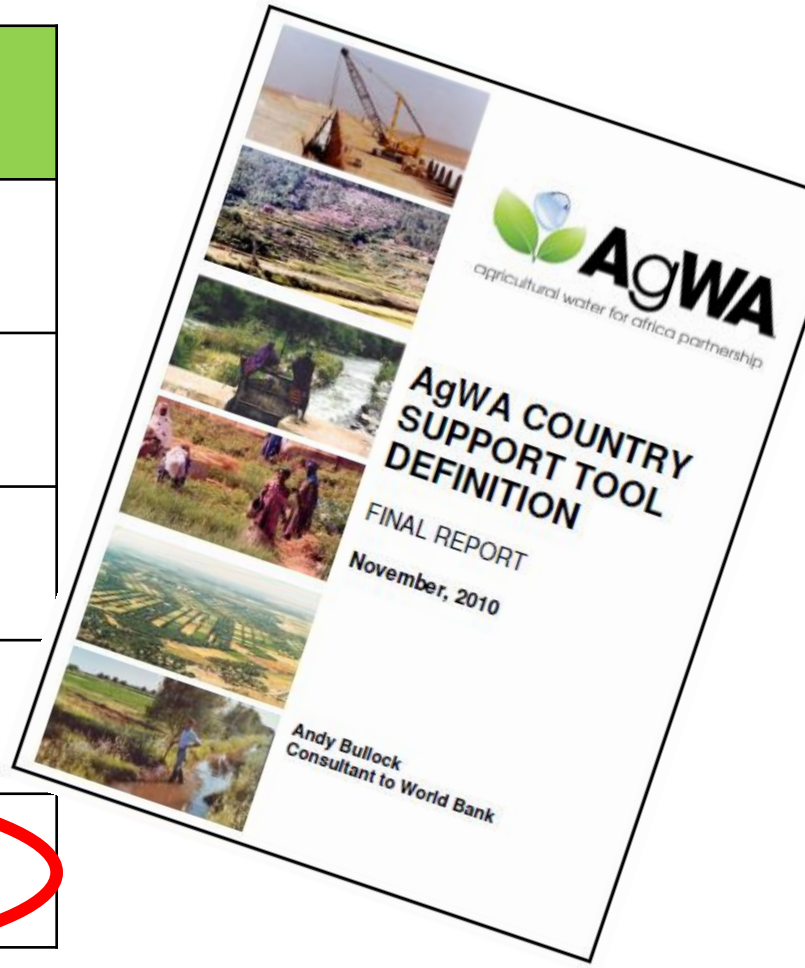
World Bank

IMAWESA

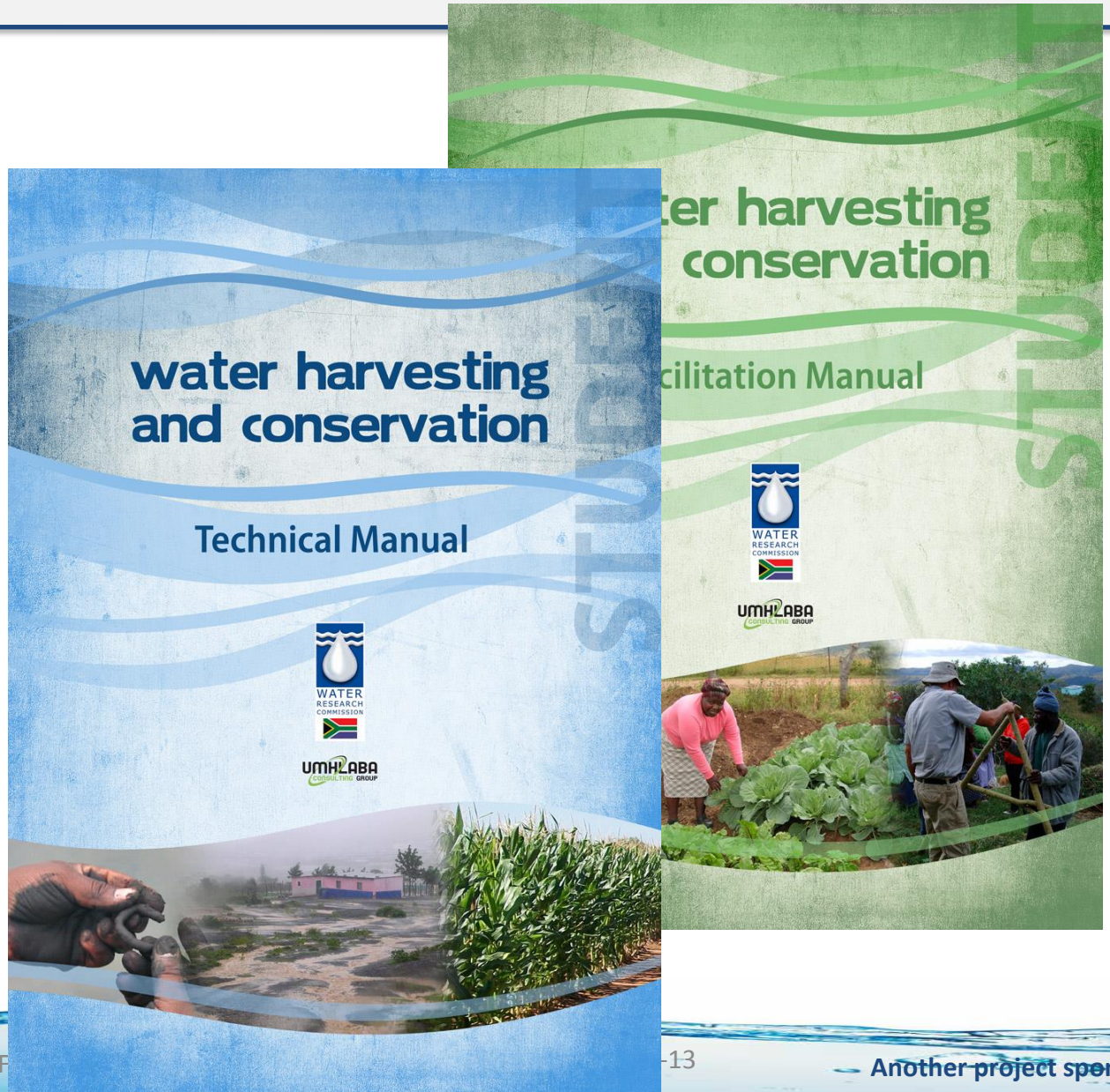
NGOs

African Agricultural Water Partnership

Agricultural Water Management 'Development Trajectories'
1. Individual micro- and small-scale irrigation
2. Community-managed small to medium-scale irrigation
3. Large-scale irrigation system modernization and development
4. Market-oriented irrigation on PPP or purely private basis
5. Enhanced water management in rainfed agriculture



WHC learning materials



OTHER WORK BY

- ***Hensley***
- ***Botha***
- ***Kundlande***
- ***van Rensburg***
- ***Kruger***
- ***Stimie***

Another project sponsored by the Water Research Commission

RWH - Small and large scale farming

"Rainwater harvesting is the collection and/or concentra-tion of runoff water for productive purposes. It includes all methods of concentrating, diverting, collecting, storing, utilizing and managing runoff for productive uses. Water can be collected from natural drainage lines, ground surfaces, roofs for domestic uses, stock and crop watering."[11]

A definition of **water conservation** is: "The protection, development, and efficient management of water resources for beneficial purposes."[12]

There are many different ways to conserve water by protecting and managing it efficiently. In situations where water is used for irrigation, conservation involves getting as much water as possible to infiltrate the soil so that the amount of water lost to evaporation or runoff (water which runs over the ground) is minimised. One method of achieving this is to cover the soil with a mulch such as a crop residue, which increases water **infiltration** and reduces evaporation.

Other examples of water conservation practices include recycling and re-using water (e.g. using bath water to water vegetables); irrigating crops in sensible ways (e.g. watering less often but more thoroughly, and not watering during the heat of the day); eliminating water leaks (e.g. fixing leaking taps and pipes); and growing indigenous plants which are suited to the local climate and environment.

Based on the above definitions, as well as the practices of people such as Phiri Maseko who harvest and conserve water, we can say that water harvesting and conservation involves:

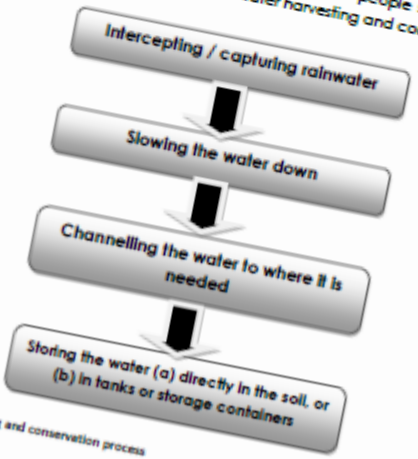


Figure 1.8 The water harvesting and conservation process

Dirk van der Merwe

...thern part of South Africa, small livestock farming ...nd supported by a water harvesting system ...dam'. 'Saaidam' is an Afrikaans word literally ...ting dam' and is the name of a flood-water ...em that is also found in North Africa, the Middle-...han. Dirk van der Merwe Jnr. and his family live ...arm in the Northern Cape near the town of ...is family have practiced this method since the ...is a qualified veterinary surgeon and follows in the farming footsteps of his father Merwe Snr.) who bred many South African Champion Merinos at Diepdrif Farm

...usiness revolves mainly around luceme production and sheep. ...aze on the luceme fields – which are dependant on the ...r water – and also on the dry surrounding Karoo-veld pastures. ...ives only about 170 mm of rainfall per year, and as a result the ...very sparse – so sparse that each sheep needs approximately ...sustain itself (40 hectares is roughly the same size as 50 soccer ...erne production, which is watered using the saaidam water-...em, is a critical part of the van der Merwe's luceme and sheep

...itself is a large flat field which is surrounded ...y a low earth wall, similar to a small dam ...n to 1.5 m high. Once every year or two, a ...rushing down the dry riverbed from the ...bout 120 km away. This floodwater is ...the saaidamme over a few days of ...ey activity by everyone on the farm. ...tem of large channels and water-gates. ...ield knee-deep in the saaidams for 2 to 3 ...aks deeply into the soil, after which the ...is released. The soils in the area are very deep (up to 10 m deep in places), and ...me has a very deep tap root it can draw up the moisture as the soil slowly dries

...Merwe's farm has 600 ha under luceme in the saaidams and they farm more than ...s well as cattle. This example shows that water-harvesting has an important place ...inds of farms, some small and others large, some producing fresh produce, others ...r and meat.

Facilitation guide

UNIT STANDARD ALIGNMENT

This guide is set at NQF level 5 and is aligned with the following South African Qualifications Authority (SAQA) unit standards, totalling 15 credits:

SAQA US ID	UNIT STANDARD TITLE	NQF LEVEL	CREDITS
252476	Develop and implement an extension programme plan. **Unit Standard Specific Outcomes:** • Assess the needs of clients to develop an intervention. • Develop extension solutions to resolve existing and anticipated problems in a programme. • Plan extension interventions for addressing the needs and problems identified. • Implement an extension plan for the selected extension intervention.	Old NQF level 5 New NQF level pending	10

SAQA US ID	UNIT STANDARD TITLE	NQF LEVEL	CREDITS
252474	Implement strategies for behaviour change and innovation. **Unit Standard Specific Outcomes:** • Apply the concept of technology adoption. • Apply the theories and practices of participatory technology innovation and development. • Identify and contextualise the extent to which influencing factors affect the final decision towards change. • Establish the scope for behaviour change/innovation to determine the extent of intervention. • Develop and implement a simple intervention plan to change the behaviour of an individual/group/community.	Old NQF level 5 New NQF level pending	5

Masonwabe Dangazelle (artist)
"Store it – use it."

Chapter 3

Facilitation Skills

Demonstrations

When doing a demonstration, make sure that everyone can see what is being done. If you are working outside with a group, encourage people to stand close to you, with a clear view of what is being demonstrated. Speak clearly and check that everyone can hear you. Allow people to ask questions, and encourage them to share their own knowledge or ideas with the group.

Figure 3.6 In this demonstration, all group members have a clear view of what is being demonstrated.

Figure 3.7 In this situation, quite a few people do not have a proper view of the demonstration. This often happens when groups are large.

If possible, give each individual the opportunity to assist with part of the demonstration. This will help the group stay focused on the task, and their active involvement will promote faster and more integrated learning.

Figure 3.8 A group member helping with a task during a demonstration.

Technical Manual

Chapter 1

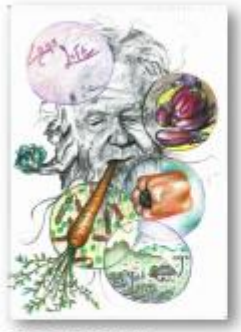
Introduction to Water Harvesting and Conservation (WHC)

Chapter 2

Water in the World

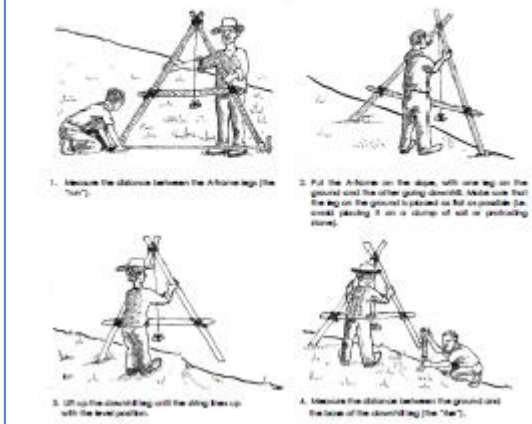
Chapter 3

Systems



Chapter 5

Soil



Another project sponsored by the Water Research Commission

How to guide for 14 WHC methods

Name Used in Manual	Similar to:	Description	Main purpose or comment	Type of Water Harvesting System
Diversion furrows 	• run-on ditches • run-on RWH • ex-field RWH • feeder channels • diversion trenches	A diversion furrow directs rainwater runoff from gullies, grasslands or hard surfaces (such as paths or roads) to a cropped area or to a storage tank. This increases the water available to the plants.	• Used for fieldcrops and in gardens. • Additional water diverted directly to soils and crops. • Additional water stored in underground tanks for later watering.	Macro-system (collects water from an external catchment and brings it to the field).
Trench beds 	• deep trenching • fertility trenches	Trench beds are 1 m wide and 2 m long. They are dug to 1 m deep then packed with dry grass/leaves, compost, manure and soil.	• Used in food-gardens. • Create highly fertile soils which can absorb and store water. • Provide an immediately usable planting bed even on shallow or poor soils. • Often used with diversion furrows and mulching.	A micro-system when used alone. However, trench beds are usually connected to diversion furrows, which collect water from adjacent areas and direct it to the trenches.
Mulching 	• no other names	Mulching is the practice of spreading organic material like compost, straw, manure, dry leaves, grass clippings or wood chips onto the surface of the soil. It is usually concentrated around the plant.	• Can be used on all crops and orchards, not pastures. • Improves plant growth. • Reduces evaporation from the soil surface. • Improves soil temperature. • Limits weed growth and makes watering easier by protecting the soil.	Water conservation method.

WHC options for Mbekweni

6. Tied Ridges

also called:	used in:	
• In-field RWH • partitioned furrows[15] • cross-ridges • furrow dikes[16]	gardens fields grazing land	✓ ✓

This method increases the water that is available to plants by collecting rainfall from an unplanted sloping basin and catching it with a furrow and ridge. Planting takes place on either side of the furrow where the water has infiltrated.

Basins are created by digging out shallow furrows along the contour lines of the slope and constructing ridges on the downside of the furrows. These are "tied" together by slightly lower ridges which are constructed at regular intervals along the furrows (these ridges are also called *crossties*). The loss of water through evaporation can also be minimised by placing mulch in the furrows.

Figure 7.10 Mulch placed in furrows to minimise evaporation

Figure 7.11 Water is captured in furrows

PLANNING

Soil	Slope	Rainfall	Tools & Equipment
Soil depth of 700-1000 mm.[17] Soils should be relatively stable. The best soils are clay or soils with a relatively permeable topsoil over a less permeable subsoil.[18]	Can be up to 7% on non-erodible soils.[19]	Annual rainfall of 400-700 mm.[20]	spade* fork tape measure string, sticks mulch wheelbarrow A-frame or line level *essential

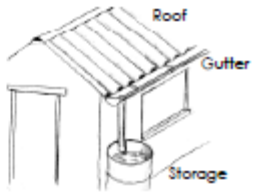
11. Roofwater Harvesting

also called:	used in:	
• No other names	gardens fields grazing and degraded land	✓

Collecting water from roofs for household and garden use is widely practiced across South Africa, and tanks and containers of all types – from large brick reservoirs to makeshift drums and buckets – are a common sight in rural areas. There are, however, many ways of improving both the quality and the quantity of water that can be harvested from the roofs of houses, schools, clinics and outbuildings.

Collecting water from roofs has the following advantages over any other surface:

- Roofs are physically in place and runoff is immediately accessible;
- Water collected from roofs is much cleaner than from ground runoff; and
- Most of the rainwater falling on a roof can be collected, as there is little absorption or infiltration on the roof surface (with thatch being an exception).



There are three main components to roofwater harvesting; the **roof**, the **gutter** and the **storage tank**. What follows is a summary of each of these components and practical suggestions as to how each can best be utilised.

Roofs

Roof type and water quality

Most roofs are suitable for rainwater collection. However, roof water can be contaminated to varying degrees by the roof material itself, by bird and animal faeces, and by leaves and dust. For this reason, a set of basic measures to limit contamination is strongly recommended, regardless of the roof material used (see the end of this section for recommendations).

Safe roofs

Corrugated iron, slate, fibre cement, asbestos cement, tiles and concrete are all sufficiently safe surfaces and provide reasonably clean water. There is no evidence to suggest that asbestos roofs should not be used to harvest drinking water, even though asbestos presents a health hazard during construction due to the potential breathing in of fibres.[33]

WHC options - Mbekweni

12. Ploegvore

also called:	used in:	
• imprinting • pitting	gardens	
	fields	
	grazing and degraded land	✓

This water-harvesting method involves creating numerous small, well-formed pits or "imprints" in the soil that collect rainwater runoff, seed, sediment and plant litter. This provides a relatively sheltered microclimate in which seed and seedlings can grow.[45] This method is particularly effective for rehabilitating degraded soils and for improving grazing land in arid areas. When used for these purposes, the pits are typically created by machine (a bulldozer or tractor with a specialised imprinter).

Figure 7.23 Degraded land | Ploegvore | Same land 15 yrs later | 'Happloeg' on tractor for pitting

PLANNING

Soil	Slope	Rainfall	Tools & Equipment
Any type of soil, including barren, crusted soils and clay soils with limited infiltration.[46]	Below 2%.[47]	Recommended for relatively low rainfall areas (100-350 mm).	tractor* imprinting implement ("happloeg") or specialised bulldozer* *essential

In other parts of the world, similar pits – called Zai or Vitengo pits – are constructed by hand for crop production, whereas in South Africa, ploegvore (a local variation where imprints are made with machines) are used to improve grazing or degraded land.[48] Hand-pitting at an extensive scale for grazing improvement in South Africa seems highly unlikely given the labour input; however, hand-pitting for crop production could have local application. In reality there are numerous WHC methods which overlap in terms of agro-climatic and soils suitability and Zai pits for crop production show little advantage over other proven and locally modified methods such as "in-field RWH" (**tied ridges**), trench beds, contour bunds and swales. Pitting is therefore recommended to improve grazing and rehabilitating degraded land, using tractors and a 'happloeg' or a specialised bulldozer. Specialist advice on happloeg design can be obtained from Glen Agricultural College, the University of Potchefstroom or Elsenburg Agricultural College.

14. Saaidamme

also called:	used in:	
• floodwater harvesting • "planting dams"	gardens	
	fields	✓
	grazing land	✓

This method entails the diversion of floodwater from non-permanent rivers into a series of flat basins which are used for cropping. Each flat field is completely surrounded by a low earth embankment (wall) of between 0.5 and 1.5 metres high. Diverted water from the flooding river is channelled into the fields and completely submerges the land for 1 to 3 days, where it fully saturates the soil.[50] Water is released from the saturated field to the next field needing water, through small stone spillways or larger steel sluice-gates.

Slopes and field size

The fields vary from a few hundred square metres to 100 ha in size.[51] The steeper the slope, the smaller the fields. (Larger field sizes are found on very flat lands; smaller fields which have some slope require levelling and this demands that topsoil is removed from higher levels to fill the lower levels. Levelling leaves a shallower layer of topsoil on the upper slope. This means that the steeper the slope of the original land, the smaller must be the fields to maintain enough soil depth.)

Implementation support

Saaidamme are used extensively on a commercial scale for lucerne and vegetable production in arid areas in South Africa.[52] This floodwater-harvesting method has potential for small-scale farming of crops and pastures elsewhere in South Africa. The implementation of a saaidam system requires some knowledge of agricultural and irrigation engineering, as well as of South African environmental procedures. Input from the Department of Agriculture or an engineering professional will most likely be needed.

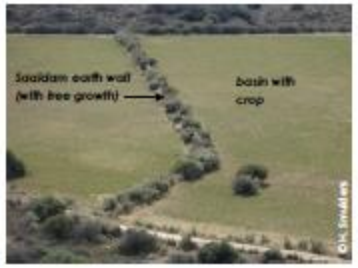
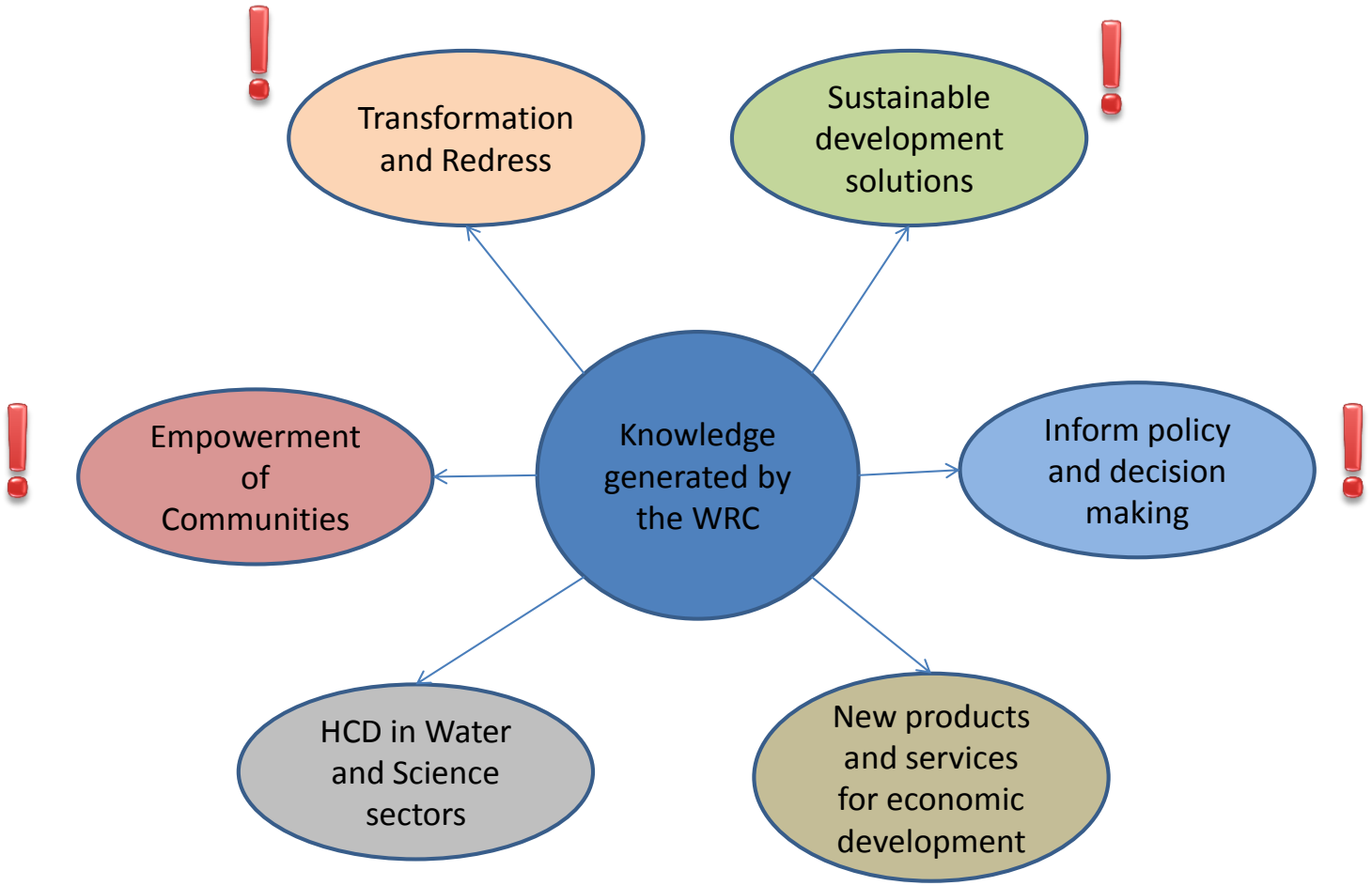


Figure 7.27 Saaidamme at Rooikrantshoogte, west of Craddock in the Eastern Cape

Figure 7.28 Ribbon of saaidamme along the Fish River, 80 km east of Calvinia in the Northern Cape (satellite image from Google Earth)

Existing research impact ?



Agwater development going forward

Year	Target HDI as a % of Allocable Water	% of Target to be allocated to Women
2014	30%	30%
2019	45%	40%
2024	60%	50%

Source: WAR Targets consolidated from the DWA Water Allocation Reform Strategy (2008)

Water Allocation Reform

NDP

"To achieve this (job creation and poverty reduction impact), irrigated agriculture and dry-land production should be expanded, with emphasis on smallholder farmers where possible.
The 1.5 million hectares under irrigation … can be expanded by at least 500 000 hectares *through the better use of existing water resources and developing new water schemes"*

Mbekweni evidence based interventions ….

An interdisciplinary 5 year programmatic intervention including:

1. Extensive first-phase WHC in home-gardens and selected fields (low-cost, short-term and knowledge emphasis)
2. Local land administration to promote leasing of high-value land utilised at low levels.
3. Phased irrigation development based on locally tailored AGWA development trajectories.
4. Extensive support to production knowledge networks and the value chain (as articulated so well in the NDP)