WINTER CEREAL TRUST

PROGRESS REPORT – JANUARY 2020

Carbon Footprint for Western Cape – Phase 3

1. INSTITUTE & TITLE:

Name of institute:	Grain SA
Project Leader / Researcher:	Dr. Hendrik Smith
Present Position Held:	Conservation Agriculture Facilitator
Years' Experience:	26

2. PROJECT DETAILS:

Project number	**WCT/W/2017/02**
Project name/Title	Determining the Carbon footprint and sequestration of different grain farming systems in the Western Cape
Start date	January 2017
End date	December 2019
Date of this report	January 2020
Other participants from this organisation	Blue North, TerraSim, Western Cape Dept. of Agriculture

ANNUAL PROGRESS REPORT
PHASE 3

Project title:

Determining the Carbon footprint and sequestration of different grain farming systems in the Western Cape

Compiled by:

Albert van Zyl, Anel Blignaut and Hendrik Smith

Submitted to:

The Winter Cereal Trust

31 January 2020

TABLE OF CONTENTS

1. Introduction

Increasingly the environmental impact of agricultural supply chains is being scrutinised by consumers, NGO's and governments. South Africa made a commitment to the international community to reduce its carbon footprint (C-footprint), hence the recent focus on carbon emissions, policy and the introduction of a carbon tax.

Improved cropland management has been highlighted as a practical and viable carbon emission mitigation option. Conservation Agriculture (CA) is promoted by many role players in the agricultural industry, including Grain SA, to *inter alia* reduce the C-footprint of agriculture. It is important to conduct an in-country, or regional, study to assess the C-footprint of farming systems, soil health and soil carbon sequestration (C-sequestration). This will provide essential information to provide producers with effective options in land management that will most efficiently be able to facilitate the reduction in the carbon budget (C-budget) and development of C-neutral / negative crop production systems.

The key motivation behind this study, especially Phase 3, is the importance to demonstrate the impacts of farming systems on the C-budget through assessment tools and models, as well as interactive sessions with producers and other key stakeholders.

2. Long term objectives

The long-term goal of the project is to determine the C-footprint (emissions, removals and sequestration) of farming systems across the winter grain regions. The C-footprint will provide farmers with benchmark data and tools that can lead to improved efficiency in farming systems, reduced C-emissions and alignment with the future carbon tax.

3. Short-term objectives

The short-term objectives for Phase 3 (2019) are:

1. To identify farms for the winter grain regions to participate in a pilot roll out of the C- footprint tools and assessments;
2. To conduct net C balance assessments with the IPCC tool (coarse, conceptual-based level);
3. To conduct C-sequestration assessments with the EPIC model (detailed, process-based level);
4. To improve the demonstration and learning impact using the EPIC model;
5. To train and interact with key stakeholders in C-footprint assessments and tools;
6. To improve the quality and applications of the tools in local situations through sense-checking, feed-back and support to key stakeholders (especially farmers).

4. Progress report per objective – January 2020 (annual progress report)

4.1. Objective 1: To identify farms for the winter grain regions to participate in a pilot roll out of the C- footprint tools and assessments

Summary of progress

Data gathered from Phase 1 was used to create specific carbon footprint reports and case-studies. Where necessary additional data was collected to complement the existing data. Grain SA has identified farming systems / sites in the sub-regions to include in the assessments and the workshops. The data from Phase 1 has been used for input into the carbon calculator tool. These datasets were used to create scenarios for training purposes.

Deliverables achieved

The development of an excel based carbon footprint calculator (based on existing Blue North Sustainability (Pty) Ltd tools) for training and awareness raising purposes is one of the deliverables of Phase 3 of the project. The tool has been completed. The tool includes the following functionality: data collection, carbon emissions calculation, reporting and sensitivity analysis. Please refer to the screenshots of the actual tool in Figures 1 to 3 below.

The protocol used for the excel based tool for grain farming is the PAS 2050: 2011 developed by the British Standards Institute (BSI). This protocol is a single issue method which only determines the carbon emissions of products (British Standards Institute, 2012). GHG emissions is only one of a range of impacts that need to be taken into account to obtain a holistic view of the environmental impacts of a product or service.

The boundaries covered are the farm and delivery of product to silos with the rest of the value chain excluded. Data for the different commodities and farming practices were collected by Grain SA and supplied to Blue North Sustainability. The extensive production cost database of Grain SA was used as basis for the input into the tool, complemented by additional data required through interviews and group discussions with producers and technicians. The data in each dataset is sense checked where after it was used to create different scenarios.

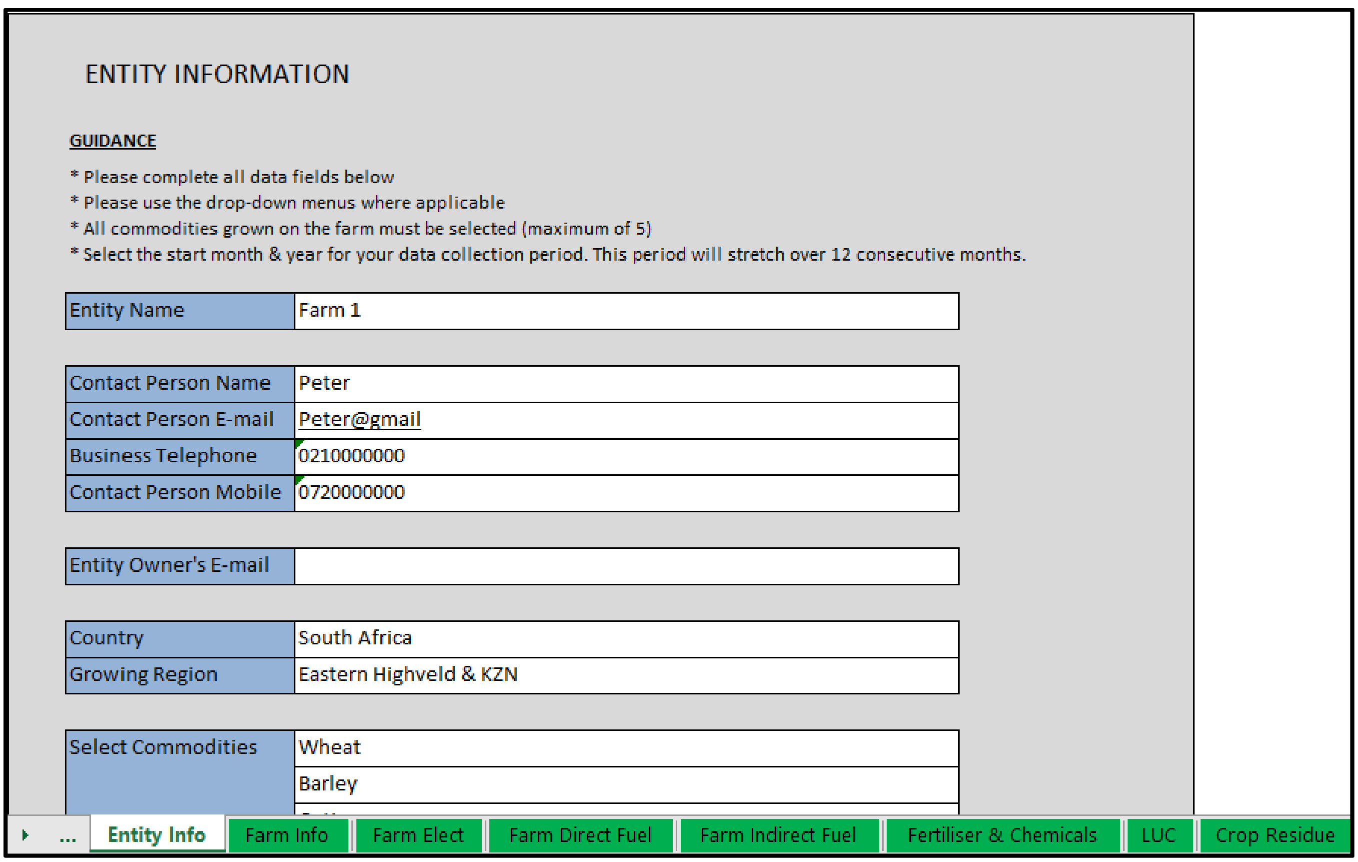


Figure 1: The screenshot above is an example of the different tabs in the carbon calculator tool where inputs are required with a partial view of the first tab with the entity information.

FARM DIRECT FUEL

GUIDANCE

* DIRECT fuel is fuel that the business unit bought and consumed itself (as opposed to INDIRECT fuel which was bought and consumed by contractors)
* Direct Fuel types include; Diesel, Petrol and Biofuels
* Fuel is allocated to Farm Activites, typical farm activities include Crop Activity, Delivery to Storage, Farm Managment and Labour Transport
* Crop Activity fuel includes i.e. planting, spraying, lime & fertiliser spreading, windrowing, harvesting, baling)
* Crop Activity Fuel is further allocated to Commodities
* Delivery to Storage Fuel is further allocated to Commodities
* Allocation of fuel is done by "L" (by consumption) (preferred) or by "%" (by estimation)

Step 1: Enter the Total fuel consumption (Litres) by type (i.e. Diesel, Petrol, Biofuels)
Step 2: Select allocation method by "L" (by consumption) or by "%" (by estimation)
Step 3: Complete allocation to Farm Activities
Step 4: Follow the blue arrow to allocate the "Crop Activities"
Step: 5 Select allocation method by "L" or by "%"
Step 6: Complete allocation to commodities
Step 7: Follow green arrow to allocate the "Delivery to Storage"
Step 8: Complete allocation to commodities

Figure 2: An example of the guidance provided in the tool within each data input tab.

Diesel		**Litres** Enter value
Allocation to **Farm Activities** by:	Select	

Farm Activities		
Crop Activity		
Delivery to Storage		
Farm Management		
Labour Transport		
Other		
Total		

Please continue

Allocation to **Commodities** by:	Select

Commodites		
Wheat		
Barley		
Cotton		
Wheat		
Select from dropdown ...		
Total		

Please continue

Allocation to **Commodities** by:	Select

Commodities		
Wheat		
Barley		
Cotton		
Wheat		
Select from dropdown ...		
Total		

Please continue

Figure 3: An example of the input data fields for diesel provided in the tool.

4.2. Objective 2: To conduct Carbon emission assessments with the IPCC tool (coarse, conceptual-based level)

Summary of progress

The carbon footprint calculator has been completed. Below are screenshots of the initial calculations in Figures 4 to 8 below.

Deliverables achieved

The assessment (calculation) of C-emissions for the different scenarios created in Phase 1 reflected the carbon footprints per farming system per sub-region. The Phase 3 excel-based tool now allows a user to input their own data and be presented with a report that reflects their carbon emissions and also the areas ("hotspots") within their business that contributes most to their carbon emissions. These are typically the areas that should be prioritised in a carbon emission reduction strategy for a business. This process and results presented in the form of a report in the excel based tool often challenges current farm management systems and highlights areas where farm management systems have limitations and/or can be improved.

The following inputs, activities and outputs are included in the grain farm boundary excel tool to calculate the carbon footprint:

- Yields and hectares;
- Electricity use;
- Fuel use;
- Fertiliser and agro-chemicals;
- Crop residues and;
- Land use change.

Please note that the excel based carbon calculator for grains is the Intellectual Property of Blue North Sustainability (Pty) Ltd and that it is used to enter data from Phase 1 to create case studies that will be used for training and awareness raising purposes relating to carbon emissions, climate change and the positive role that Conservation Agriculture can play within the winter grain region. The excel based tool is not available to freely distribute but the aim is to launch the tool into an online platform that would assist individual producers and the industry as a whole to start measuring and managing carbon emissions.

The creation of an online carbon emissions calculator is subject to future funding.

Carbon Emission Results for: Farm 1 October 2017 to September 2018

Carbon Footprint (kgs CO_2e)

Commodity	Total	/ hectare	/ ton
Wheat	968	968	**358**
Barley	966	966	**358**
Cotton	941	941	**349**
Wheat	0	0	0
Total farm emissions:	**2.87**	**Tons CO2e**	

Figure 4: A portion of the report output in the tool indicating emissions per hectares and per ton.

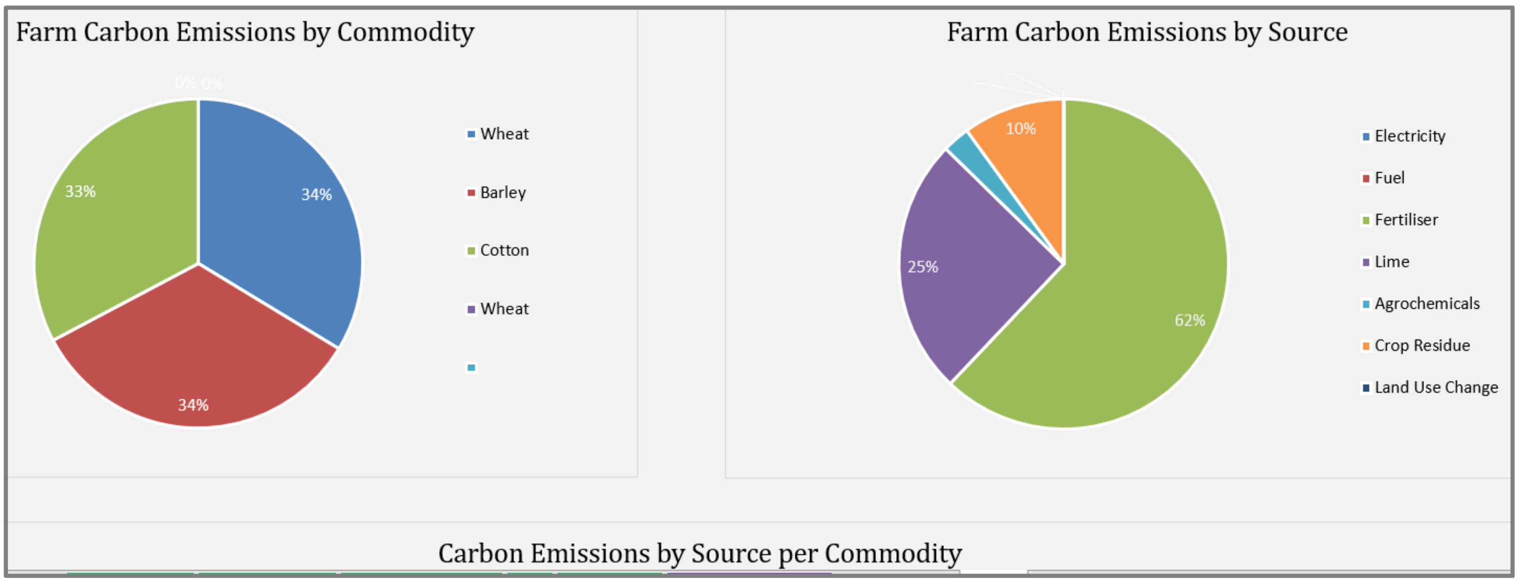


Figure 5: A portion of the report output in the tool indicating the emissions as a percentage per commodity as well as the source of the emissions.

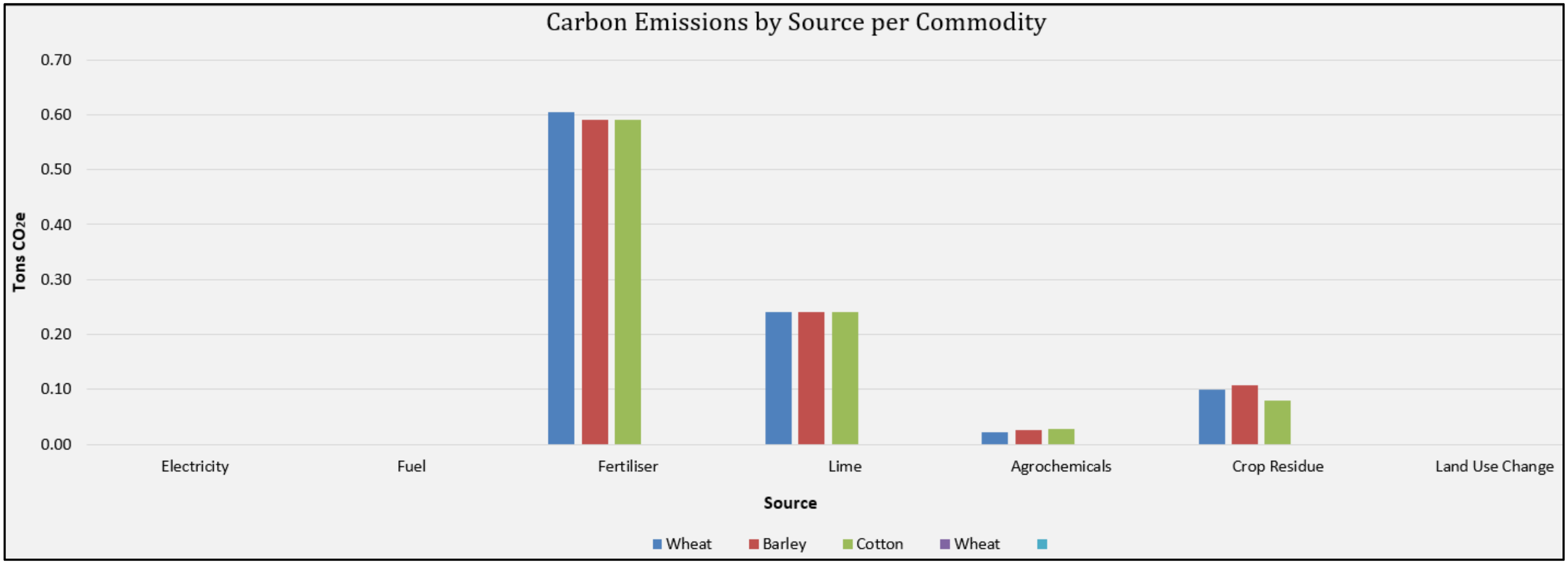


Figure 6: The screenshot above details the look, feel and contents of the reporting output of the tool. Once a user has entered their data, the report will be created which will indicate the carbon emission intensity and hotspots.

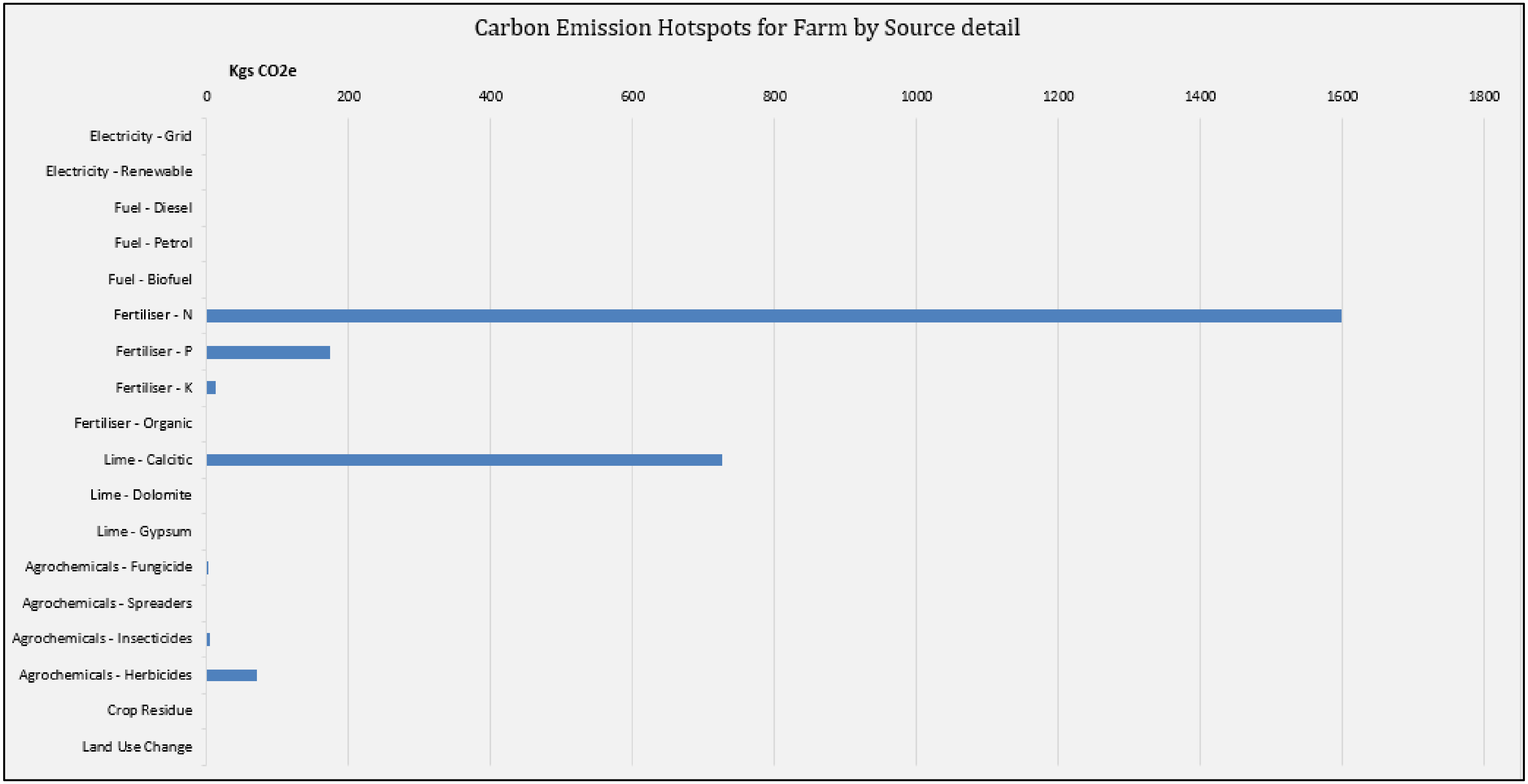


Figure 7: An additional reporting example from the tool indicating the “Hotspots” in terms of carbon emissions, that a producer needs to focus on.

Expected % Change in Production Variables

Production Variable	Commodities				
	Wheat	Barley	Cotton	Wheat	
Yield	10%				
Electricity					
Fuel	10%				
Syn N					
Δ% per ton crop	-10%	0%	0%	#DIV/0!	

Note:
- for decrease
+ for increase

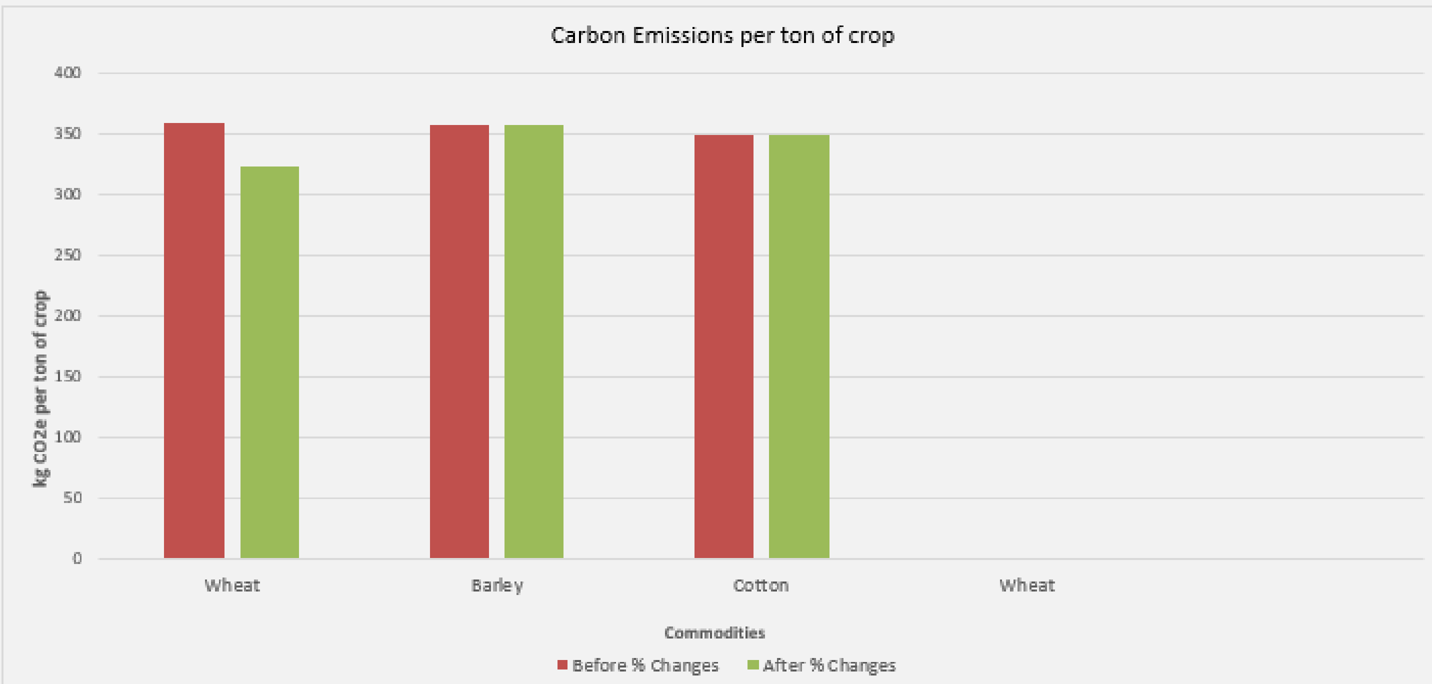


Figure 8: The sensitivity analysis that has been built into the carbon calculator tool.

4.3. Objective 3: To conduct C-sequestration assessments with the EPIC model

The focus of this objective is to predict the impact of conservation agriculture on soil organic carbon build-up (C-sequestration) using a numerical C-sequestration model and readily available data.

4.3.1. *Modelling approach*

The C-sequestration numerical modelling component involved a two-phase approach, namely:

- *Detailed numerical modelling* to predict the impact of farming systems on the C-sequestration potential based on readily available data; and
- *Develop a user-friendly application (app)* as a tool to demonstrate the impact of farming systems on C-sequestration potential based on the results from the numerical modelling.

The modelling approach is summarised in Table 1.

Table 1: Approach of C-sequestration modelling component

Approach	Methodology
1. C-sequestration numerical modelling - Predict C-sequestration potential of farming systems - Detailed, infrequent exercise - Discussed in Section 4.3	- Theoretically evaluate C-sequestration models and select suitable model - Prepare model data files - Predict C-sequestration potential for farming systems
2. C-sequestration potential app - User-friendly tool to demonstrate impact of farming systems on C-sequestration - No data required from user; interaction based on drop-down menus - Discussed in Section 4.4	- Develop app - Include C-sequestration potential modelling results for farming systems - Demonstrate effect of farming systems on C-sequestration potential at workshop

The impact of farming systems on C-sequestration potential were predicted as a function of the following for the winter grain subregions:

- Climate;
- Soil properties;
- Cultivation- and cropping systems;
- Crop growth and development characteristics; and
- Tillage- and agronomic practices.

The predicted C-sequestration represents the net carbon included in the soil organic matter and the cumulative build-up or loss of soil organic carbon in the long-term (decades).

The study approach involved numerical modelling at the field-scale that is based on units with relative homogeneous climate, soil, farming systems and associated agronomic- and tillage practices. The modelling did not involve spatially distributed C-sequestration modelling. A spatially distributed C-sequestration modelling was beyond the scope and financial resources of the project considering the large amount of spatial data that could be required and likelihood that spatial distributed data could not be readily available for all the required model input.

The study focused on the application of numerical modelling to predict the impact of farming systems on C-sequestration potential based on readily available data, rather than producing large spatially distributed data sets on the C-sequestration factors. The study approach made it possible to provide decision-making information on the impact of farming systems on C-sequestration potential with readily available data and the financial resources available to the study. This provides the basis for future refinement in collating a larger amount of spatially distributed data for model input, that can be supported by the application of Geographic Information Systems.

4.3.2. Evaluation of C-sequestration numerical models

Fourteen numerical models were evaluated theoretically during Phase 2 that predict C-sequestration. The models were evaluated on the following aspects:

- Ability to predict the impact of the farming systems of the winter grain region such as the effect of crop rotation, cultivation and agronomic practices and timing;
- Extent that the difference in conventional- and conservation agriculture on C-sequestration can be predicted;
- Availability of the model code and user-friendliness; and
- Model data requirements with consideration of minimum data requirements and extent that this data is readily available.

The Windows interface (WinEPIC) of the EPIC version 08.10 (Environmental Policy Integrated Climate) numerical model was selected and applied to predict C-sequestration for conventional- and conservation agricultural farming systems for the winter grain sub-regions. WinEPIC was developed by Texas A&M AgriLife Research.

WinEPIC was selected for the study for the following reasons:

- WinEPIC is a freeware, and model code is easily accessible and downloadable from a dedicated home page;
- The model is well documented with tutorials to learn the model in a user-friendly manner;
- WinEPIC is user friendly for setting up model input files and simulating various farming practices of the winter grain regions;
- Extensive database on crop growth and development, tillage implements, cropping- and cultivation systems and soils with default files that could be used as basis to change model input values specific for the winter wheat regions;
- The minimum data required by WinEPIC to simulate C-sequestration are readily available or could be determined / calculated from readily available data;
- The process-based model can simulate C-sequestration for the various farming regimes of conventional and conservation agriculture in the winter wheat regions in detail;
- Capability to be used in modelling involving up-scaling (from field-based to region) and the use of GIS.

The C-sequestration module of WinEPIC is based on the CENTURY C-sequestration model (Parton *et al.,* 1992). The CENTURY model simulates the soil organic matter processes and dynamics to predict the extent of C-sequestration. The important processes and components simulated in the CENTURY model, which the WinEPIC C-sequestration component is based on, is shown in Figure 9. The application of the WinEPIC model in the project is summarised in Table ***1***.

Table 1: Summary of the application of WinEPIC model in the project.

Aspect	Description
Model type	Continuous process-based
Spatial scale	Field-scale, can simulate field, farm or small/agricultural catchment
Spatial unit	Units with homogeneous climate, soil, topography, land use and crop management system
Temporal scale	Daily time step predicting over decades (long-term)
Evaluate impact of conservation agriculture	Simulate impact of crop, land management practices and tillage systems in considerable detail

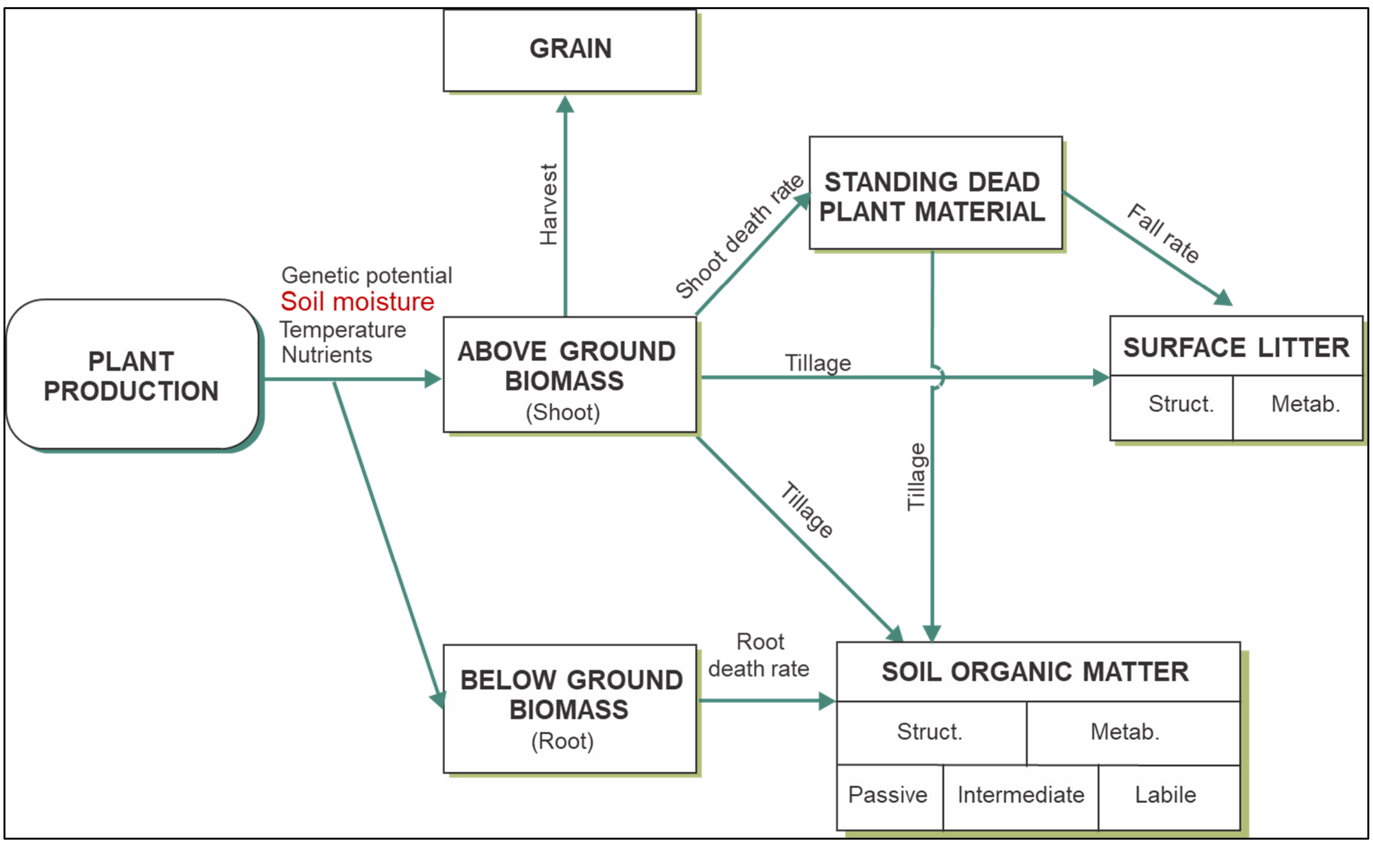


Figure 9: Summary of WinEPIC C-sequestration modelling components.

4.3.3. Farming systems

The impact of three farming system scenarios on soil organic carbon (SOC) contents were predicted for the Swartland and Overberg subregions. The scenarios include:

- Conventional cultivation;
- Current conservation agriculture; and
- Future conservation agriculture scenario.

The *conventional cultivation scenario* represents wheat mono-cropping that involves disc ploughing and scarifying the soil with a shallow tine cultivator before planting.

The *current conservation agriculture scenario* represents a crop rotation and minimum (reduced) tillage cropping system that involves scarifying the soil with a tine cultivator before planting.

The *future conservation agriculture scenario* represents a crop rotation and no tillage cropping system of an ideal but realistic conservation agriculture system to be adopted by most grain producers twenty years into the future.

4.3.4. Model input files

Model files on the climate, soil properties, crop rotation and characteristics, and tillage- and agronomic practices were prepared for data input to WinEPIC for the winter grain subregions. The preparation of the data files is discussed in subsequent sections.

4.3.4.1. Climate

Climate files were prepared using a supporting program of EPIC to prepare the model files. The utility was also used to scan climate data for data errors and days with missing data.

The minimum data required for EPIC is daily rainfall and air temperatures, but solar radiation and windspeed are also important to simulate the soil water budget and plant growth aspects for the C-sequestration model component. The climate files were prepared from daily rainfall, and minimum- and maximum temperature data included in the WeatherDatabase developed by NB Systems CC. The database includes daily rainfall and temperature record of 50 years based on recoded data and infilled data for record periods with missing data. Daily solar radiation was calculated from the temperature data. The mean monthly daily wind speed information was used as input to climate files.

Climate files were prepared for selected climate stations that serves as a “driver” (primary) climate station to represent the climate of a subregion. The “driver” climate stations in the winter grain sub-regions are shown in Figure 10 and Figure 11 for the Swartland and Overberg sub-regions.

Future refinement of the climate modelling component includes:

- Inclusion of additional climate stations in a subregion to improve the spatial distribution of climate in the modelling; and
- Refinement of the rainfall, and preferably also temperature, of the climate data files to improve the spatial variability in mean annual precipitation and temperature accounted for in the modelling for a subregion.

It should be noted that the above-mentioned refinements were beyond the scope of this project.

Figure 10: Climate stations used for the Swartland sub-regions.

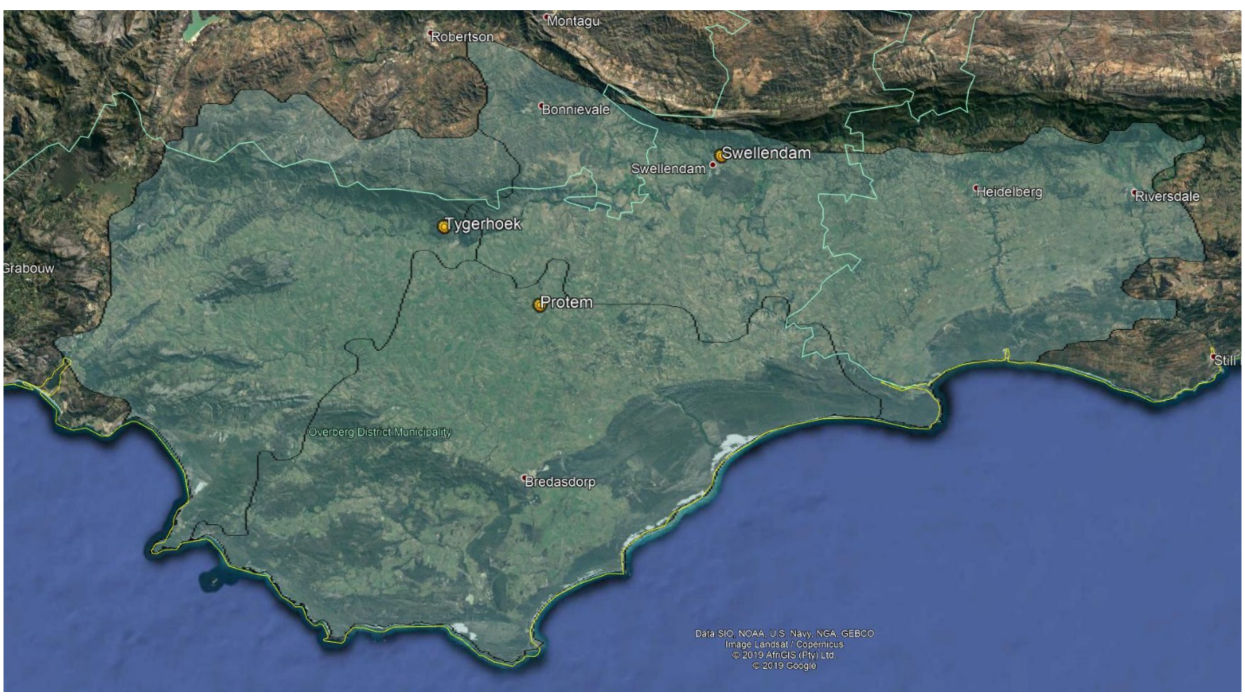


Figure 11: Climate stations used for the Overberg sub-region.

4.3.4.2. Soil

Soil property files were prepared for WinEPIC for two soils in a subregion based on the main texture classes of the A- and B soil horizons in a subregion. Soil texture was used as the basis to prepare the two soil files per subregion for the following reasons:

- The temporal variability (change over time) is low compared to a range of soil physical and chemical properties, including soil organic carbon. A soil property was required that is (relatively) invariable over time;
- It is considerably less impacted by cultivation and agronomic practices than a range of soil physical and chemical properties. The exception relates mostly to the mixture of different soil textured layers, such as cultivation with a plough were the change is texture occurs over a short period of time. A soil property was required that is not significantly affected by cultivation and agronomic practises;
- It is a primary soil property that has considerable impact on the range of soil physical and chemical properties important to C-sequestration, including soil water storage, plant available water, soil fertility, natural soil carbon (matter) contents and the rate that soil organic carbon changes over time with tillage- and agronomic practices. A soil property was required that functions as a composite soil indicator;
- It is readily available data, or can be obtained from % clay and sand, which is readily available data.

The main soil texture classes were determined for the A-horizon in a subregion from the soil profile descriptions and analyses information included in the ARC-ISCW Soil Profile Information System (Soil Survey Staff, 2006). This was followed by determining the main texture classes of the B- or E-soil horizons underlying the selected A-horizon texture class(es). The distribution of the soil profiles in the subregions from which the soil textures were determined are shown in Fig 12 and Fig 13.

The main soil texture classes determined for the Swartland subregions includes:

- Northern area:
  - Sandy loam A-horizon overlying sandy loam B-horizon,
  - Sandy loam A-horizon overlying clayey B-horizon;
- Middle Swartland:
  - Sandy loam A-horizon overlying sandy clay loam B-horizon,
  - Sandy loam A-horizon overlying clayey B-horizon;
- Southern Swartland:
  - Sandy loam A-horizon overlying sandy clay loam B-horizon,
  - Sandy loam A-horizon overlying clayey B-horizon;
- Darling/Hopefield area:
  - Sandy A-horizon overlying sandy E/B-horizon,
  - Sandy A-horizon overlying sandy loam E/B-horizon.

The main soil texture classes determined for the Overberg subregions includes:

- Western Rûens:
  - Loamy A-horizon overlying clayey B-horizon,
  - Sandy loam A-horizon overlying loamy B-horizon;
- Southern Rûens:
  - Sandy loam A-horizon overlying sandy loam B-horizon,
  - Loamy A-horizon overlying clayey B-horizon;
- Eastern Rûens:
  - Sandy loam A-horizon overlying sandy loam B-horizon,
  - Loamy A-horizon overlying clayey B-horizon.

The soil hydraulic properties, such as wilting point, field capacity, plant available water capacity and saturated hydraulic conductivity, were predicted for the selected soils with the Soil Water Characteristics utility. The Soil Water Characteristics utility make use of pedo-transfer functions and a soil hydraulic properties database that includes an extensive amount of soils for which the hydraulic properties were determined. The Soil Water Characteristics utility was developed by the US Department of Agriculture Agricultural Research Service and Department of Biological Systems Engineering of the Washington State University.

Soil property files were selected from the WinEPIC database with analogous soil textures to the soils selected for the Swartland- and Overberg subregions. Parameter values of soil properties important to C-sequestration, such as soil horizon thickness, particle size fractions, rock contents, dry density, soil hydraulic properties and initial soil organic matter content were adjusted to represent the properties of the selected soils.

The conventional cultivation (base case) scenario was used to predict the soil organic carbon contents until equilibrium conditions was reached in the carbon content in the long-term. This carbon content was used as the initial soil carbon content in the Conservation Agriculture (CA) farming systems scenarios. The conventional cultivation scenario is represented by mono-cropping with wheat that includes disc ploughing and shallow tine tillage before planting (Section 4.3.3). This approach was followed in establishing the initial organic carbon contents of a soil. The approach is based on the assumption that conventional cultivation practices were followed historically for over a decade and that the soil organic carbon content has decreased to equilibrium conditions of conventional cultivation.

Further refinement of the soils modelling component includes:

- Inclusion of soil files representing additional soil textures in the subregion to the soil textures used in the study;
- Analyse soils with a range in soil texture that have been cultivated for a significant period (i.e. over 20 years) under conventional cultivation conditions to determine the SOC contents. This SOC contents can be used to refine the initial SOC contents used in the modelling. It will also improve the value to be used for the base case scenario (base line value) from which extent of increase in SOC content occurs following CA farming systems;
- Refine values for the soil hydraulic properties, and preferably also soil chemistry, to be used for the soils model files from soil databases and other data sources with measured data.

It should be noted that the above-mentioned refinements were beyond the scope of this project.

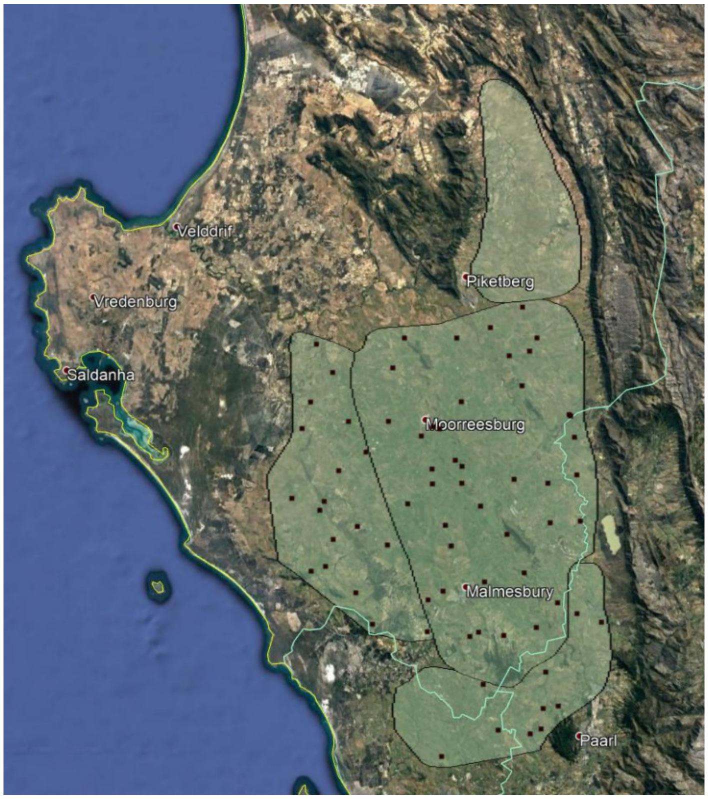


Figure 12: Distribution of soil profiles in the Swartland subregions used for study[1].

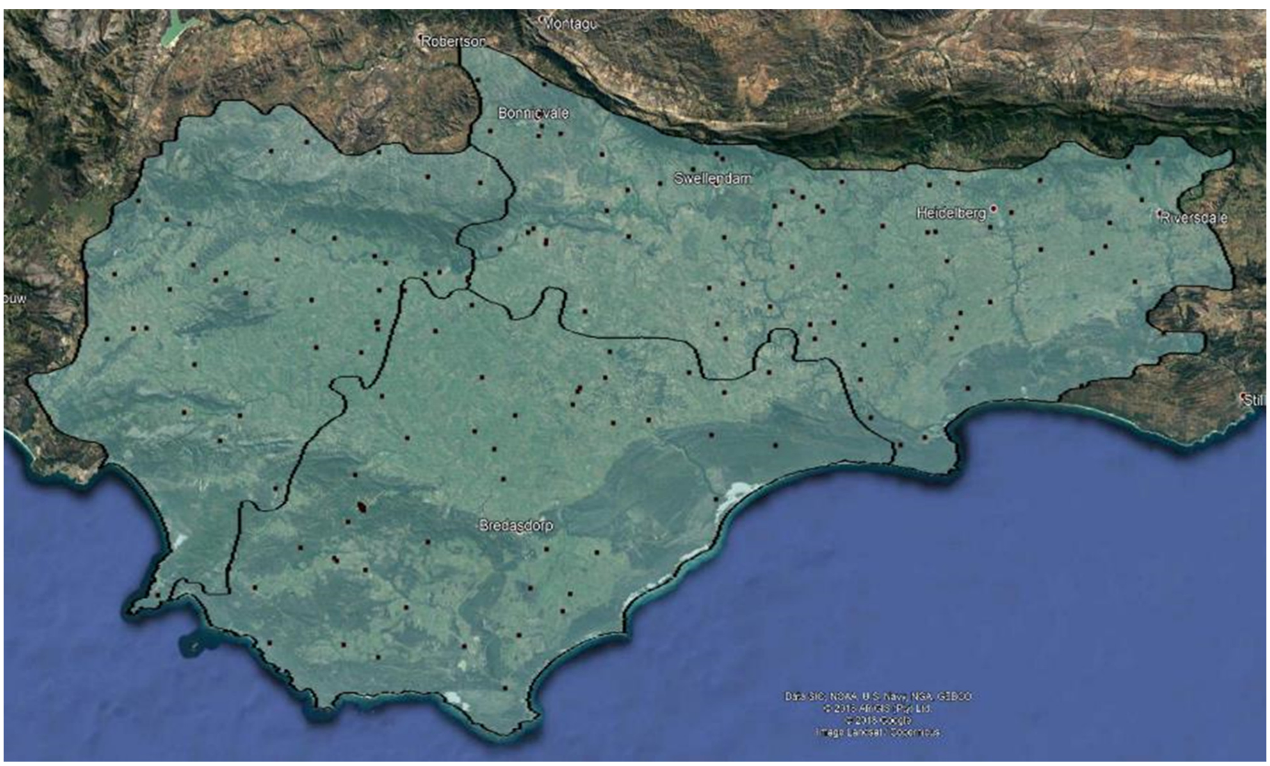


Figure 13: Distribution of soil profiles in the Overberg subregions used for study[1].

Note: [1] Soil Survey Staff, 2006. Soil profile descriptions and soil analyses data. In: ARC-ISCW Soil Profile Information System.

4.3.4.3. Cropping systems

The crop rotation and sequence of crops (crop order) needs to be specified in WinEPIC's cropping system files. The crop rotations simulated for the farming systems of the Swartland- and Overberg subregions are summarised in Table 4. The crop rotations are based on data provided by Grain SA.

Table 4: Crop rotation systems simulated for the subregions

Region	Subregion	Farming system	Crop rotation
Swartland	Northern area	Conventional cultivation	Mono-crop wheat
		Conservation agriculture	Wheat-Lupins
		Future conservation agriculture	Wheat-Cover crops-Canola
	Middle Swartland	Conventional cultivation	Mono-crop wheat
		Conservation agriculture	Wheat-Medics
		Future conservation agriculture	Wheat-Cover crops-Wheat-Canola
	Southern Swartland	Conventional cultivation	Mono-crop wheat
		Conservation agriculture	Wheat-Medics-Canola
		Future conservation agriculture	Wheat-Cover crops-Canola
	Darling/ Hopefield area	Conventional cultivation	Mono-crop wheat
		Conservation agriculture	Wheat-Medics-Lupins
		Future conservation agriculture	Wheat-Cover crops-Canola
Overberg		Conventional cultivation	Mono-crop wheat
		Conservation agriculture	Wheat-Barley-Canola
		Future conservation agriculture	Wheat-Barley-Cover crops-Canola

Cover crops were included in the conservation agriculture cropping systems with the objective to increase the soil organic carbon content and C-sequestration potential through:

- Limiting soil disturbance with minimum- or no tillage;
- Providing a large root mass in addition to high crop residue rates; and
- Fixing atmospheric nitrogen to optimise crop- and soil organic carbon to nitrogen (C:N) ratio for optimising C-sequestration.

Cover crops generally includes a mixture of crops to achieve above-mentioned objectives by including a legume and crop(s) with a high root mass. The crops that can be included in a cover crop mixture can include a number of crops that can varies, which complicated the C-sequestration modelling. Consequently, medics was used to represent cover crops in the modelling. Medics was selected as it is used in the Swartland as a cover crop, and the above-listed objectives for a cover crop is met.

4.3.4.4. Crop characteristics

The crop characteristics file includes an extensive list of parameters relating to crop growth, leaf properties and development, root development, biomass production, plant nutrient uptake, harvest index and organic carbon and nitrogen contents of leaves, roots and grain.

The parameter values represent the maximum potential growth rate, leaf area, nutrient uptake and harvest index that could possibly be attained under non-stressed conditions. Parameter values should be based on experimental data where crop stresses related to climate and moisture- and plant nutrient availability have been minimised to allow the crop to attain its potential. It should be noted that the effect of climate, moisture and plant nutrient stresses on plant growth, plant nutrient uptake and biomass production are accounted for in the model components related to soil water balance and plant available water, plant growth and C-sequestration. Moisture availability was the main limiting factor of the Swartland and Overberg subregions in attaining the maximum potential of a crop. The soil water balance modelling component included in WinEPIC was imperative to predict changes in soil moisture, plant available water and crop stress (drought) during the growing season.

A questionnaire to obtain crop parameter values for dryland wheat, barley, medics, lupin and canola for the winter grain regions was sent to agronomists/plant physiologists, but no feedback was received. A literature study was then conducted to obtain crop parameter values for those parameters sensitive to crop growth and biomass production.

The literature study indicated that parameter values of the WinEPIC crop files were comparable to the limited amount of values obtained from the literature study. Consequently, the parameter values included in the WinEPIC database for winter dryland wheat, barley, canola, red clover and peas were used as values were not available to the study for the winter grain region. Parameter values of clover were used for lupins, and that of peas for medics as lupin and medics were not included in the WinEpic crop database. Clover was selected to represent lupins rather than alfalfa as alfalfa is perennial.

Future refinement in the C-sequestration modelling should focus on further refinement of the crop parameter values for the winter grain regions, especially those parameters sensitive to crop growth and biomass production. It should be noted that model calibration of crop characteristics and growth were beyond the scope of this study.

4.3.4.5. Agronomic and tillage practices

The crop management file of WinEPIC requires that the type and schedule (timing) of agronomic- and tillage activities are specified for each cropping system. The agronomic- and tillage activities that were accounted for in the C-sequestration modelling include:

- Planting and harvesting;
- Tillage before, during and after planting; and
- Fertilizer and lime application.

The scheduling of agronomic- and tillage activities for a cropping system is based on the data provided by Grain SA on the type and timing of the activity for the subregions.

The following activities were not accounted for in the C-sequestration modelling:

- Pesticide application. The frequency and specific pesticide to be used can vary between growth seasons. Minimum soil disturbance also occurs during pesticide application. Consequently, the activity of pesticide application was not included as it unnecessary complicates the modelling without having a significant effect on C-sequestration. The C-sequestration modelling is based on healthy crops that are not affected by pests;
- Grazing and burning of crop residue after harvesting. The sheep stocking rates and duration of grazing is highly variable. Consequently, the fraction (%) of crop residue removed during grazing was account with harvesting to simplify the modelling. The effect of soil disturbance and the inclusion of plant rests into the soil by the hooves is therefore not accounted for in the C-sequestration modelling conducted for this study.

Information is also required describing each agronomic- and tillage practice when an activity is scheduled in the crop management file. The information includes:

- Implement type and properties. The data provided by Grain SA on the various implements used for the farming systems was used as basis to select the implements from the extensive list of implements included in the WinEPIC database. The WinEPIC database also includes a detailed description on a tillage implement, including the tillage depth and the extent of soil mixture and crop residue incorporation during tillage;
- Planter type, properties and planting density. Data provided by Grain SA on the planters used for conventional, minimum- and no tillage was used as basis to select the specific planters from the implements list included in the WinEPIC database. The WinEPIC database also includes detail description of the planters and their effect on extent of soil mixture during planting. The data on grain yield provided by Grain SA was used as basis to specify the planting density according to literature on plant densities and grain yield of the Winter regions;
- Fertilizer and lime application. Data provided by Grain SA on the nitrogen, phosphorus, potassium and lime (calcitic and/or dolomitic) application rate for the various cropping systems were used to specify the amount fertiliser- and lime applied before, during and after planting for the cropping systems for each subregion;
- Harvesting. A combine, self-propelled harvester was selected from the WinEPIC implements database. The amount of crop residue that was specified to be removed is based on the data provided by Grain SA on residue removal through grazing and burning after harvesting for the cropping systems for the various subregions.

4.4. Objective 4: To improve the demonstration and learning impact using the EPIC model

The focus of this objective is to develop a user-friendly application (app) as a tool to demonstrate the potential impact of conservation agriculture on soil organic carbon build-up (C-sequestration) based on the results from the numerical C-sequestration modelling. The approach is discussed in Section 4.3.1 and shown in Figure 14.

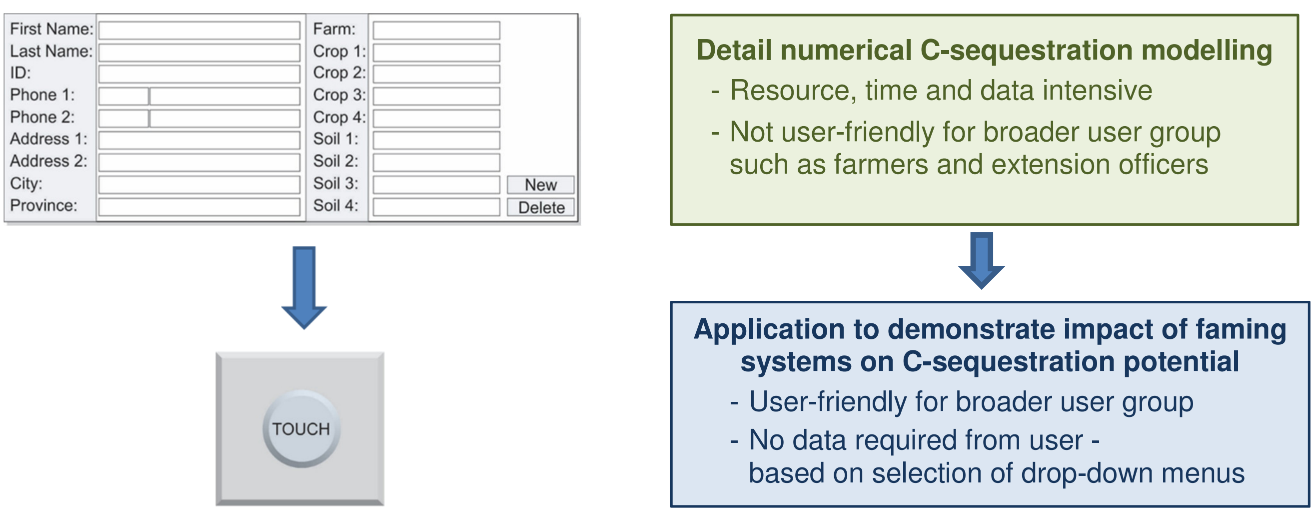


Figure 14: Approach in developing user-friendly application as demonstration tool of C-sequestration.

The application is intended to be used by a wide group, including farmers and extension officers. Drop-down menus allow users to evaluate the impact of farming systems on the potential to sequestrate soil organic carbon (C-sequestration). While the EPIC model can fairly accurately simulate C-sequestration given long and accurate climate records, known soil properties and fixed farming practices, the application uses model results for selected climate conditions that represent a wider farming sub-region, while soils and farming practices could vary more than the application allows for. Results of the model are therefore presented as potential C-sequestration that represent likely average conditions within a farming sub-region.

The farming systems includes conventional cultivation as a base case scenario, and current- and future conservation agriculture scenarios as discussed in Section 4.3.3. Conservation agriculture scenarios include a cover crop in the crop rotation that is characterised by high root mass and includes a legume in the cover crop mixture to optimise the organic carbon to nitrogen ratio (C:N) of roots, plant residue and the soil.

The application provides a basic tool to compare the potential of farming systems to sequestrate soil organic carbon, creating awareness of various C-sequestration options. The intention is *not* to provide an application that can model (predict) or conduct detailed analyses of C-sequestration.

The application was initially developed to include drop-down menus on the soil texture- and gravel content classes, cultivation systems (conventional-, minimum- and no tillage) and crop rotation systems for a subregion of the Swartland and Overberg grain regions. However, latter development focussed on further simplifying the application to make a more user-friendly tool.

Simplified drop-down menus use one of two soil texture classes for a subregion. The user must select a subregion of the Swartland- or Overberg grain region, and a soil texture class. The application will provide an output of predicted C-sequestration potential for the various farming systems scenarios. The output comprises time series graphs of predicted C-sequestration potential. These graphs show how C-sequestration potential changes over time for each farming system and allows a comparison between the effects of the farming systems. Initial high potentials for C-sequestration are predicted with conservation agriculture that decrease over time as equilibrium conditions are reached in the long-term (>20 years). The drop-down menus of the application are shown in Figure 15.

The predicted C-sequestration potential for the various farming systems included in the application for the Swartland- and Overberg subregions are included in Annexure 3.

4.5. Objective 5: To train and interact with key stakeholders in C-footprint assessments and tools

The C-sequestration potential application was presented at the workshops for the Swartland and Overberg grain regions during a presentation on “Soil carbon sequestration potential of different grain production systems in Western Cape”. The workshops were at the Overberg Agri hall, Morreesburg on 04 December 2019 for the Swartland region, and at the Overberg Agri Rietpoel hall, Caledon on 05 December 2019 for the Overberg region.

The workshop programme and attendance registers are attached in Annexure 1.

An infographic on the excel-based carbon emissions calculator was developed that was circulated to all that attended. Workshop presentations were also made available. Please see the infographic attached in Annexure 2.

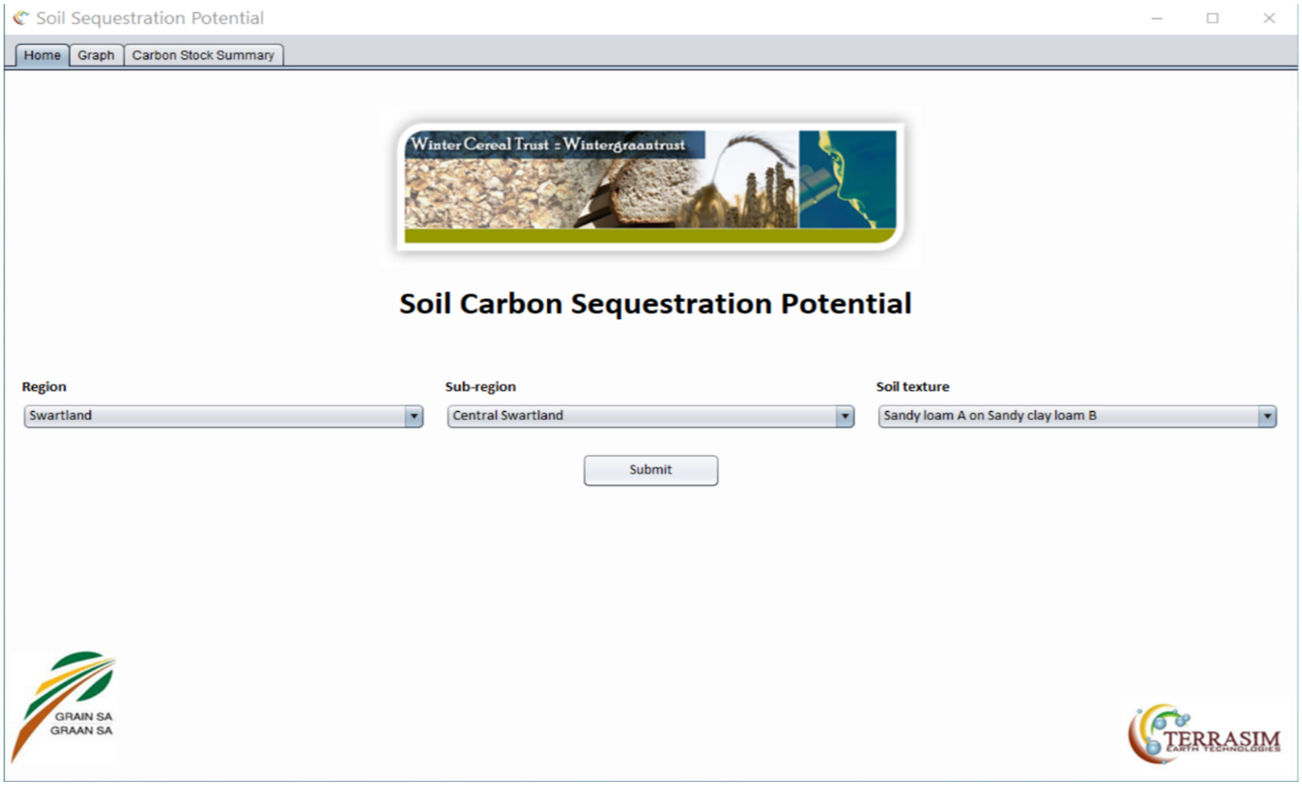


Figure 15: Drop-down menu selection of C-sequestration potential application.

4.6. Objective 6: To improve the quality and applications of the tools in local situations through sense-checking, feed-back and support to key stakeholders (especially farmers).

During the workshops the participants' inputs and comments were used in sense-checking the data and results yielded by the C-footprint tool and model. Once that step was completed the data in each tool was yet again sense checked by the research team and feedback to the farmers is included in this annual progress report. The main idea was to optimise the learning and management ability of the tool.

Summary of progress

Feedback received during the workshops on the excel-based carbon emissions calculator was positive and no specific amendments to the tool was required.

5. Conclusion

As shown by the screenshots above in Section 4.2 the carbon footprint data input tool, calculator with reporting function and sensitivity analysis tool has been developed by Blue North Sustainability (Pty) Ltd for training purposes. Training sessions and an informative infographic has been delivered to inform farmers about the project and use and application of the carbon emissions calculator.

Positive feedback has been received from the workshops especially from individual farmers in the Southern Cape area. In future an online tool for grain farmers to determine carbon emissions and a move towards reduced carbon emissions would be ideal. It is clear that a switch to Conservation Agriculture ensures a reduction in overall carbon emissions, but it is important that this is measured year-on-year to be able to document the trend in carbon emissions over time and to use the information to make informed decisions. An online tool would not only be valuable to the individual farmer but also to industry as a whole in terms of the primary data that is collected. Further along in the value chain it will also be important to understand the carbon footprint of grains as an input into many different products. The pressure world-wide on companies to understand, manage and declare their carbon emissions is increasing and it will be beneficial in future to provide farmers with an online tool in order to deal with the potential future requirements of carbon emission reporting.

The following can be concluded from the C-sequestration potential modelling and application developed for the subregions of the Winter grain region:

- After 50 years of EPIC modelling, no-till cultivation systems showed the highest soil organic carbon carbon levels (SOC), followed by reduced tillage. Conventional tillage systems have the lowest SOC. High SOC levels are associated with high C-sequestration potential of the farming system.
- Conservation agriculture shows an initial high potential for carbon sequestration, with marked increases in SOC, but increases in SOC do decrease with time, until a new equilibrium is reached for the conditions of the conservation agriculture farming practices.
- More carbon is sequestrated in the soils when crop rotation systems include crops that have a high root mass. Some advantage of inclusion of legumes (nitrogen fixing function) in the crop rotation, in addition to the inclusion of cover crops with high root mass.
- Predicted carbon stocks are generally comparable to the stocks calculated using the IPCC tool and marginally higher than the stocks determined by long-term experimental field trials.

6. Budget Summary by December 2019

Description of actions in Phase 3, 2019	Total Actual YTD 2019	Total Budget YTD 2019	Available to use
Develop database for model: TerraSim	24 000	24 000	-
Develop carbon sequestration app: TerraSim	10 000	10 000	-
Develop database for app: TerraSim	24 000	24 000	-
Modifications to data collection: TerraSim	7 500	7 500	-
Modifications to data collection: Blue North	20 400	20 400	-
Set up presentations for workshops: TerraSim	5 000	5 000	-
Set up presentations for workshops: Blue North	6 800	6 800	-
Workshops: Blue North	13 600	13 600	-
Workshops: TerraSim	18 000	18 000	-
Sense-checking of data and support	15 300	15 300	-
Case study and infographic: Blue North	20 400	20 400	-
C-sequestration app report: TerraSim	-	5 000	5 000
Communication: Blue North	13 600	13 600	-
Evaluate Model: TerraSim	5 156	5 000	-156
Venue & Catering: GSA	7 000	10 000	3 000
Total	**190 756**	**198 600**	**7 844**
Plus: Management fee (10%)	**19 076**	**18 257**	**-819**
Grand Total	**209 831**	**216 857**	**7 026**

NOTE: Please take note that the agreed upon procedures (AUP) has not been done yet. Figures may differ after factual findings.

Annexure 1: The workshop programme and attendance registers

TYD/TIME	ITEM	AANBIEDER / PRESENTER
08:30-09:00	AANKOMS & REGISTRATSIE / ARRIVAL & REGISTRATION	Facilitator: Dr Hendrik Smith, Grain SA
09:00-09:10	Opening en Verwelkoming / Opening and Welcome	
09:10-10:00	Klimaat in die Wes Kaap – wat moet ons weet? Climate in the Western Cape – what we need to know?	Dr Peter Johnston, Climatologist, UCT
10:00-10:45	IPCC* Spesiale verslag op Klimaatsverandering en Grond – 'n Suid-Afrikaanse Perspektief / IPCC* Special Report on Climate Change and Land - A South African Perspective	Dr Tony Knowles, co-author of IPCC report, The Cirrus Group
10:45-11:00	FruitLook – die waarde vir produsente FruitLook – the value for producers	Annaline Smith, FruitLook Tech Coach
11:00-11:30	TEE / TEA	
11:30-13:00	Kweekhuisgas vrystelling van verskillende graanverbouing-stelsels in die Wes Kaap / Greenhouse gas emissions of different grain production systems in the Western Cape	Anel Blignaut & Kerry Saywood, Blue North
13:00-14:00	MIDDAGETE / LUNCH	
14:00-16:00	Koolstofvaslegging van verskillende graanverbouingstelsels in Wes Kaap / Carbon sequestration of different grain production systems in the Western Cape	Albert van Zyl, TerraSim
16:00	AFSLUITING / CLOSURE	

Stuur asb aan annaline@bluenorth.co.za

CARBON FOOTPRINT INFORMATION DAY, WESTERN CAPE
WEDNESDAY 20 NOVEMBER 2019
Overberg Agri saal – Moorreesburg, 08:30 for 9:00

ATTENDANCE LIST

NAME & SURNAME	COMPANY	CONTACT DETAILS	SIGNATURE
Hendrik Smith	Grain SA	Tel: 082 3310 688 Email: hendrik.smith@grainsa.co.za	
Peter Johnston	Univ CAPE TOWN	Tel: 0833058582 Email: peter@csag.uct.ac.za	
Anél Blignaut	Blue North	Tel: 0827519596 Email: anel@bluenorth.co.za	
Annaline Smith	Blue North	Tel: 066 212 2211 Email: annaline@bluenorth.co.za	
KERRY SAYWOOD	BLUE NORTH	Tel: 0722734935 Email: kerry@bluenorth.co.za	K.S.
Tony Knowles	Cirrus	Tel: 083 415 6239 Email: tony@cirrusafrica.com	
Johann Strauss	DLWR	Tel: 082 907 3109 Email: johannst@elsenburg.com	
NICOLE WAGNER	WC DOA	Tel: 021 808 7767 Email: nicolew@elsenburg.com	

NAME & SURNAME	COMPANY	CONTACT DETAILS	SIGNATURE
Wendy Engel	WWF	Tel: 072 298 7890 Email: wengel@wwf.org.za	[signature]
Nina Slabber	M.J. Slabber Plaas	Tel: 0794962399 Email: nina@wcaccess.co.za	[signature]
Willem Barn	Uitenkraal Plaas	Tel: 0824956925 Email: admin@uitenkraal.co.za	[signature]
Sakkie Slabbert	Priv	Tel: 0836499304 Email: sakkiesior@gmail.com	[signature]
Lisa Smorenburg	DLWK	Tel: 082 88 55029 Email: lisas@elsenburg.com	[signature]
Willie Pretorius	Soil Health Solutions	Tel: 0834589854 Email: willie@soilhealthsolutions.com	[signature]
Attie Haasbroek	Omnia Kunsmis	Tel: 0835575321 Email: adriaan.haasbroek@omnia.co.za	[signature]
Francois van Heerden	Fr Heerden.	Tel: 0828073539 Email: fheerdend@gmail.com	[signature]
Kobus du Plessis	Univ. v. Stellenbosch	Tel: 0835605536 Email: jadup@sun.ac.za	[signature]
NIËL ACKERMANN	Flatfoot Ideas	Tel: 0829777553 Email: flatfootideas@lando.co.za	[signature]
Ryan Schutte	GSA	Tel: 074 549 2081 Email: ruan@grainsa.co.za	[signature]
Willem Oosthuizen	Erdvark Engineering	0824986619 willem@erdvark.co.za.	[signature]

NAME & SURNAME	COMPANY	CONTACT DETAILS	SIGNATURE
André Erasmus	Inteligro	Tel: 0832513524 Email: andree@inteligro.co.za	[signature]
Gerrit de Kock	Inteligro	Tel: 0824620547 Email: gerritdk@inteligro.co.za	[signature]
[illegible]	Pirow	Tel: 072 275 005 Email: [illegible]@gmail.co.za	[signature]
Malissa Murphy	Elsenburg Agricultural College/SUN	Tel: 079 716 8959 Email: murphy.malissa@gmail.com	[signature]
Charne´ Viljoen	Stellenbosch University	Tel: 082 723 3773 Email: charneV@elsenburg.com	[signature]
Reno Smit	DLWK	Tel: 073 182 4113 Email: renos@elsenburg.com	[signature]
Nico Bouwer	Agricol	Tel: nbouwer@agricol.co.za Email: 083 844 3369	[signature]
Shayne Jacobs	Stellenbosch Univ.	Tel: 082 336 7254 Email: sjacobs@sun.ac.za	[signature]
[illegible]	DLWK	Tel: 076 091 3885 Email: [illegible]@elsenburg.com	[signature]
Albert van Zyl	Terrasim	Tel: 082 214 2152 Email: avanzyl@terrasim.co.za	[signature]
		Tel: Email:	

CARBON FOOTPRINT INFORMATION DAY, WESTERN CAPE
THURSDAY 21 NOVEMBER 2019
Overberg Agri Rietpoel – Caledon, 08:30 for 9:00

ATTENDANCE LIST

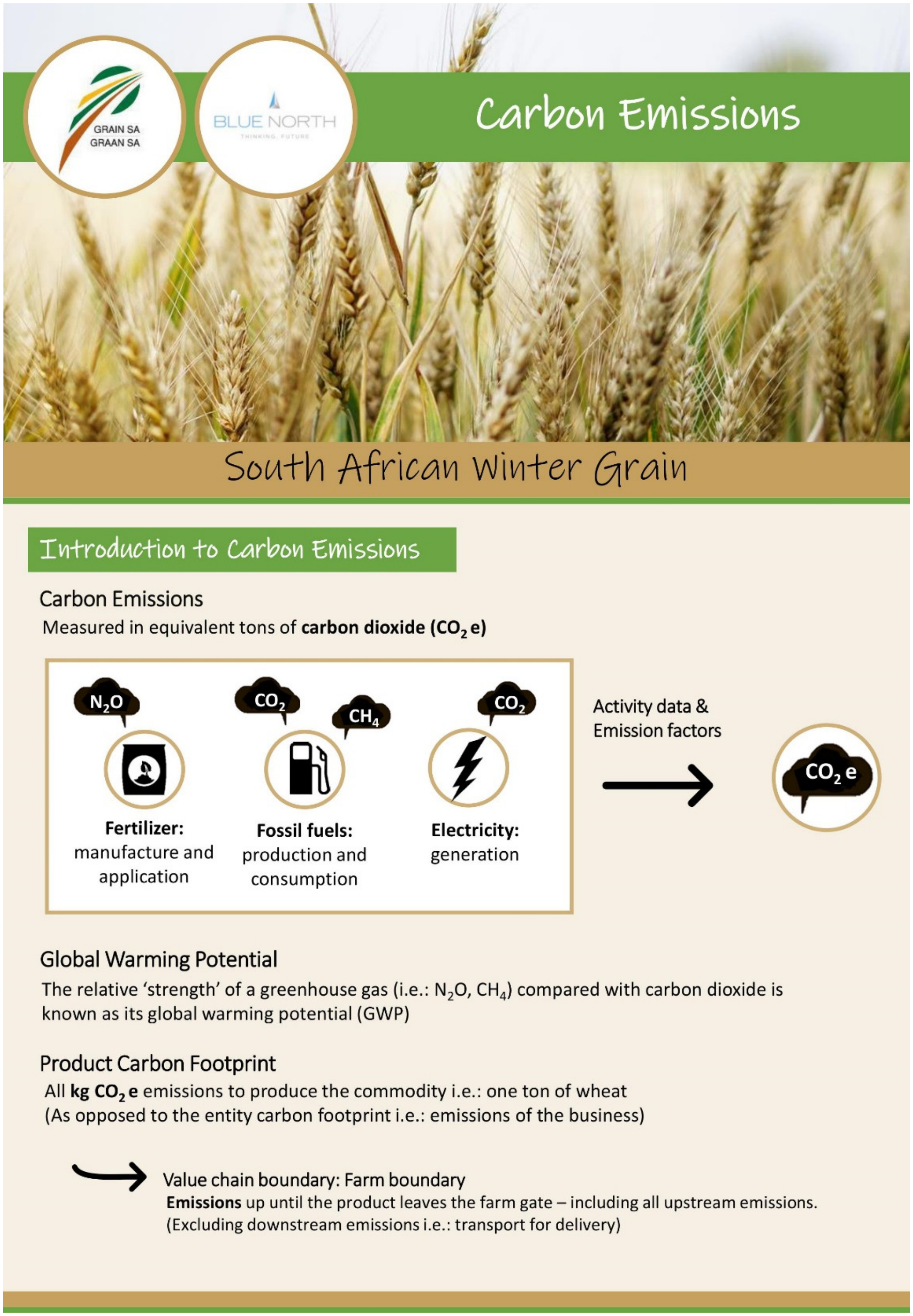
NAME & SURNAME	COMPANY	CONTACT DETAILS	SIGNATURE
Hendrik Smith	Graan SA	Tel: 082 331 0456 Email: hendrik.smith@grainsa.co.za	[illegible]
T. Knowles	Cirrus	Tel: 083 415 6239 Email: tony@cirrusafrica.com	[illegible]
Anelia Genis	Landbouweek-blad	Tel: 083 462 4597 Email: agenis@landbou.com	[illegible]
Dirk van Zyl	Adico Boerdery BK	Tel: 0796444898 Email: dirkvanzyl24@gmail.com	[illegible]
Wessel van Dyk	Duiker Boerdery	Tel: 082 833 0737 Email: vandykwessel@gmail.com	[illegible]
G.F. Montgomery	Virbac	Tel: 082 905 8382 Email: gf.montgomery@virbac.co.za	[illegible]
P.J. Laubscher	Overberg Agri	Tel: Email: pierreL@overbergagri.co.za	[illegible]
J.D. De Kock.	De Kock Agri	Tel: 082 572 0109 Email: josedekock@gmail.com	[illegible]

NAME & SURNAME	COMPANY	CONTACT DETAILS	SIGNATURE
Pierre-Jacques Human	Goedgeleë Boerdery	Tel: 0822980663 Email: pjhumans2@gmail.com	PHuman
Albert Bester	Schildskloof Landgoed	Tel: 0728120379 Email: albetbester09@gmail.com	
J.P. Du PLESSIS	GROOTRANDDRIFT	Tel: 0825798292 Email: pierrez@whalemail.co.za	JdPlessis
E.v.R DU TOIT	TOIT BROERS BOERDERY	Tel: Email: evr@whalemail.co.za	EduToit
Albert van Zyl	Terrasim	Tel: 082 211 2152 Email: avanzyl@terrasim.co.za	
SF STREICHER	SFS BOERDERY	Tel: 0823720343 Email: streich@iafrica.com	
M. Oosthuizen	Wankie Boerdery	Tel: 0713625018 Email: marthinusoosthuize@gmail.com	MO
~~T.S. du Toit~~ C.O. du Toit	Toit Broers Bdry	Tel: Email: cddt@lantic.net	
LESIBA MABITSELA	Dept. of Agriculture	Tel: 0632921639 Email: lesibam@elsenburg.com	Mabitsela
Anél Blignaut	Blue North	Tel: 0827519596 Email: anel@bluenorth.co.za	
KERRY SAYWOOD	BLUE NORTH	Tel: 0722754935 Email: kerry@bluenorth.co.za	KS.

NAME & SURNAME	COMPANY	CONTACT DETAILS	SIGNATURE
Annaline Smith	Blue North	Tel: 066 212 2211 Email: annaline@bluenorth.co.za	
Pieter Blom	SSK	Tel: 082 3880020 Email: pieter.blom@ssk.co.za	
Richard Krige	Boontjies Kraal Bdy	Tel: 0823163230 Email: boontjieskraal@.com 2000 co.za	
Ivan Jansen van Rensburg	Barenbrug	Tel: 082 301 59 34 Email: ijvr@barenbrug.co.za	
Pierre Theron	Kynoch	Tel: 0832736285 Email: tptheron1@gmail.com	
M.G. LÖTTER	Warmoeskraal Bdy	Tel: 082 8716588 Email: admin@klipfonteintrust.co.za	
Servaas Lötter	Warmoeskraal Bdy	Tel: 084 400 0258 Email: servaaslotter@gmail.com	
ROBERT BOSCH	VIKING	Tel: 0825682933 Email: rbosch@viking.co.za	
MARIUS RAS	Rovic Leers	Tel: 082 45 34 808 Email: mariusr@rovicleers.co.za	
Hennie le Roux	SABBF	Tel: 0829217995 Email: hennie.leroux@za.ab-inbev.com	
Manfred Venter	ABInBev	Tel: 0826371419 Email: manfred.venter@za.ab-inbev.com	

NAME & SURNAME	COMPANY	CONTACT DETAILS	SIGNATURE
Jan-Willem du Plessis	Dupsen Boerdery	Tel: 0768783673 Email: jwmoreson@gmail.com	
Andrew Ardington	Regen Ag SA	Tel: 0825703764 Email: andrew@regenagsa.org.za	
Lesley Richardson	Agulhas Biodiversity Initiative (ABI)	Tel: 082-3290249 Email: Lesley@flowervalley.co.za	
Peter Johnston	Univ Cape Town	Tel: 0833058582 Email: peter@csag.uct.ac.za	
J. Streicher	Boer.	Tel: 0722877505 Email: jurystreicher@gmail.com	
		Tel: Email:	
		Tel: Email:	
		Tel: Email:	
		Tel: Email:	
		Tel: Email:	
		Tel: Email:	

Annexure 2: Carbon Emissions Infographic



Project Phase 1

Calculation of Carbon Emissions of Winter Grain in South Africa

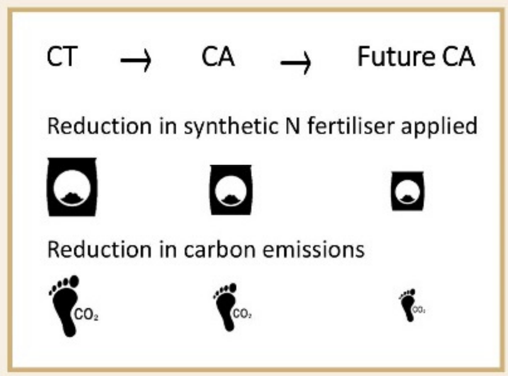
In phase 1 of this project the carbon footprint of winter grain was compared for 3 farming systems in the **Overberg** and **Swartland** regions of South Africa.

The 3 farming systems were:
1. Conventional (CT)
2. Conservation Agriculture (CA)
3. Future Conservation Agriculture (Future CA)

Conservation agriculture was characterised by minimum tillage, permanent soil cover and crop rotation (Blignaut *et al.* 2015).

> Results

Findings of Phase 1 project: A reduction in carbon emissions from CT to CA and further to Future CA. Key hotspot identified was the **synthetic nitrogen** input followed by lime and diesel.



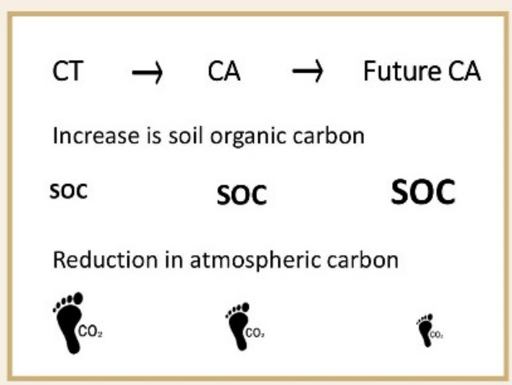
Project Phase 2

Carbon Sequestration

In phase 2, the capture of carbon was investigated as opposed to carbon emissions.

> Results

An increase in carbon captured / Soil Organic Carbon (SOC) from CT to CA and further to Future CA.



Blignaut J., Knot, J., Smith, H.J., Nkambule, N., Crookes, D., Saki, A., Drimie, S., Midgley, S., De Wit, M., Von Loeper, W. and Strauss, J., 2015. Promoting and advancing the uptake of sustainable, regenerative, conservation agricultural practices in South Africa with a specific focus on dryland maize and extensive beef production. Asset research, booklet nr 2. Pretoria: ASSET Research.

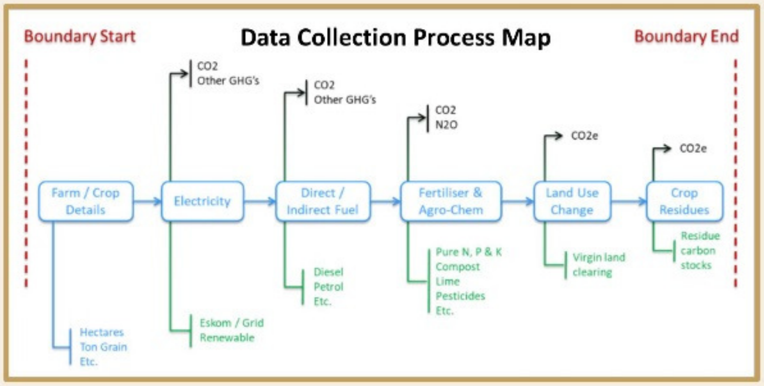
Project Phase 3

Excel Tool for Calculation of Carbon Emissions of Grains

In project phase 3, an excel based tool was created to include data capture and reporting.

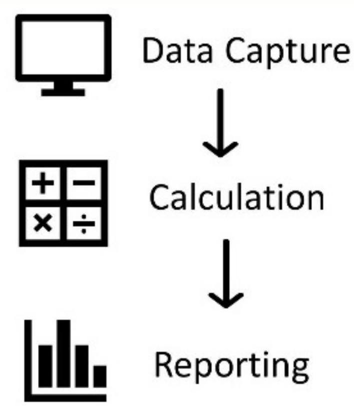
> Method

The protocol followed was the PAS2050 methodology for the calculation of a product carbon footprint within the farm boundary.



> Tool Contents

Guidance
Entity Info
Farm Info
Farm Electricity
Farm Direct Fuel
Farm Indirect Fuel
Fertilisers & Chemicals
Land Use Change
Crop Residue
Sense Check
Report
Sensitivity Analysis



> Data Capture

*Example for Synthetic Fertiliser

	PURE NITROGEN (N)	PURE PHOSPHORUS (P)	PURE POTASSIUM (K)
COMMODITIES	Kgs applied to all hectares	Kgs applied to all hectares	Kgs applied to all hectares
Wheat			
Barley			
Canola			
Total			

ENTER Total kgs:
Pure N, P and K
for each Commodity

> Reporting

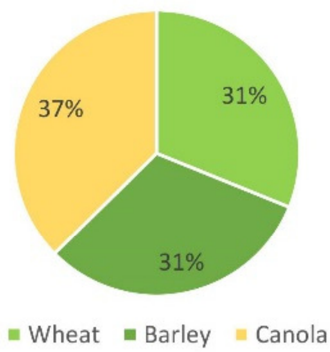
*Example for 1 ha Wheat / 1 ha Barley / 1 ha Canola

Canola has a higher emissions per ton compared to wheat

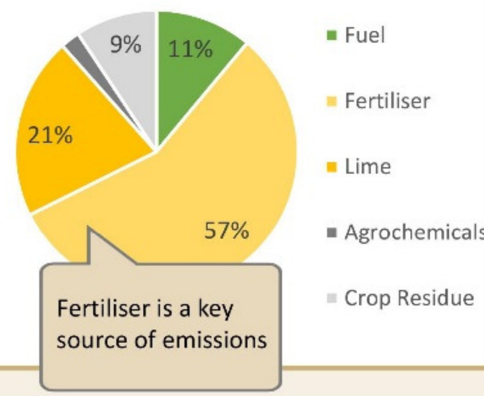
CARBON FOOTPRINT

COMMODITIES	TOTAL TONS CO2e	KGS CO2e / HECTARE	KGS CO2e / TON
Wheat	1,08	1085	**402**
Barley	1,10	1096	**392**
Canola	1,30	1303	**868**
FARM TOTAL:	**3,48**		

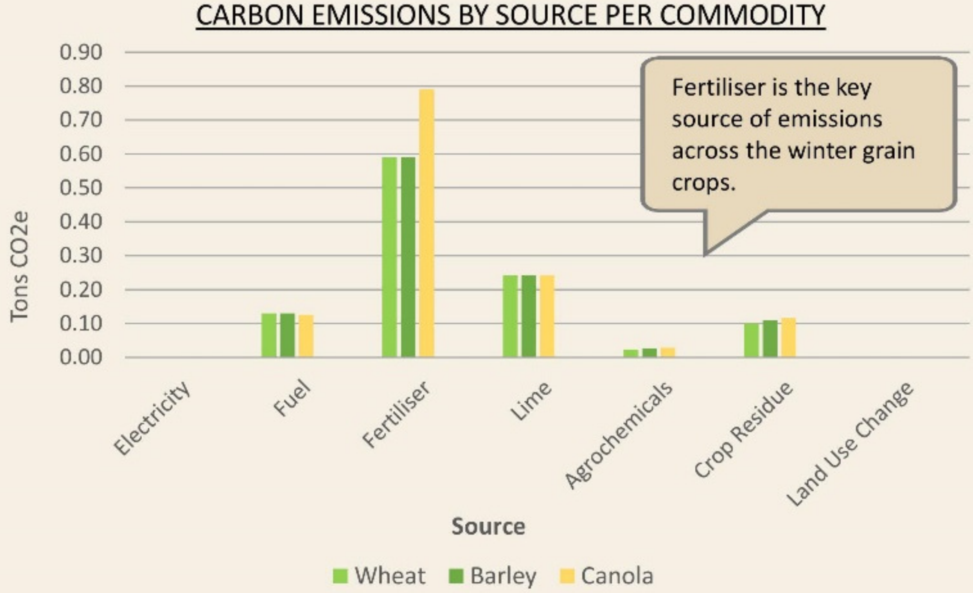
FARM CARBON EMISSIONS BY COMMODITY



FARM CARBON EMISSIONS BY SOURCE

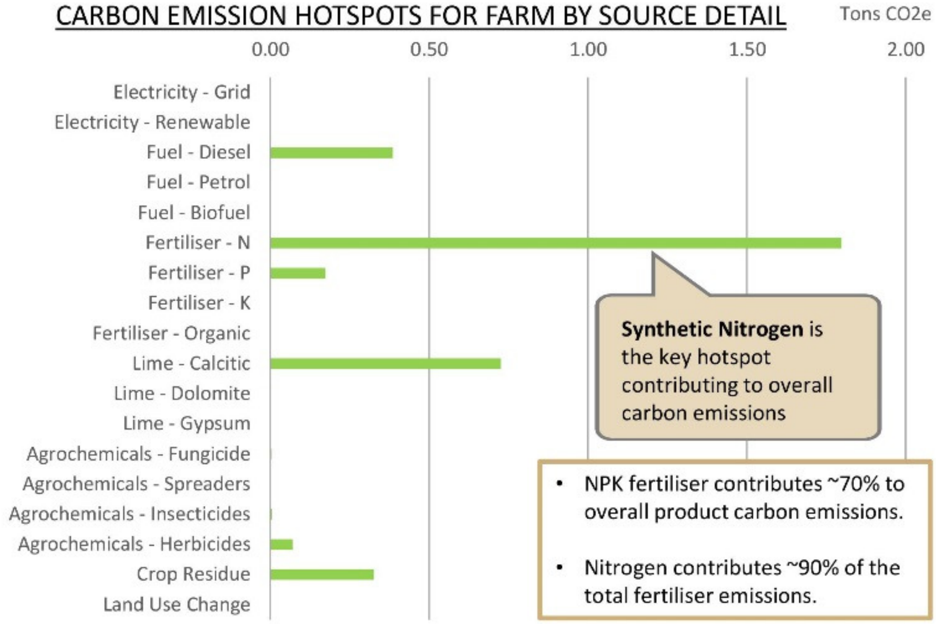


CARBON EMISSIONS BY SOURCE PER COMMODITY



Continued...

CARBON EMISSION HOTSPOTS FOR FARM BY SOURCE DETAIL



- NPK fertiliser contributes ~70% to overall product carbon emissions.
- Nitrogen contributes ~90% of the total fertiliser emissions.

> Sensitivity Analysis

This section of the tool allows one to view the effect of % changes of inputs and the corresponding % change of kgs CO2e per ton crop.

Enter % change in production variables

% CHANGE IN PRODUCTION VARIABLES

VARIABLE	COMMODITIES		
	Wheat	Barley	Canola
Yield			
Electricity			
Fuel			
Synthetic Nitrogen	-20%	-20%	-20%
%Δ CO_2e PER TON CROP	**-10%**	**-10%**	**-11%**

CARBON EMISSIONS PER TON OF CROP

A reduction in the synthetic nitrogen applied to wheat of 20% shows a reduction in 10% carbon emissions for wheat.

Nitrogen can be reduced by adopting **conservation agriculture practices**

How can I reduce my CO_2e emissions?

The transition from conventional farming practices towards conservation agriculture farming practices has shown an overall reduction in carbon emissions.

We know that the use of synthetic nitrogen is one of the "hotspots" on a farm as it is one of the inputs that contributes most to carbon emissions. A reduction in the amount of nitrogen used will lower the carbon emissions on the farm.

The use of Conservation Agriculture principles and methods will assist with this.

Another large contributing factor to overall carbon emissions on Wintergrain farms is the amount of lime used. A reduction in lime usage will result in a reduction of input costs and carbon emissions.

You are saving on input costs and reducing your impacts on the environment! A win-win scenario!

Please share your stories about environmental protection, carbon emission reductions and saving on input costs with us. We are keen to listen.

Contact Us

Anel Blignaut
anel@bluenorth.co.za
0827519596

www.climatefruitandwine.co.za

Project Partnering

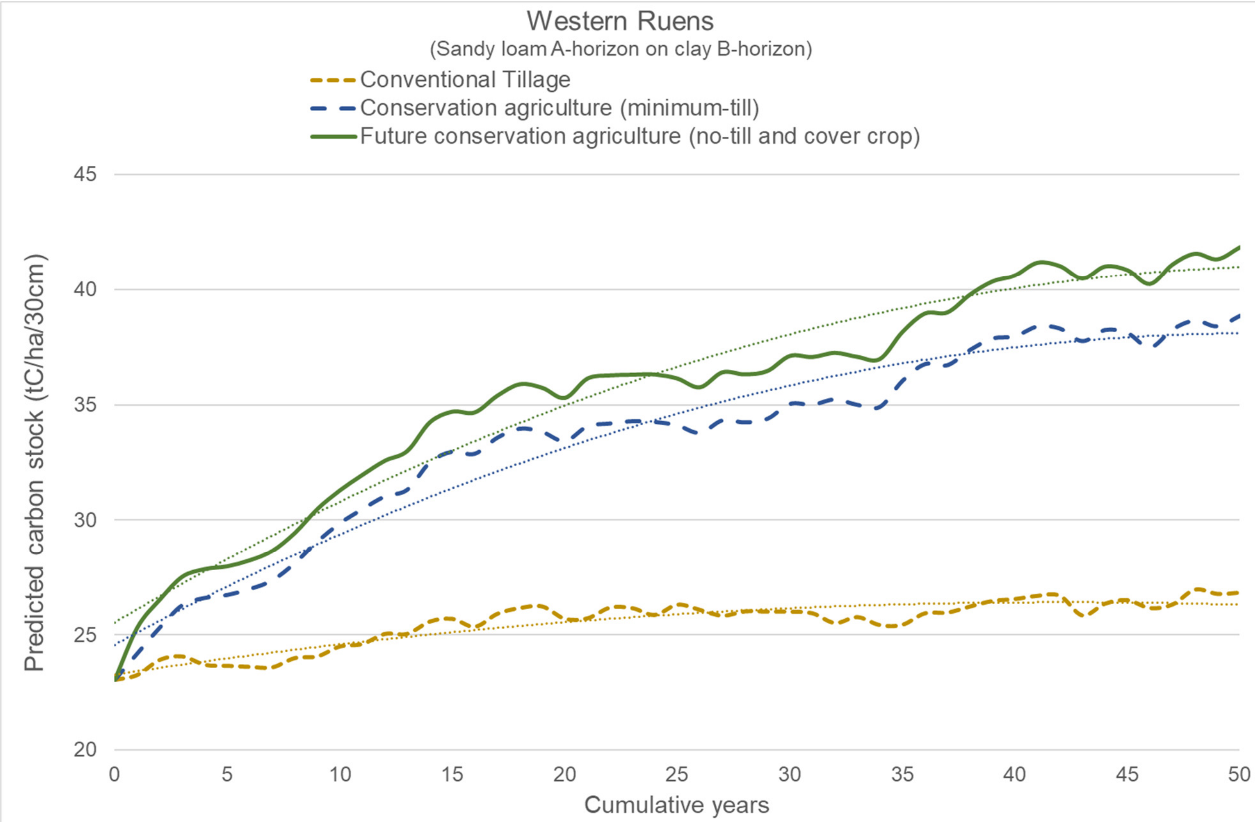
GRAIN SA / GRAAN SA

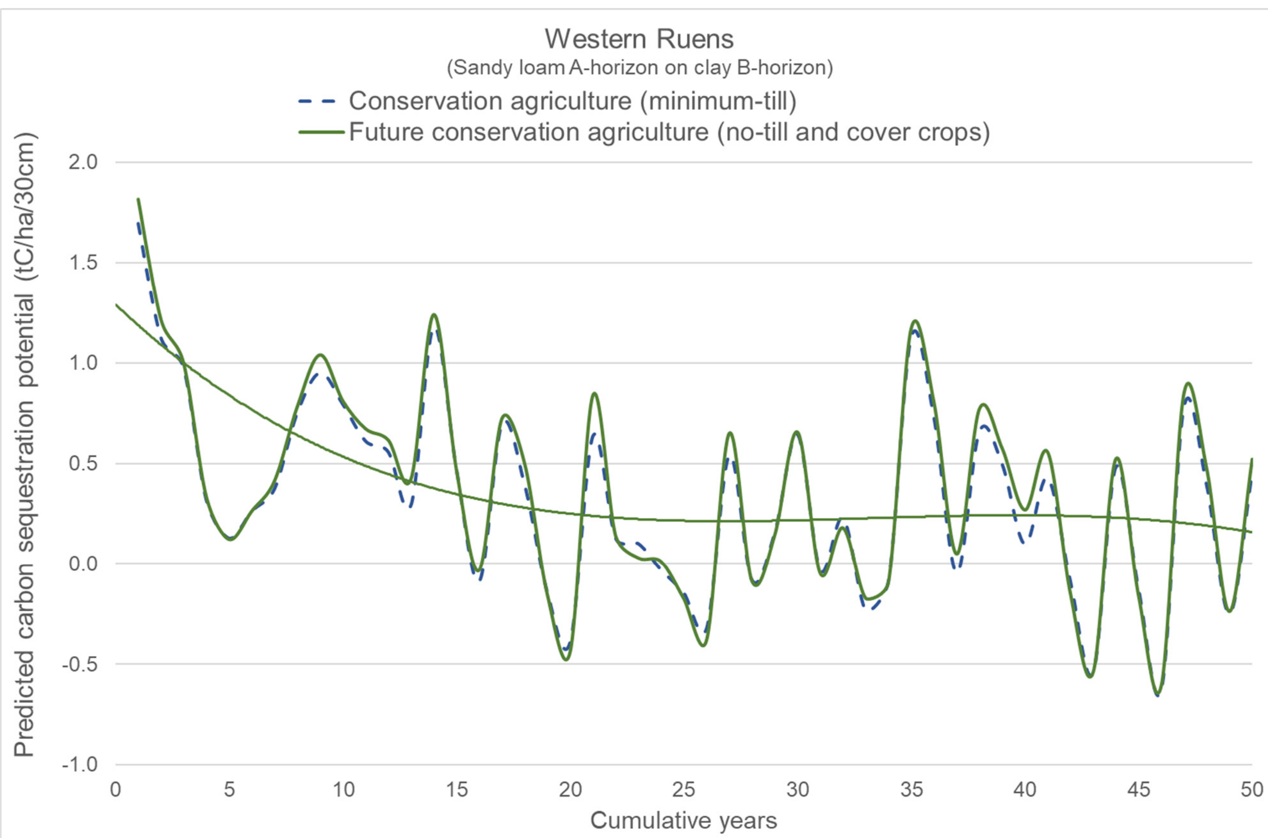
Winter Cereal Trust

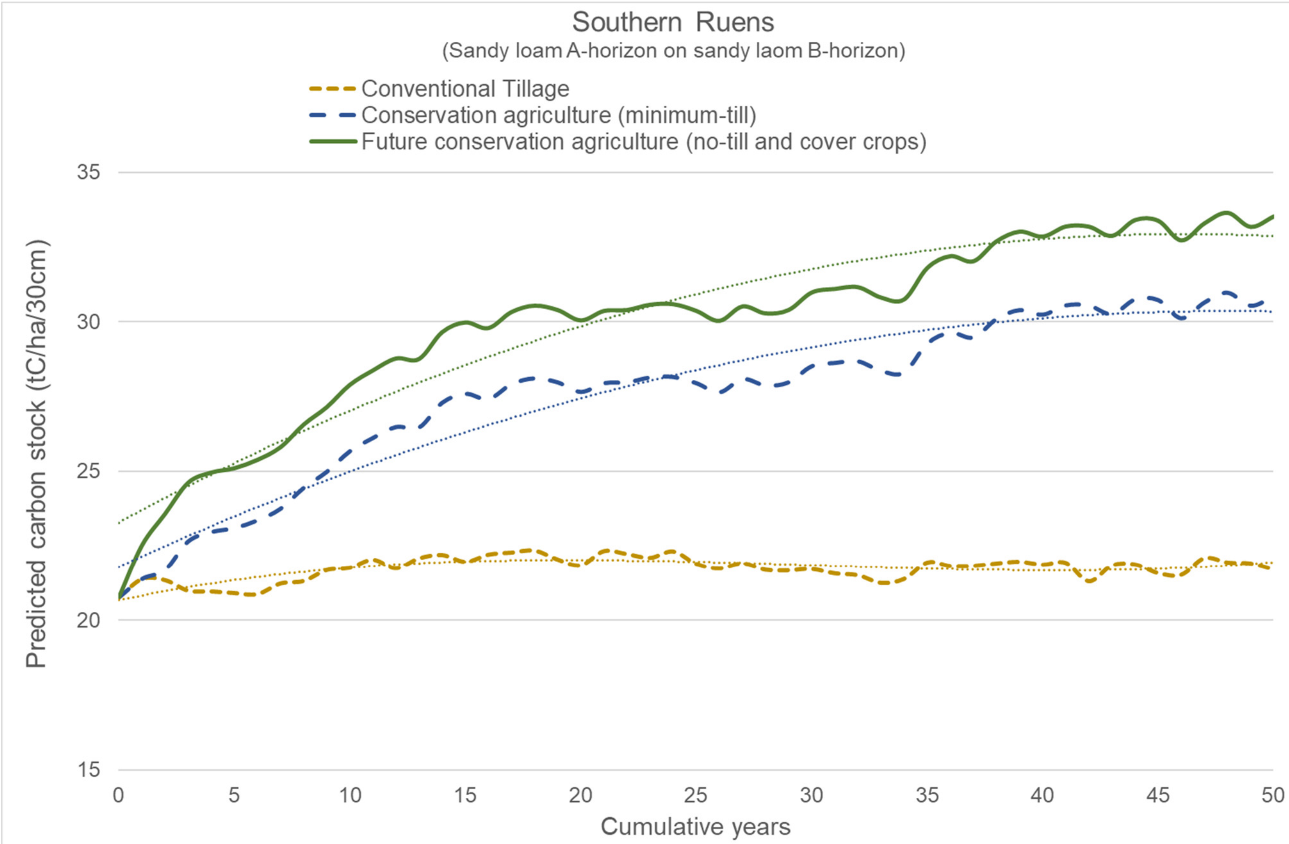
CONFRONTING CLIMATE CHANGE – A SOUTH AFRICAN FRUIT & WINE INITIATIVE

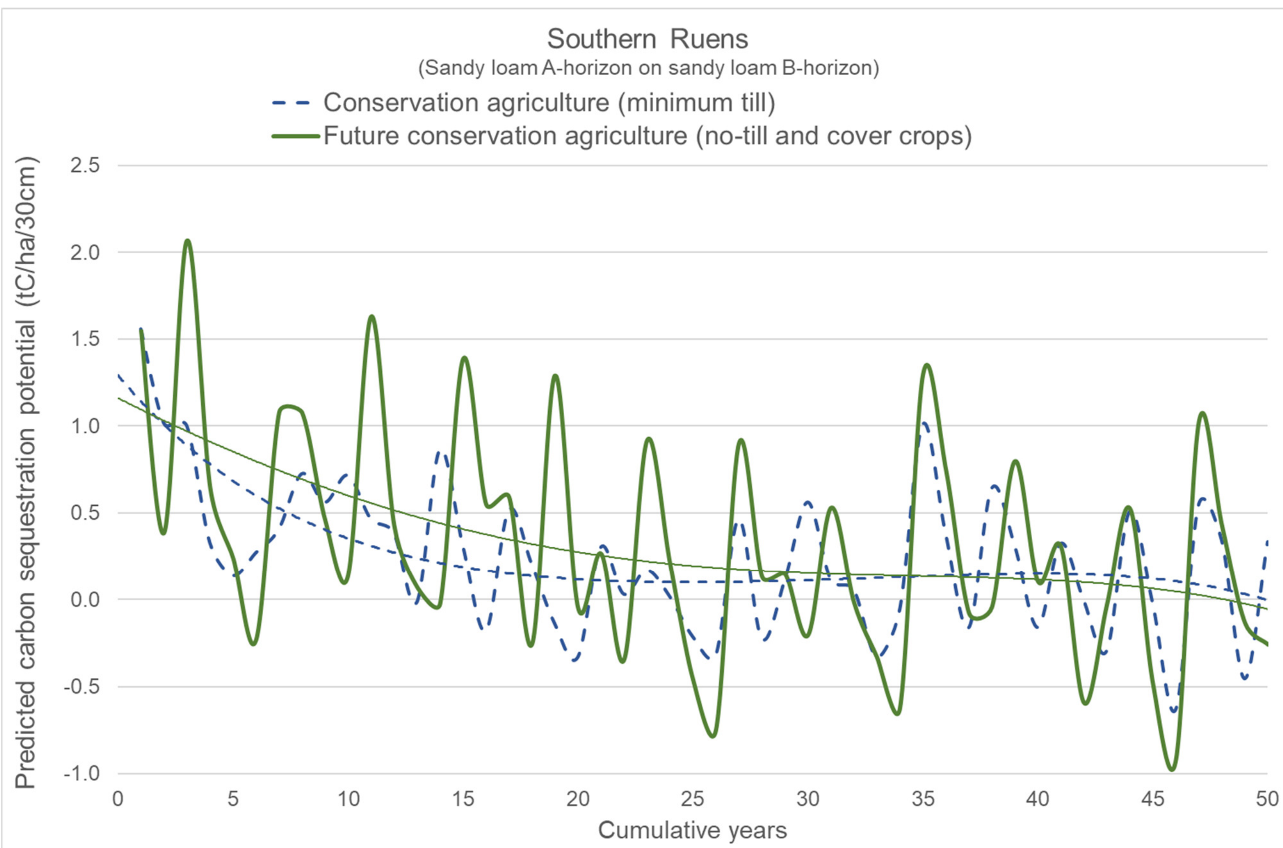
The data used to compile this report was provided by Grain SA.

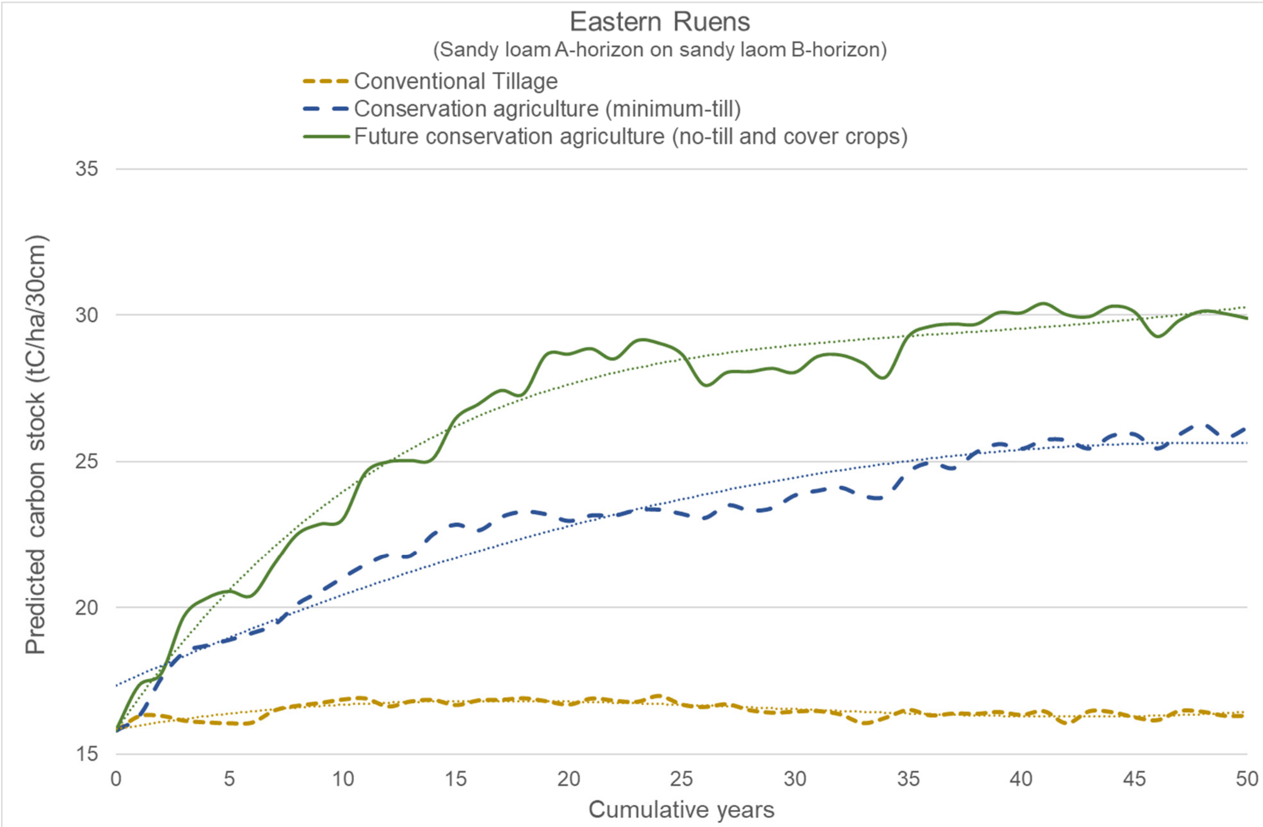
Annexure 3: Predicted soil carbon sequestration potential

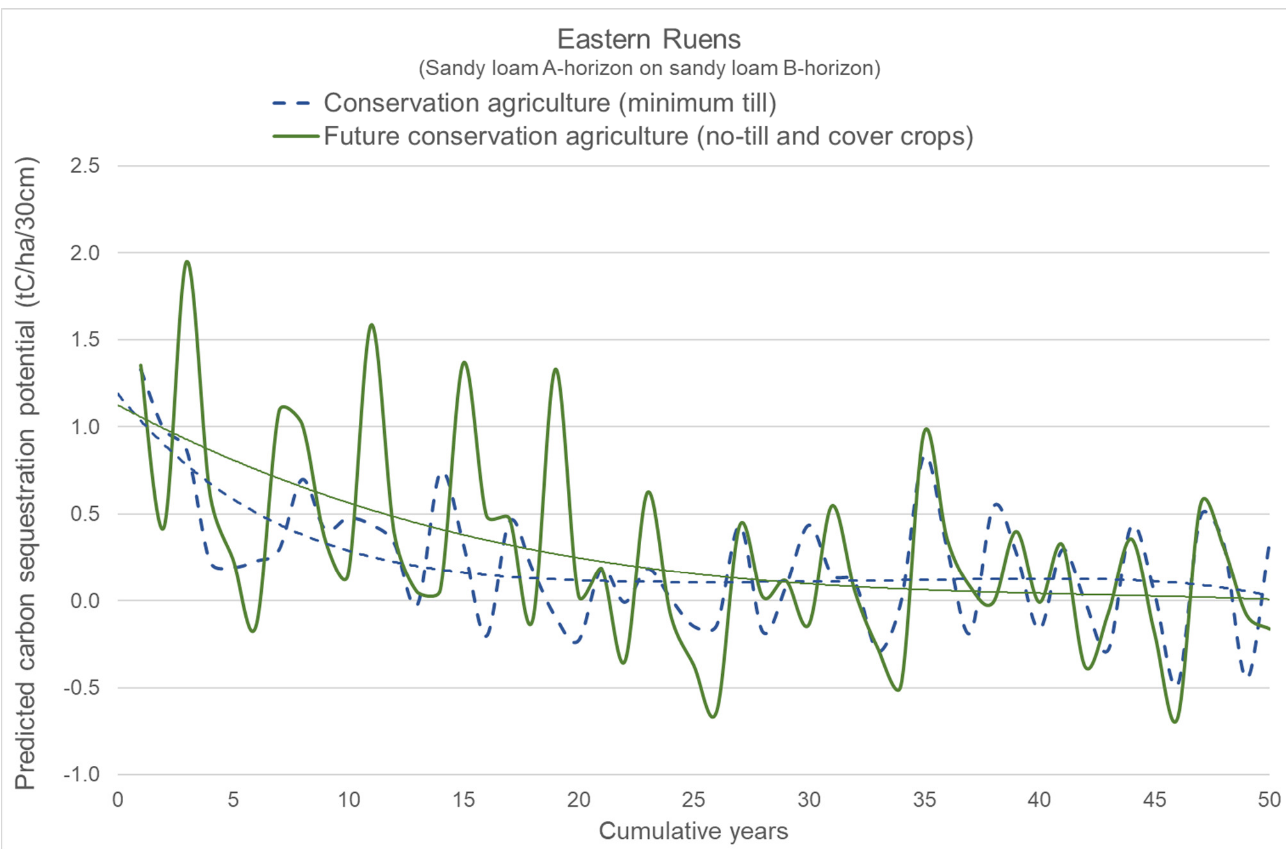


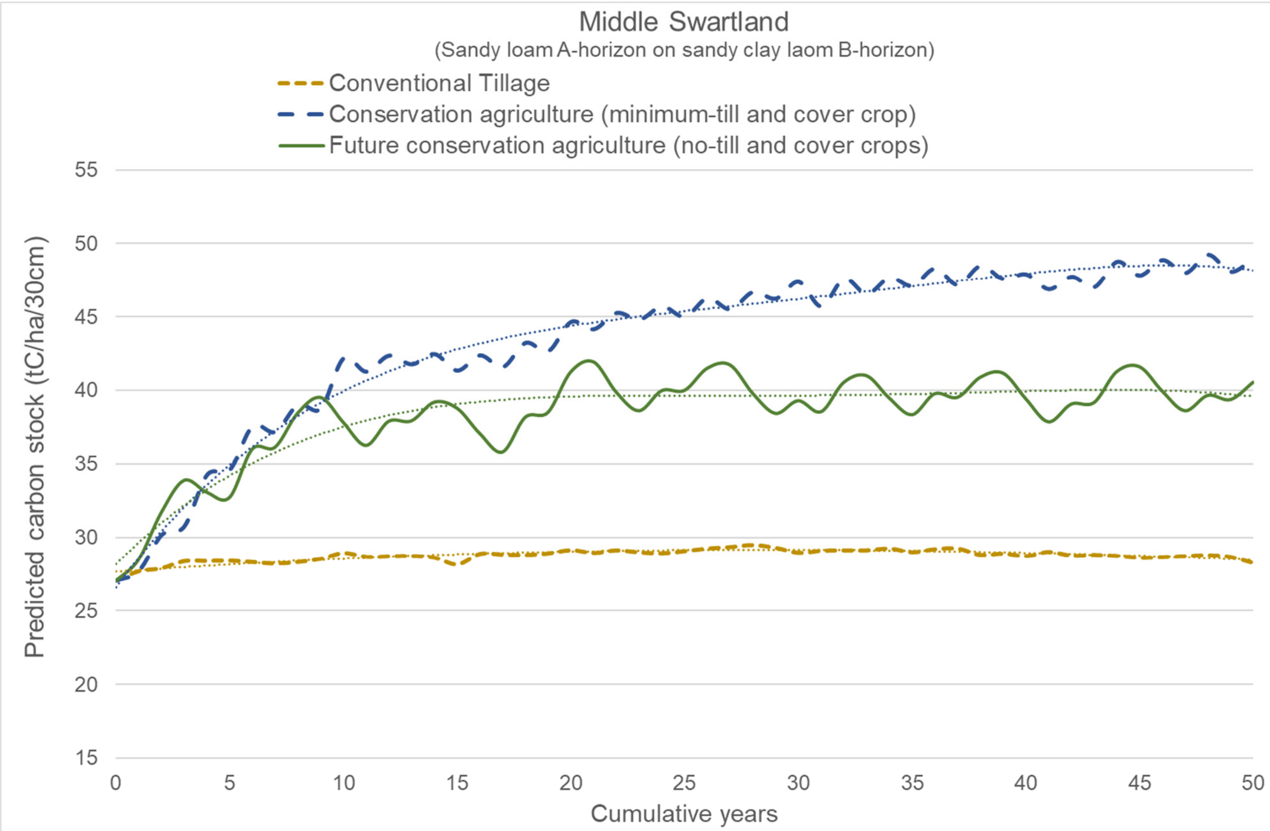


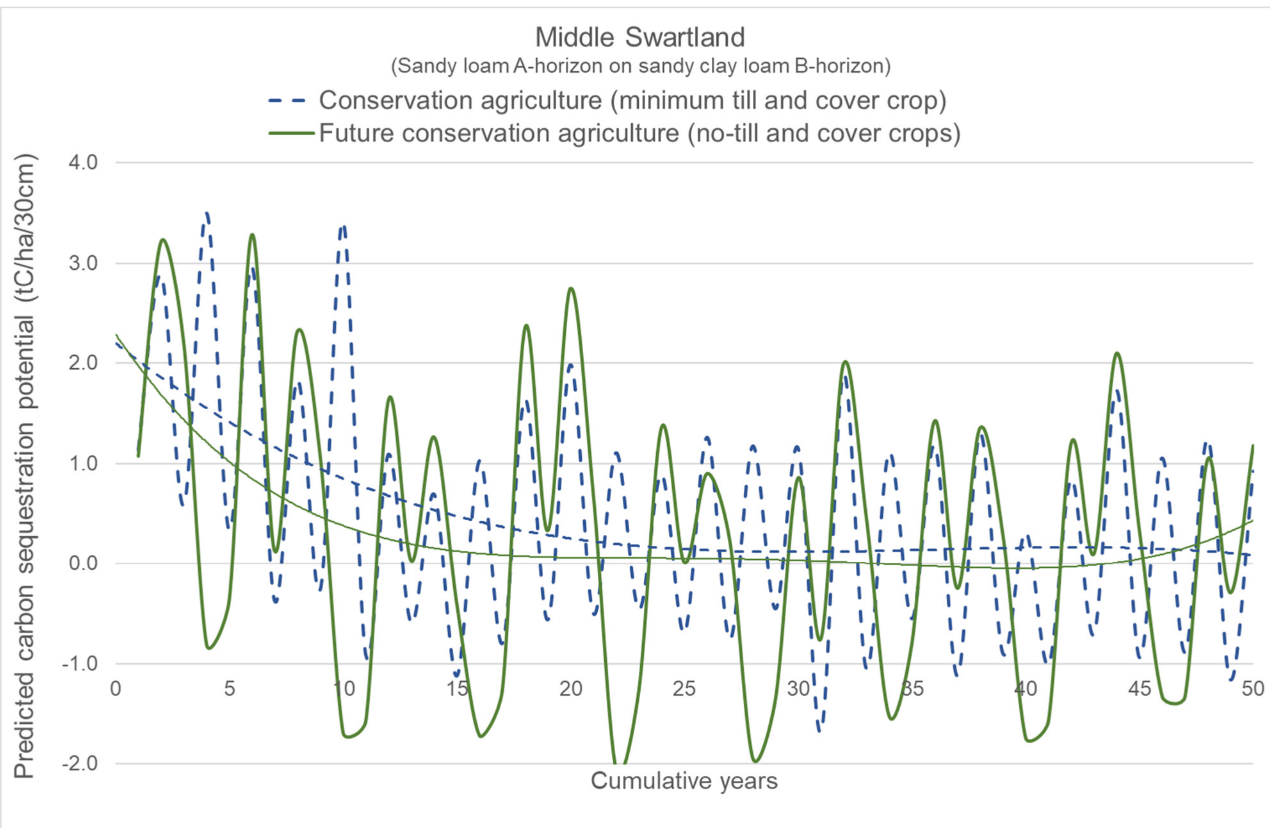

Southern Ruens
(Sandy loam A-horizon on sandy laom B-horizon)
Conventional Tillage
Conservation agriculture (minimum-till)
Future conservation agriculture (no-till and cover crops)
Predicted carbon stock (tC/ha/30cm)
35
30
25
20
15
0
5
10
15
20
25
30
35
40
45
50
Cumulative years

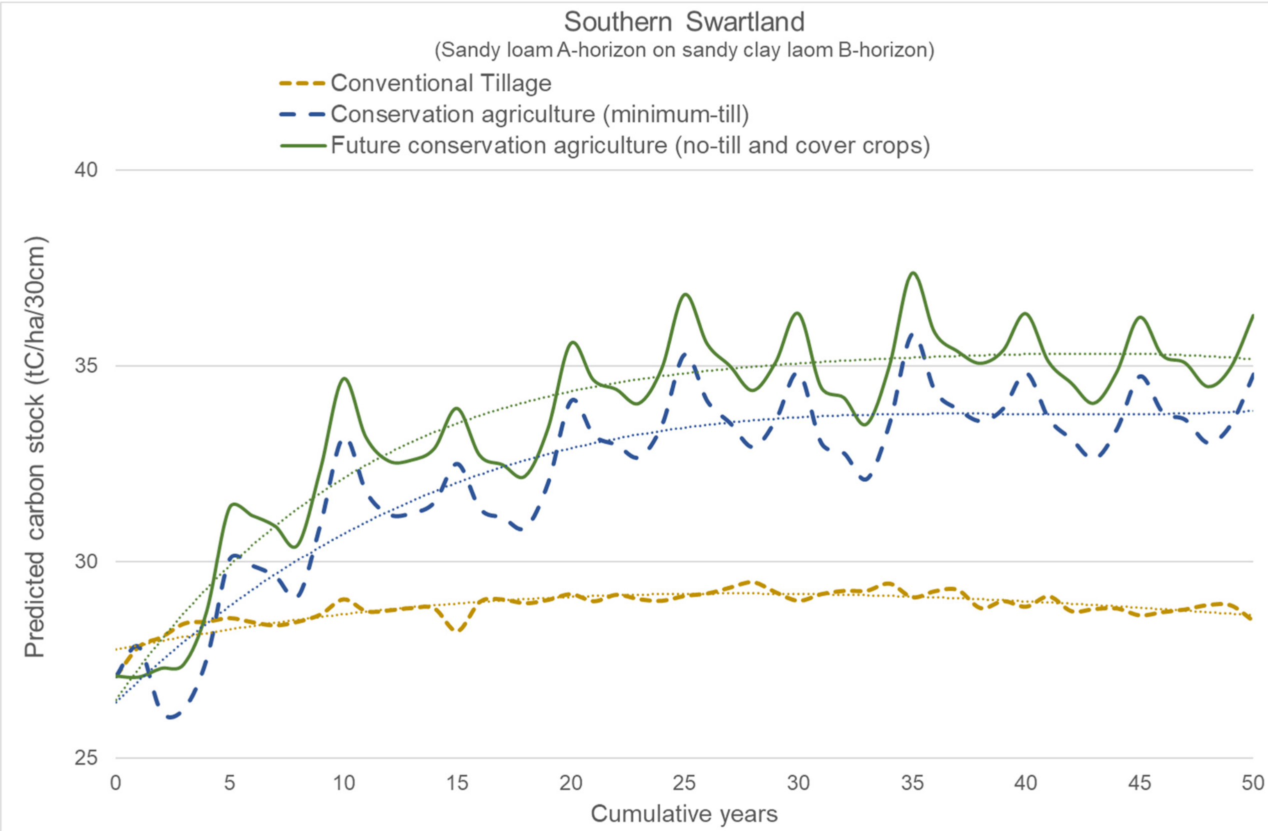

Southern Ruens
(Sandy loam A-horizon on sandy loam B-horizon)
Conservation agriculture (minimum till)
Future conservation agriculture (no-till and cover crops)
Predicted carbon sequestration potential (tC/ha/30cm)
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
0
5
10
15
20
25
30
35
40
45
50
Cumulative years

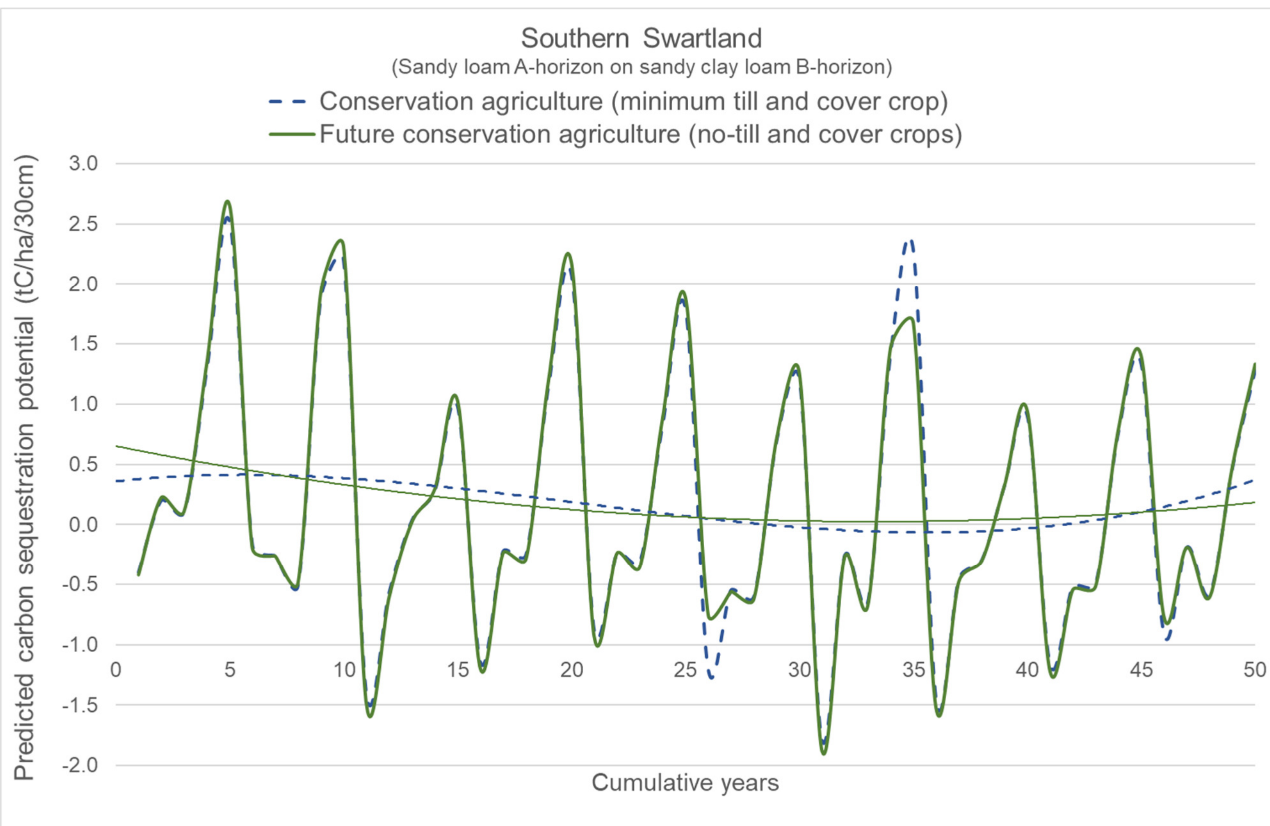

Eastern Ruens
(Sandy loam A-horizon on sandy laom B-horizon)
Conventional Tillage
Conservation agriculture (minimum-till)
Future conservation agriculture (no-till and cover crops)
Predicted carbon stock (tC/ha/30cm)
35
30
25
20
15
0
5
10
15
20
25
30
35
40
45
50
Cumulative years


Eastern Ruens
(Sandy loam A-horizon on sandy loam B-horizon)
Conservation agriculture (minimum till)
Future conservation agriculture (no-till and cover crops)
Predicted carbon sequestration potential (tC/ha/30cm)
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
0
5
10
15
20
25
30
35
40
45
50
Cumulative years


Middle Swartland
(Sandy loam A-horizon on sandy clay laom B-horizon)
Conventional Tillage
Conservation agriculture (minimum-till and cover crop)
Future conservation agriculture (no-till and cover crops)
Predicted carbon stock (tC/ha/30cm)
55
50
45
40
35
30
25
20
15
0
5
10
15
20
25
30
35
40
45
50
Cumulative years


Middle Swartland
(Sandy loam A-horizon on sandy clay loam B-horizon)
Conservation agriculture (minimum till and cover crop)
Future conservation agriculture (no-till and cover crops)
Predicted carbon sequestration potential (tC/ha/30cm)
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
0
5
10
15
20
25
30
35
40
45
50
Cumulative years


Southern Swartland
(Sandy loam A-horizon on sandy clay laom B-horizon)
Conventional Tillage
Conservation agriculture (minimum-till)
Future conservation agriculture (no-till and cover crops)
Predicted carbon stock (tC/ha/30cm)
40
35
30
25
0
5
10
15
20
25
30
35
40
45
50
Cumulative years


Southern Swartland
(Sandy loam A-horizon on sandy clay loam B-horizon)
Conservation agriculture (minimum till and cover crop)
Future conservation agriculture (no-till and cover crops)
Predicted carbon sequestration potential (tC/ha/30cm)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
0
5
10
15
20
25
30
35
40
45
50
Cumulative years