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ARC Research Initiatives on Climate Variability and Change

SELECT COMMITTEE ON LAND REFORM, ENVIRONMENT, MINERAL RESOURCES AND ENERGY

August 2020

ARC DESIRED OUTCOMES AND INTERVENTIONS (Strategy)

Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5
Increased agricultural production and productivity	Sustainable ecosystems and natural resources	Improved nutritional value, quality and safety of agricultural products	A skilled and capable agriculture sector	Enhanced resilience of agriculture
Crops with improved characteristics	Biodiversity Management	Product Development	Skills Development	Climate Resilient Solutions
Diagnostic and Analytical Services	Soil Health Assessment	Broadening the Food Base	Technology Transfer	Diagnostic and Analytical Services
	Weed Control	Processing, preservation, and storage methods	Smallholder Farmer Support	
	Low carbon technologies		Knowledge Generated	

Introduction

- **Agricultural Research Council (ARC) is highly active in the areas of climate variability and change with a number of initiatives in the following areas:**
  - **Climate monitoring**
    - ***Establishing of network of climate stations***
    - ***The use of remote sensing to monitor changes in climate***
  - **Climate variability research**
    - ***Research on effects of climate variability on agriculture***
  - **Climate variability and extreme weather mitigation**
    - ***Development of early warning systems and Surveillance systems***
  - **Climate adaptation**
    - ***Targeting climate change resilience in the agricultural sector***
  - **Green House Gas (GHG) quantification**
    - ***Crucial understanding of the contribution of agricultural sector towards enhanced GHG effect***
  - **Climate change mitigation – GHG reduction**
    - ***Developing systems that mitigate GHG emissions in agriculture***
  - **Climate change capacity building**
  - **UNCCD and other Protocols (SA is signatory to)**

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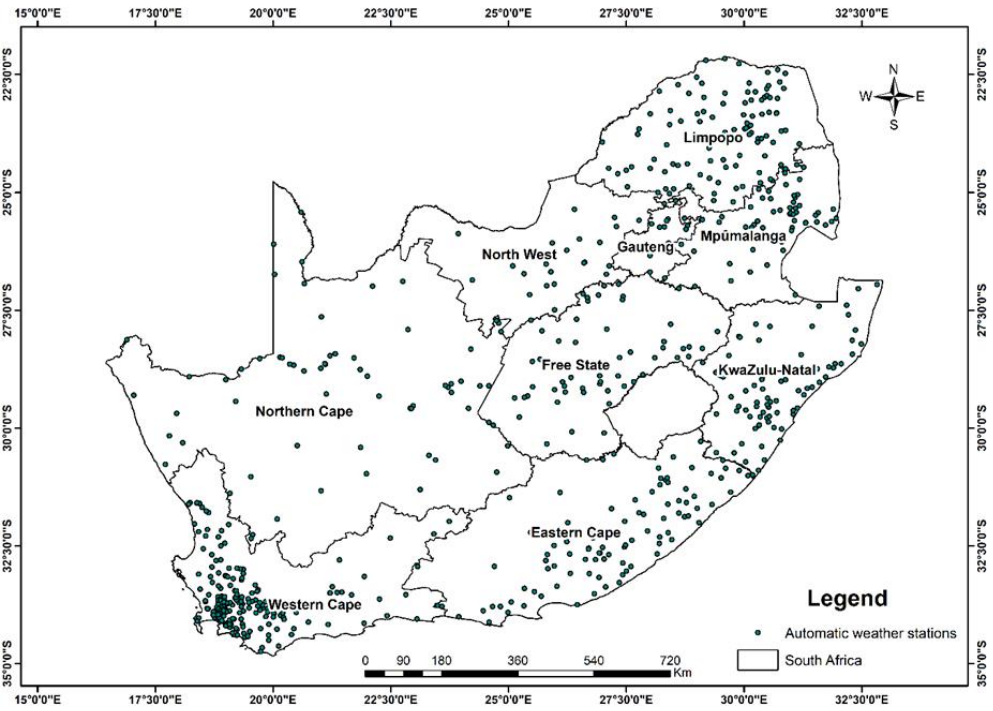
Climate change monitoring for Agriculture



Weather station network

- 537 Automatic

Key impacts:

- Climate data used as input to climate risk tools by farmers;
- Information of climate dating back to 1900 utilized by research communities in investigating issues of climate change
- High temporal weather data up to 10 minutes intervals beneficial for monitoring weather hazards like storms ;
- Enables SA to meet/report global agreements

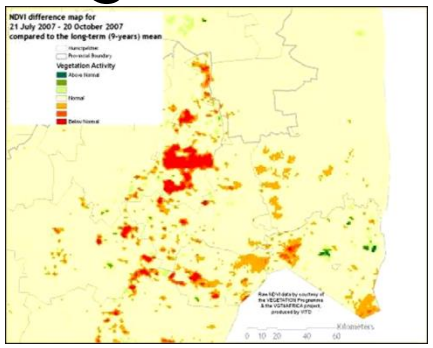
Coarse Resolution Imagery Database (CRID) and early warning

- **Rationale & objectives**: Improve food security under a changing climate. Various climate smart agricultural (**CSA**) practices and technologies are enhanced by information around impending risks.

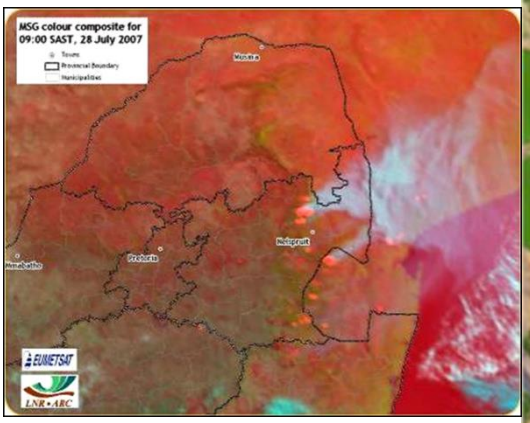
Impact:

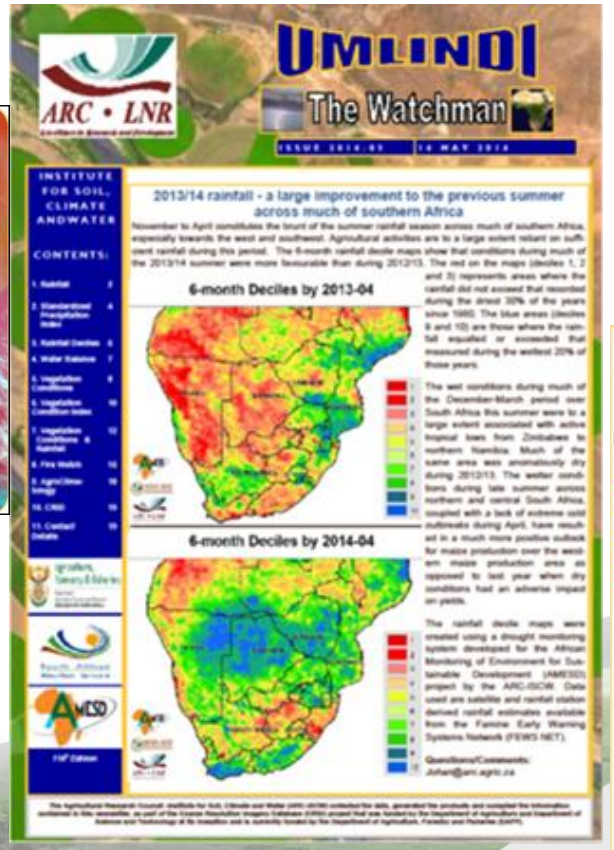
1. Early indication of vegetation response to climatic conditions
2. Insurance industry (ABSA) position themselves for possible payments later in the season
3. Enhance preparedness of the country to disasters. National Government and Provincial Governments are able to anticipate disasters, plan better, and monitor disaster event
4. RISK MITIGATION

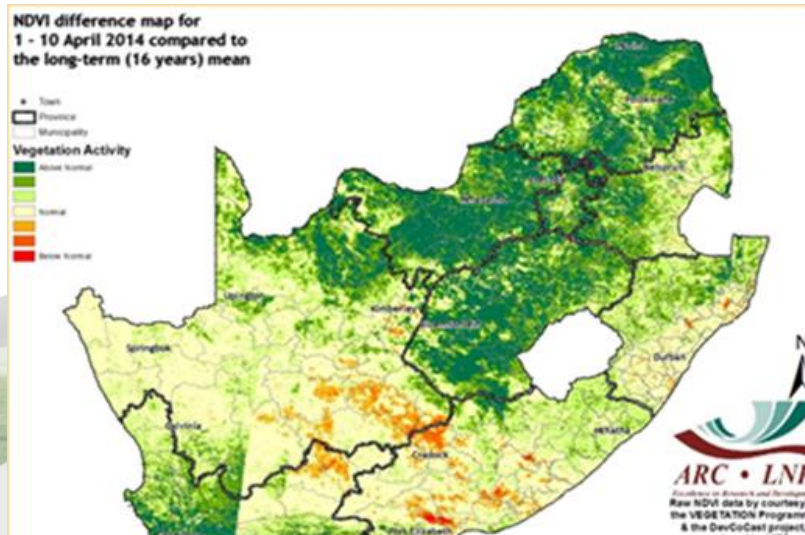
Drought Monitoring



Fire Monitoring







Climate Change Adaptation Research

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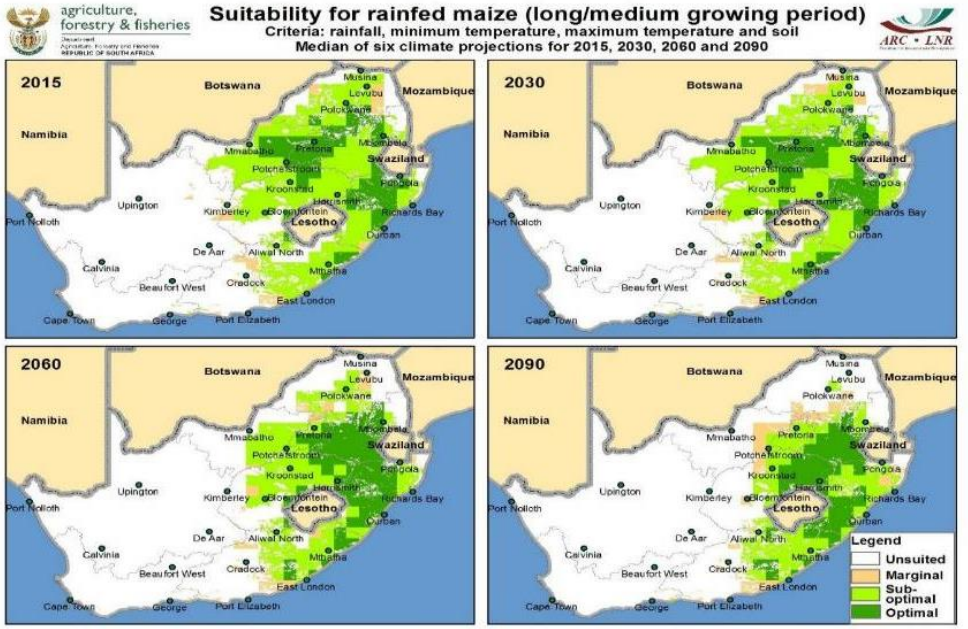
Climate Modelling (Climate Change) and Crop Suitability at National Scale

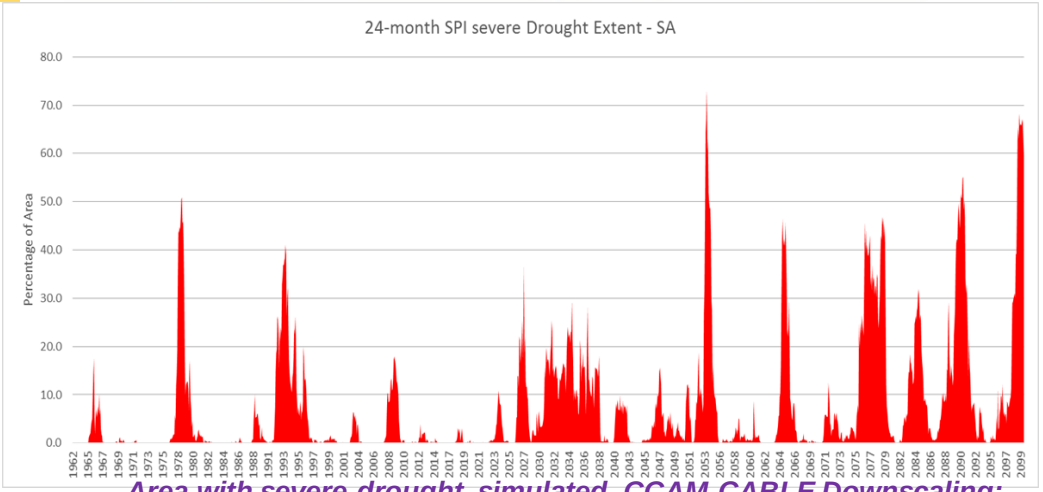
- Climate projections, together with suitability parameters (soil, climate) are used to make informed projections on future suitability for crop production
- High-resolution Projected changes temperature, rainfall, evaporation etc. are used
- Projected shifting of production areas is key towards agricultural risk management at national level
- For maize, projections indicate a potential shift to cooler areas for successful production

Simulated change in maize suitability through the 21st century

Maize



- Observed data shows increasing rainfall variability since 1940 over parts of South Africa
- Climate projections for South Africa, under low-mitigation scenarios, indicate a higher frequency and extent of large multi-year droughts later in the 21st century
- Such droughts have negative implications for dryland as well as irrigated crops production



Area with severe drought, simulated. CCAM-CABLE Downscaling: Input model: ACC. RCP8.5. Period: 1962 – 2099

WEMA Drought *TELA*™ HYBRIDS

- Five Bt hybrids released and registered by ARC in 2017:
  - WE6206B; WE6207B
  - WE6208B; WE6209B
  - WE6210B

  ✓ Bt (MON89034) protection from stalk borer and fall armyworm

Heavy fall armyworm infestation in smallholder farmer's crop in Xikukwani, Limpopo province, (3 March 2017)

No fall armyworm damage in nearby Bt crop

Establishment of a Drought Tolerant Wheat Germplasm Pool in South Africa

- **Rationale and objectives**

To develop high yielding climate resilient wheat cultivars that are adaptable to the effect of climate change against drought, new pests, diseases and pre/post-harvest effects

- **Study area in brief**

Agronomy, plant pathology and biotechnological methods are deployed to study drought tolerance response as well as host plant resistance traits across various environments (Free State, Kwa-Zulu Natal & Western Cape)

- **Impact of the project**
  - ✓ At least 10 wheat genotypes with good yielding attributes and drought tolerance were identified. The resulting genotypes were recommended to breeders for further development
  - ✓ Nine genetic clusters were observed for the development of molecular markers
  - ✓ MAS using newly developed markers would assist the development of cultivars with multiple traits aimed at mitigating the effects of climate change
  - ✓ Six peer-reviewed publications linked to the project were made available to the scientific community
  - ✓ Farmers stand to benefit from planting drought tolerant cultivars

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Climate-Smart Agriculture Technologies for Tropical and Subtropical Crops

Scientific solutions developed by the ARC have increasingly moved toward ensuring that citrus and subtropical fruit production is resilient to climate change. These solutions can be divided into the following focus areas:

- **Plant improvement by breeding new cultivars with improved fruit quality characteristics**, **yield and shelf life**. These cultivars cater for the ever changing consumer preferences and demands and allow farmers to produce citrus and subtropical fruits in different climatic conditions, ranging from the cooler Southern areas to the warm Northern areas as well as the drier Western to the wetter Eastern parts of South Africa.

- **Development of suitable rootstocks** for specific cultivars and/or disease tolerance. An example is the avocado rootstock “Bounty” that is tolerant to waterlogged conditions.

- **Orchard management** practices have been developed with different climatic and soil conditions in mind. These research outcomes created opportunities for agricultural engineering to design orchard management practices such as mechanical pruning machines and orchard sprayers.

Climate-Smart Agriculture Technologies for the Production of Vegetable and Ornamental Crops

The aim of the ARC Potato Research Programme is to develop new potato varieties with improved yield potential, yield stability, drought tolerance, heat tolerance and resistance/tolerance to the major potato pests and diseases.

Potato field with different potato cultivars to determine susceptibility towards common scab caused by Streptomyces scabiei, a bacterial soil-born plant pathogen

Currently, the ARC manages the only active **potato breeding programme in Africa** and this is one of only five potato breeding programmes in the Southern Hemisphere catering for the specific variety requirements of the developing countries in the warmer climates.

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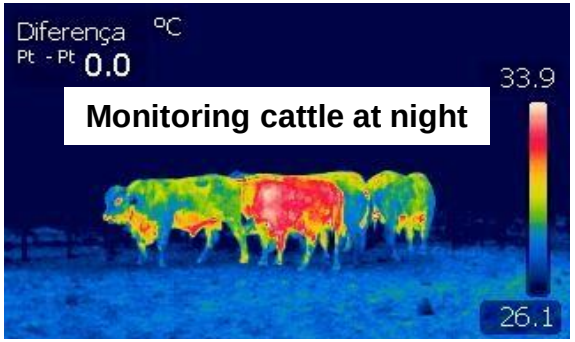
Climate-Smart Livestock Production

Livestock production contribute to climate change and suffer from its consequences. The impact of global warming and release of greenhouse gas has twofold implications for livestock production and food security

1. Increase in temperature will affect future distribution of livestock species and breeds, their adaptation to heat stress, incidence and type of diseases, feed supplies and grazing potential
2. The responsibility from livestock production is to reduce carbon and water footprint to ensure sustainable livestock production

Research and development to support climate-smart livestock production is essential. Different elements of climate-smart agricultural systems include:

- Management of farms, crops, livestock, aquaculture and capture fisheries to balance food security and livelihood needs with priorities for adaptation and mitigation
- Ecosystem and landscape management to conserve ecosystem services that are important for food security, agricultural development, adaptation and mitigation
- Services for farmers and land managers to enable better management of climate risks/impacts and mitigation actions
- Changes in the wider food system including demand-side measures, and value chain interventions that enhance the benefits of climate smart agriculture.



Using infrared camera, it is possible to identify cattle under heat stress. The **"red"** bull in the middle is under heat stress

Cow efficiency of indigenous Afrikaner cattle improved by 18% resulting in 12% **reduction in environmental impact**

Climate Variability and Extreme Weather Mitigation Projects

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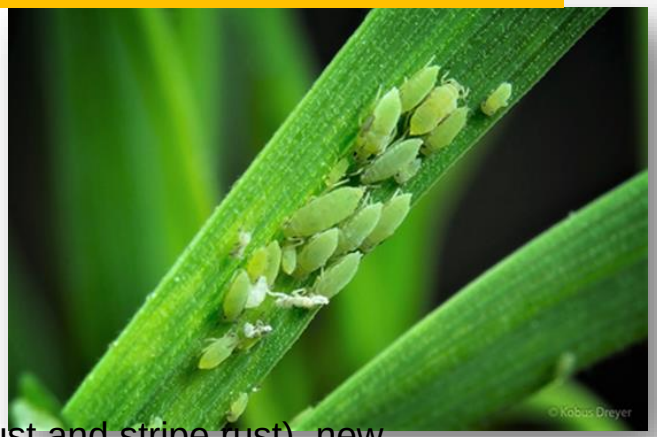
Surveillance and Early-Warning Systems to Reduce Pest Damage Severity under Changing Climate



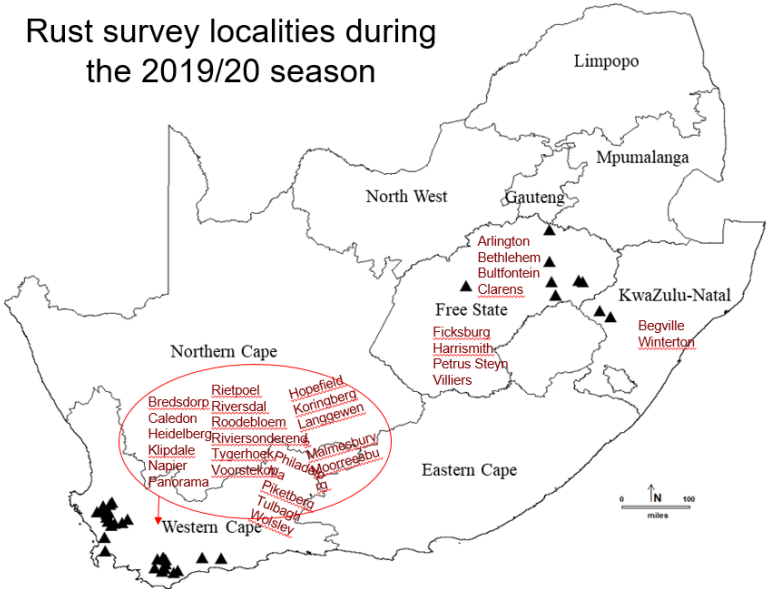
Rationale/objectives: Climate change is expected to facilitate pest range-expansion and/or pest damage severity. Surveillance and early-warning systems are key mitigating activities performed by ARC, ultimately supporting national food security.

Study area: all major wheat and barley production areas, including Limpopo,
Free State, KwaZulu-Natal, Northern Cape and Western Cape.

Impact:

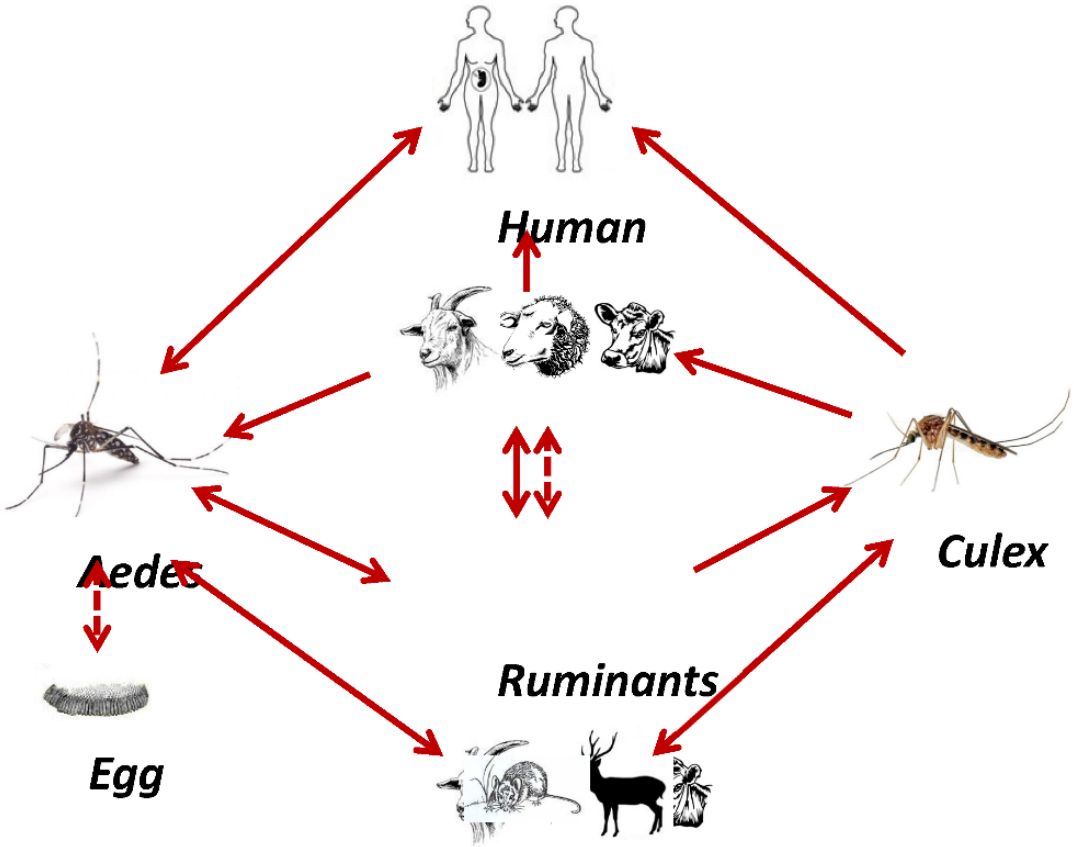
Through country-wide monitoring of wheat rust diseases (stem rust, leaf rust and stripe rust), new emerging pathotypes are being intercepted. Screening of germplasm against such inoculum facilitates breeding of resistant cultivars, thus supporting food security
amidst a changing environment.
Likewise, diseases emerging in bordering countries can be tracked and screened before potential entry into the country.

Rust survey localities during the 2019/20 season



Early Warning System for Rift-Valley Fever (RVF)

- Future climate change will inevitably impact on the distribution of pests and diseases in South Africa
- An increase in temperature will not only increase vector populations (mosquitoes, midges) but will also shorten both the time span between blood meals (increased biting rate) and the intrinsic incubation period by increasing the speed of virus development within the insect.
- Early warning systems for disease outbreaks could provide short- and long-term decision support for risk management and production of vaccines and diagnostic kits. A RVF early warning system was developed in a geographical information system (GIS) environment by retrospective analysis of rainfall and rainfall-associated climate variables in target areas during the 2008-2011 RVF epidemics in South Africa. This model correctly identified the risk in nearly 70% of instances at least a month before an outbreak.



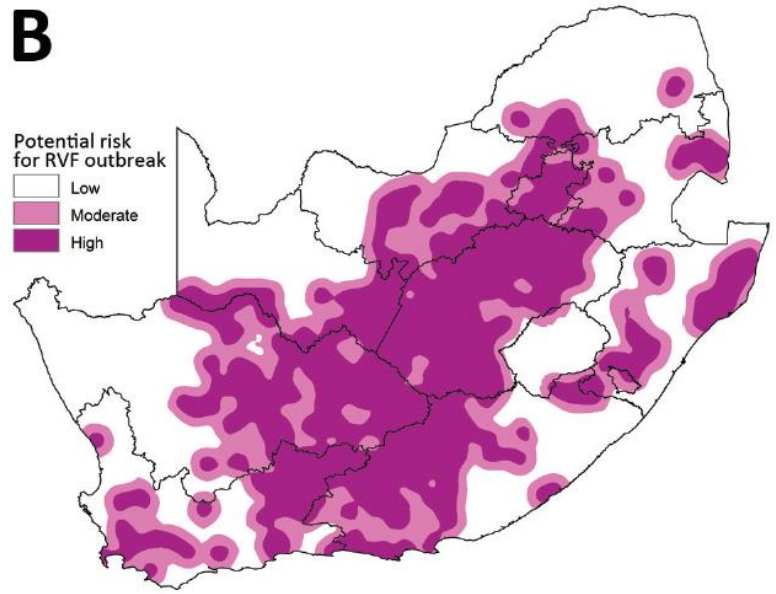


Figure 1. Historic sites of Rift Valley fever (RVF) outbreaks in South Africa from 1950 through 2011 (A) and a base map indicating areas at low, moderate, and high risk for an outbreak (B). Each dot in panel A represents a RVF outbreak. The base map in panel B was created by an interpolation method based on the distance from historic sites: high risk (≤20 km), moderate risk (>20 km to ≤40 km), and low risk (>40 km).

Rain4Africa to AgriCloud Service

AgriCloud is an online weather based agricultural advisory system that:

- Enriched weather & climate data with agric info and local knowledge
- Generates real-time personalized forecasts & warnings
- All tailored to farmers own needs.

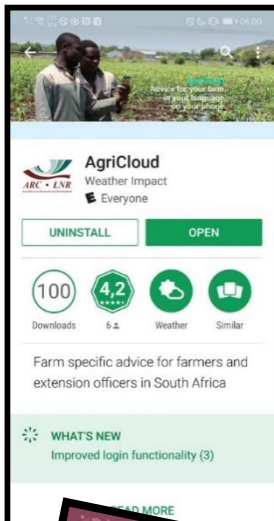
Study area: Summer Rainfall cropping Areas

Impact: Available in all 11 South African official local languages.

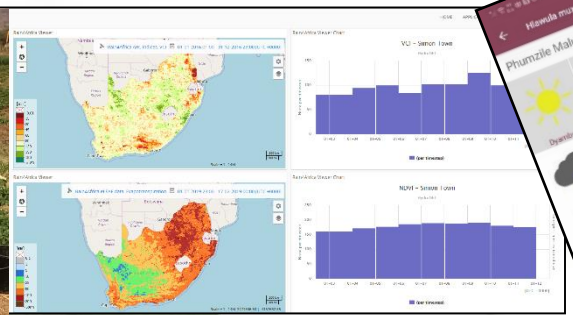
- Trained more than 1000 extension officers
- Reach across 6 provinces

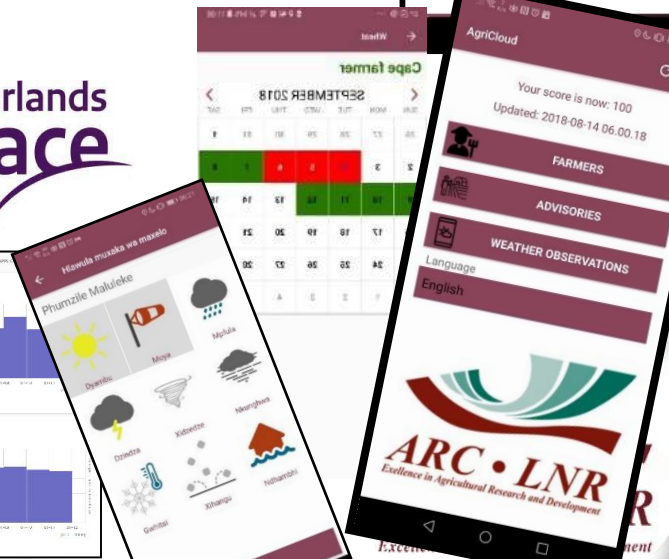
Three Delivery Methods with SAWS & Hydrologic Partners:

- Mobile App
- Platform by subscription
- API for other platforms



Netherlands Space Office





GHG estimation and climate change policy

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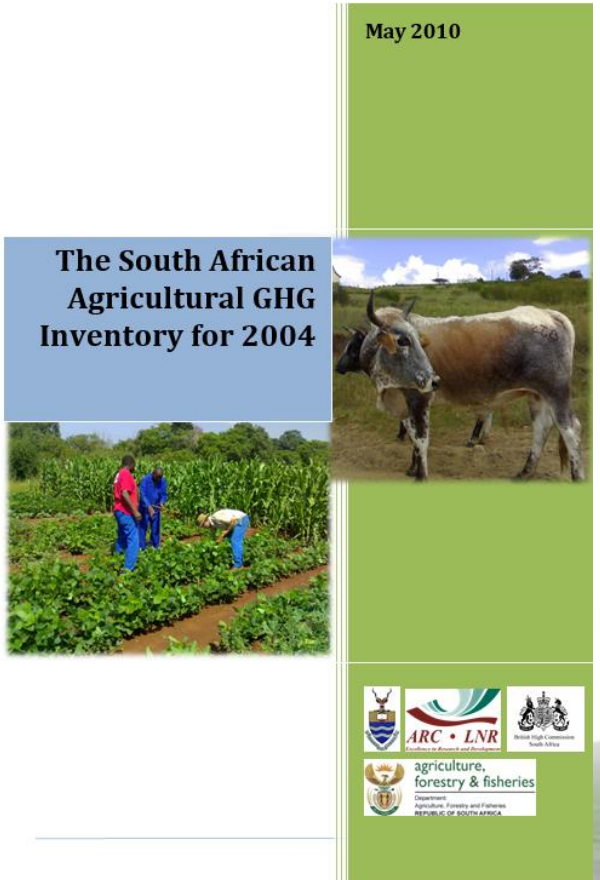
Quantification and Research on Agricultural GHG Emissions

- Important to estimate and report all emissions based on IPCC guidelines
- Estimation of agricultural contribution to greenhouse gas emissions
- Improvement of GHG estimates crucial for policy-makers in SA



Prepared for
DFID Southern Africa

Prepared by
Agricultural Research Council

Project managed by
Cardno Emerging Markets

09 September 2015

Prepared for
DFID Southern Africa

Climate Change Mitigation-Reduction in GHG Emissions Projects

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Implement Climate Change Programme on Bio-gas Production Integrated Crop Livestock System

Aim: The main aim of the project was to enhance agricultural productivity by promoting the adoption of an integrated crop-livestock system that effectively mitigates, adapts to and reduces vulnerabilities to climate variability and climate change. **The main important activity was to build bio-digesters for generation of biogas for cooking and/lighting from livestock manure**

Project findings:

- Production of biogas for energy and bio-digester affluent for fertilization of vegetable gardens, increasing food production (maize and beans) using CA technologies
- Assisting farmers with agricultural decision-making related to animal and crop production by providing weather and climate information, and raising awareness about climate variability and change in rural agricultural communities
- Co-benefits include reduction of the methane emissions from manure management as well as reduction of emissions associated with reduced tillage practice

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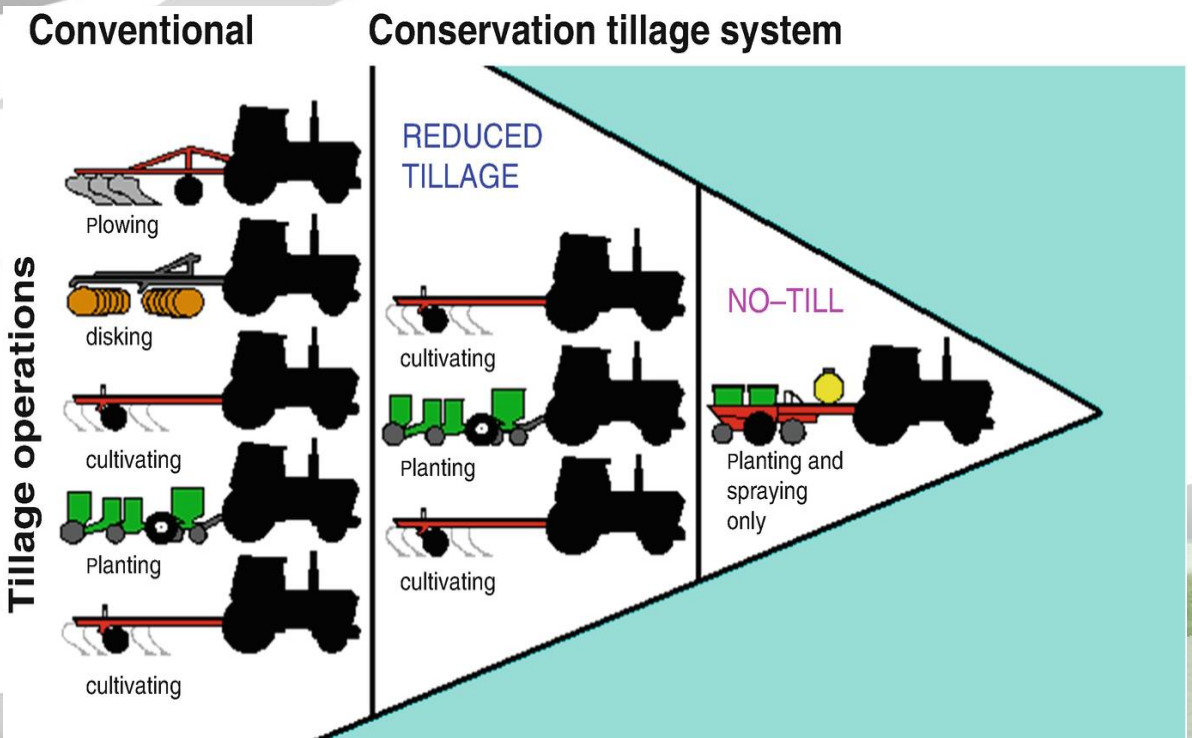
Mechanisation and Climate Change

Converting conventional tillage to conservation tillage, i.e. reduced tillage or no-till

CA is on the rise and there is a need to adapt old technology and develop new technologies that will increase production whilst protecting the Environment



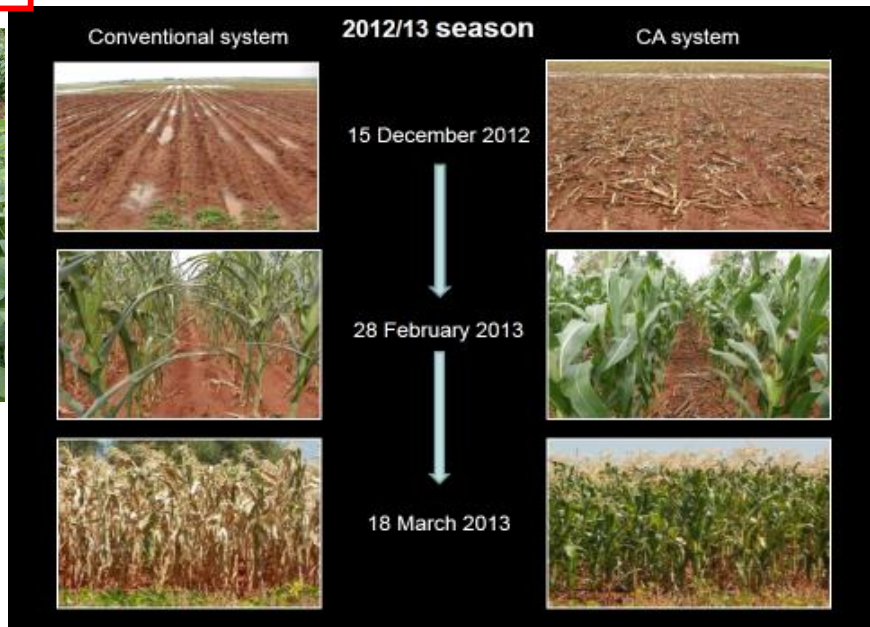
Demonstration, Evaluation and Analysis of Conservation Agriculture Technology in Various Climate Regions in South Africa

Rationale and objectives

Conservation agriculture (CA) plays a major role in mitigating climate change effects through better soil water retention and improved soil health. Although adoption of CA in South Africa has been limited, awareness among the commercial grain farming community is steadily on the increase. CA principles include:

- no-tillage or minimal mechanical soil disturbance
- the use of multiple cropping systems and
- a permanent soil cover of plant material

These principles support the sequestering of carbon from the atmosphere into soil organic matter pools, maintaining and increasing productivity and promoting a healthy environment. One third of carbon emitted by fossil fuel could be offset by implementing CA



Study areas

Countrywide

Impact of the research

- Training of farmers in issues related to CA
- Improved household income
- Improved household food security
- High climate adaptability
- Reduced agricultural GHG emissions

Climate Change Capacity Building Projects

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Training of Public Extension Practitioner on Climate-Smart Agriculture in South Africa

- Facilitating training program for 100 Extension Practitioner om Climate-Smart Agriculture (CSA) and to develop awareness raising program toolkit for farmers
- **Limpopo, North West & Eastern Cape Provinces**

Each extension worker attends 3-week-long courses for total 15d:

- **Agro-meteorology and Natural Resources Management**
- **Climate Smart Animal Production**
  - Beef & Dairy Cattle, Sheep & Goats, Diseases
  - Poultry & Pigs
  - Aquaculture & hydroponics
- **Climate Smart Crop Production**
  - Grains & legume
  - Vegetables & Fruit

Conclusions

- Climate change solutions for the agricultural sector is key towards multiple UN development goals (SDGs)
- It is key to monitor climate through weather stations to assess the extend of climate change as it impact Agriculture
- Continuation of support for research on climate change to ensure that the agricultural sector copes
- Tailor-made mitigation solutions for SA needs to be developed to reduce GHG emissions
- Policy-making should be informed by high quality local research and sound findings on climate change => continual interaction between scientists and policy makers