INTERRIM PROGRESS REPORT

Project title:

Determining the Carbon Footprint intensity of different maize farming systems within the summer rainfall crop production area in South Africa

<u>Phase 1</u>

Compiled by:

Hendrik Smith, Petru Fourie, Anel Blignaut, Lorren de Kock and Andre Nel

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1. Project Background

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

Improved cropland management has been highlighted as a very practical and viable carbon emission mitigation option and for that reason (and others) Conservation Agriculture (CA) is currently promoted by many role players in the agricultural industry, including Grain SA. However, it is important to conduct an in-country, or regional, study to assess the carbon footprint of different systems, including the assessment of soil health, which will provide essential information eventually facilitating the reduction in the carbon budget and increase in carbon sequestration rates.

It will therefore be important to demonstrate the impacts of different farming systems on the carbon footprint through accurate assessment tools and calculators of the carbon budgets. For example, through a combination of soil health assessments, carbon sequestration rates / potential and a farm carbon calculator it will be possible to determine the impact of various management options on the net carbon budget and show how this can lead to improved farming efficiency, reduced emissions and alignment with the future carbon tax. The proposed carbon tax legislation also contains mechanisms for selling agricultural carbon credits to other South African organisations to reduce their carbon tax exposure. This project will take the first steps towards understanding the potential of this farm-based carbon credit income stream.

2. Project Goal and Objectives

The long term goal of this project is to determine the carbon footprint of selected maize-based farming systems across a key agro-ecological regions of the summer rainfall crop production area of South Africa.

The project's short-term objectives of Phase 1 are:

1. To calculate and analyse the carbon footprint of maize-based cropping systems (e.g. to identify the carbon hotspots).
2. To understand the carbon impact of different grain farming regimes in different regions of the summer rainfall area.
3. To assess soil health under each of the different farming systems per region as an indication of the carbon sequestration potential of different crop systems.

3. Project Approach

Phase 1 of this project aims to determine the carbon footprint of selected maize-based farming systems across eight key agro-ecological regions and for three different farming regimes (conventional, conservation agriculture with high external inputs and future ideal CA with low external inputs) from a sample of 1 dataset per region, per farming regime. Phase 1 forms part of a longer term project where the carbon footprint methodology and results can be used within the grain industry as an adaptive management tool (Figure 1).

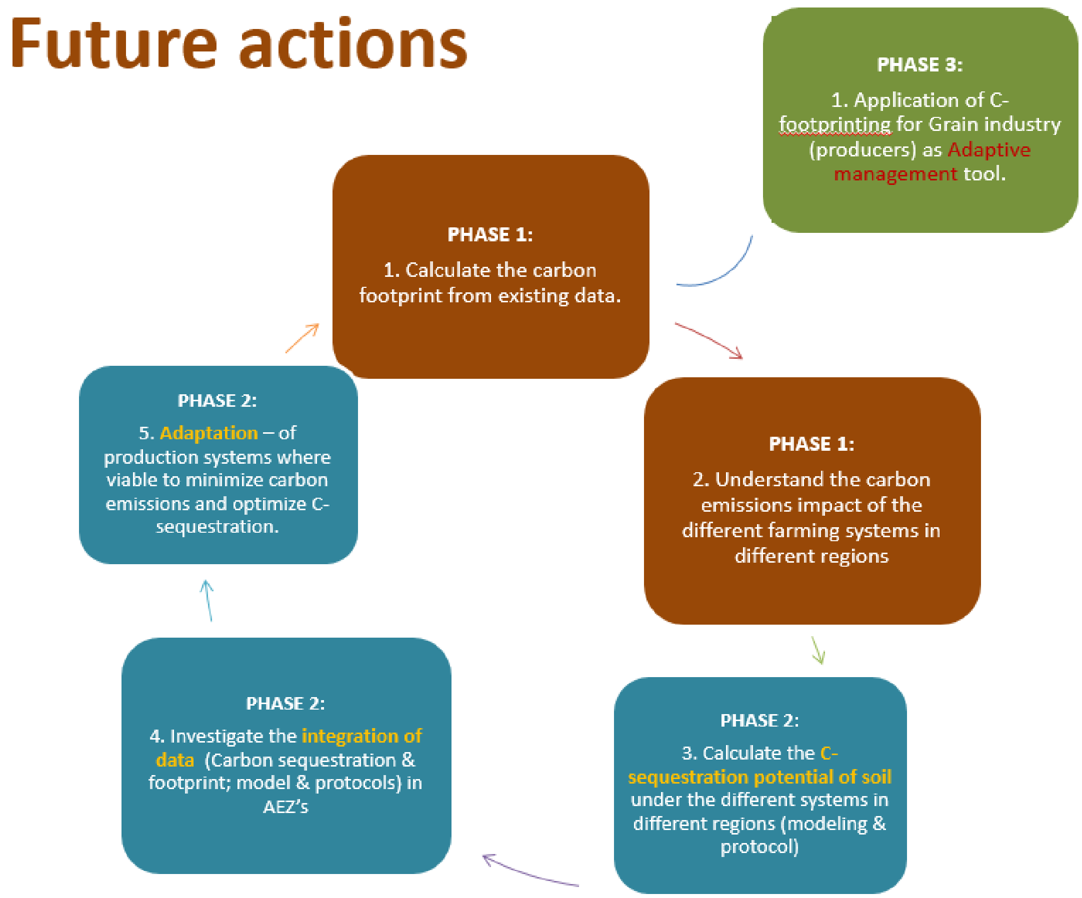

Figure 1: Carbon footprint project phases envisaged by Grain SA.

The extensive production cost database of Grain SA will be used as basis for this assessment, complemented by additional data required (see Appendix C). It is important to recognise that the assessment will therefore not be representative of all farms in a specific region but rather to provide a "snapshot" view of a particular farming regime in a particular region. From 8 years of experience in the agricultural carbon footprinting, CCC can confirm that farmers who measure their carbon footprint improve their farm management systems. When collecting primary diesel, electricity, fertiliser, etc. data at farm level, farmers must allocate the consumption to various farm activities, equipment and commodities. This process often challenges current farm management systems and highlights areas where farm management systems do not exist or can be improved. Backed-up by data on soil health under different practices in the regions identified, the potential of soil carbon sequestration can further stimulate thinking and awareness on more sustainable and climate-smart agricultural options. The calculation of soil carbon sequestration potential is envisaged as part of **Phase 2** of the project.

4. Project Scope – Carbon footprint

The project scope for C-footprint calculation includes the following:

- **Carbon Footprinting Protocol:** PAS 2050.
- **Data Collection Period:** The same 12 consecutive months for all datasets.
- **Commodity:** Grain (Maize only).
- **Value-chain Boundaries:** Only the Farm boundary, including delivery to silo storage will be reported. Mills and the rest of the value chain are excluded.
- **Farming Systems:** Conventional, CA with high external inputs (current systems) and CA with low external inputs – the latter will be the 'ideal future state' of CA farming systems.
- **Regions:** The following eight (8) regions have been identified as a framework for the assessment:
  - ✓ **Limpopo (Springbok flats) rain fed**
  - ✓ **North Western Province**
  - ✓ **North West Free State**
  - ✓ **Eastern Free State**
  - ✓ **Northern Free State**
  - ✓ **Eastern Highveld (Mpumalanga) & KwaZulu-Natal**
  - ✓ **Lower Orange river irrigation**
  - ✓ **Smallholders (KZN)**

- **Datasets:** Grain SA will collect and supply the datasets for each of the farming systems / region combinations. CCC will not be required to collect data.
- **Calculations:** The carbon footprints will be calculated per farming system per region. The carbon footprint results of the three different farming systems for a specific region will be weighted to calculate the regional carbon footprint figure. In turn, the regional figures will be extrapolated to calculate a snapshot summer grain region carbon footprint.
- **Output:** PDF report describing the project methodology and results. Grain SA will also receive an Excel spreadsheet with the Kg CO2e / Ton of Grain breakdown for each of the farming system / region combinations, as well as the pro-rata regional carbon footprint and the extrapolated winter grain region carbon footprint.

5. Project Scope – Soil health assessment

This objective was to compliment the C-footprint results by data on soil health under different practices in the regions identified, as a) an indication of their potential to sequestrate soil carbon, b) to stimulate thinking and awareness on more sustainable and climate-smart agricultural options, and c) to provide partial baseline and/or input data for C-sequestration modelling in Phase 2. This soil health assessment is not aimed to be a comprehensive regional soil health study, but rather to provide a snapshot idea of soil health and C- sequestration supporting the overall C-footprint study.

The regions (or agro-ecological zones) listed above were identified as a sampling framework for the assessment:

Two sampling locations will be selected on specific farms in each of the seven sub-regions, one representing the local conventional tillage (CT) system and one representing the local CA system. Grain SA structures and knowledge of farmers' practices will be used to make this selection.

6. Methods and materials – Soil health

Composite soil samples will be taken on a representative field on each of the selected farms per region; soil samples will be taken in the top 5 cm of a specific area in the field, mixed together and used for the composite sample and further analyses.

For this specific assessment, it was decided to use the Soil Health Tool (SHT) developed by Rick Haney (Haney *et al.,* 2008; Haney and Haney, 2010). The SHT is an integrated approach to soil testing using chemical and biological soil test data; it is designed to mimic nature's approach to soil nutrient availability as best we can in the lab. This tool is the culmination of nearly 20 years of research in soil fertility and is widely believed to represent the next step in soil testing for the 21st century.

The SHT is designed to work with any soil under any management scenario because the programme asks simple, universally applicable questions. The methods use nature's biology and chemistry, in that, the soil analysis is performed using a soil microbial activity indicator, a soil water extract (nature's solvent), and H3A extractant, which mimics organic acids produced by living plant roots to temporarily change the soil pH thereby increasing nutrient availability. These organic acids are then broken down by soil microbes since these are excellent soluble carbon source, which returns the soil pH to its natural, ambient level. The SHT doesn't measure just one thing to arrive at the plant available NPK, it uses an integrated approach.

7. Project Expected Impacts

This project will provide novel (new) data on and create awareness in the entire agricultural value chain (from farmers to markets) on their carbon footprint and provide information on which farming systems to implement in order to reduce the C-footprint, improve soil health and farming efficiency and reduce the impact on climate change. In the long term this will lead to improved land management, healthier natural resources, a reduction in greenhouse gas emissions and a general improvement in the sustainability of the maize industry. Furthermore, if carbon tax is implemented in the future this information, followed by a rigorous monitoring and implementation process, will be very useful for this sector, specifically the maize industry, inter alia to access carbon tax offset funds to launch CA projects in the grain industry. Determining the impact of various farming systems on carbon budgets also has long term policy implications as the information can be used to assist government in focussing their mitigation strategies for the agriculture sector.

8. Project Collaboration

Grain SA will collaborate with the following institutions:

Confronting Climate Change (CCC), which is a South African fruit & wine industry initiative established in 2008. The initiative focuses on the Life Cycle Assessment (LCA) of greenhouse gas emissions at farm-level and across agricultural value chains, as well as a climate change knowledge resources for the industry. The initiative currently focusses on perennial tree orchards, but CCC has already developed a carbon footprint protocol, the data collection tools, database and reporting tools for grain farming in South Africa.

The CCC initiative is project managed by **Blue North Sustainability**, a Stellenbosch-based sustainability practice that is focused on the development and implementation of robust and credible sustainability programs in agricultural businesses and value chains. Blue North was founded in 2011.

Soil Health Solutions (SHS), which offers an analytical service that establishes how far soils have been degraded on the one hand as well as how good soils have been managed on a "Conservation Agriculture" production system and what the benefit from this practice is quantified in nutrient resource (C, N and P) capture that need not to be provided for in the next crop. SHS can routinely establish where a particular soil fits into a degradation continuum and then guide an operation in the right direction to maintain its superior status and to get the not so "superior" on the correct road.

Dr Andre Nel, agronomy and soil science consultant, has been doing agricultural research since 1990 (working for the Agricultural Research Council), inter alia on the water use and irrigation scheduling of wheat, crop rotation in dryland conditions and irrigation with crops such as maize, wheat, sunflower, groundnuts barley, canola, lupines, dry beans, cowpeas and millet. Several studies were focused on the general agronomy and cultivar evaluation of sunflower and canola, as well as the nitrogen requirement of maize, sunflower and canola. The focus of his most recent work was on conservation agriculture with maize and sunflower. As researcher, he is also involved in the Grain SA / The Maize Trust conservation agriculture farmer innovation program at Ottosdal.

9. PROGRESS AND RESULTS

9.1 Carbon footprint data collection

9.1.1 Compile the 8 regions, 3 farming systems datasets

Grain SA sourced data from different role-players in the summer grain production regions. The main participants who collaborated with production input data for the different systems include:

- Grain and oilseed farmers
- Agribusinesses
- Input suppliers (chemical, fertiliser)
- Grain SA personnel
- Independent experts

An excel sheet was compiled to collect the required input data in a uniform way for the 2 farming systems. Raw input data was collected for conventional (CT) and conservation agriculture (CA) systems. The raw data collected will be processed by Grain SA and summarised in the Blue North Grain Data Collection tool, where after it will be used to calculate the carbon footprint (greenhouse gas emissions) of the different farming systems in the different regions.

In order to calculate the carbon footprint per ton product, Grain SA gather data for the following maize production regions:

- North West Province
- NW Free State
- Eastern Free State
- Northern Free State
- Eastern Highveld (Mpumalanga) & KwaZulu-Natal
- Lower Orange river irrigation
- Limpopo (Springbok flats dry land)
- Smallholders (KZN)

The following input data were collected per region for each farming system, to calculate the carbon footprint for CA and CT:

- ✓ Crops in rotation
- ✓ Yield per crop
- ✓ Fuel consumption per crop
- ✓ Fertiliser, lime and gypsum application per crop Chemical spray programme per crop
- ✓ Residue (% burn / bale / removal after harvest) per crop

Progress and results achieved

Discussions were held with several stakeholders in the grain industry to compile Table 1 to 3. Table 1 illustrates the two different grain farming systems (CA and CT) with their maize-based crop rotations in the summer grain production regions. The commodities cultivated per system differ from one system to the other. In the CT system maize is mostly planted with one other crop in rotation while a bigger variety of crops are planted in rotation with each other in the CA systems.

Table 1: Two different grain farming systems in the summer grain production region with their crop rotations

Regions	Farming regime	
	CT	**CA**
North West	Maize	Maize
	Sunflower	Sunflower
NW Free State	Maize	Maize
		Soybeans
		Cover crop
		Sunflower
Northern Free state	Maize	Maize
	Soybeans	Maize
		Soybean +WCC
		Cover crop
		Soybean + WCC
Eastern Free state	Maize	Maize
	Soybeans	Soybeans
	Maize	Wheat
	Dry beans	Sunflower
		Cover crop
Eastern Highveld & KwaZulu-Natal	Maize	Maize
	Soybeans	Soybeans
Limpopo (Springbok flats)	Grain sorghum	Grain sorghum
	Sunflower	Sunflower
Lower Orange river irrigation	Maize	Maize
	Wheat	Wheat
		Soybean
		Wheat
Smallholders (KZN)	Maize	Maize-intercropping

WCC=Winter cover crop

Table 2 summarises the raw data that was gathered - yield, total fuel usage, fertiliser and crop residue. Table 3 shows the further breakdown of the total fuel usage per region for the 2 different regimes.

Table 2: Inputs per hectare for farming regimes

Regions	Regime	Commodity	Yield	Total Fuel	Fertiliser			Crop residue	
			t/ha	l	N	P	K	% area burnt	% residue removed
NWFS	CT	Maize	5	64,4	90	16	8	0%	20%
NWFS	CA	Maize	5	28,0	90	16	8	0%	20%
NWFS	CA	Soybeans	2,1	31,9	8	12	16	0%	20%
NWFS	CA	Cover crop		16,3	40	12	6	0%	50%
NWFS	CA	Sunflower	2	26,3	54	12	6	0%	20%
North FS	CT	Maize	5	53,4	70	24	12	0%	80%
North FS	CT	Soybeans	1,6	53,4	8	12	16	0%	0%
North FS	CA	Maize	7	32,2	75	18	9	0%	30%
North FS	CA	Maize	7	32,2	75	18	9	0%	30%
North FS	CA	Soybean +WCC	2	45,9	0	0	0	0%	30%
North FS	CA	Cover crop		30,6	60	15	7	0%	30%
North FS	CA	Soybean + WCC	2	44,5	0	0	0	0%	30%
Eastern Highveld & KZN	CT	Maize	7,8	72,4	140,4	28	35	0%	10%
Eastern Highveld & KZN	CT	Soybeans	2,2	64,6	10	25	48	0%	10%
Eastern Highveld & KZN	CA	Maize	7,6	45,3	140,4	28	35	0%	10%
Eastern Highveld & KZN	CA	Soybeans	2,2	38,6	10	25	48	0%	10%
Limpopo (Springbok flats)	CT	Grain sorghum	2	71,0	0	0	0	0%	0%
Limpopo (Springbok flats)	CT	Sunflower	1,2	69,5	0	0	0	0%	0%
Limpopo (Springbok flats)	CA	Grain sorghum	4	27,0	10	20	0	0%	5%
Limpopo (Springbok flats)	CA	Sunflower	1,5	19,0	10	20	0	0%	5%
Lower Orange river irrigation	CT	Maize	14	42,3	260	45	50	80%	0%
Lower Orange river irrigation	CT	Wheat	8	51,1	250	48	75	20%	0%
Lower Orange river irrigation	CT	Maize	14	42,3	260	45	50	80%	0%
Lower Orange river irrigation	CT	Wheat	8	51,1	250	48	75	20%	0%
Lower Orange river irrigation	CA	Maize	14	42,3	260	45	50	80%	0%
Lower Orange river irrigation	CA	Wheat	8	43,6	250	48	75	20%	0%
Lower Orange river irrigation	CA	Soybean	4	42.3	120	36	50	0%	0%
Lower Orange river irrigation	CA	Wheat	9,5	43,6	250	48	75	20%	0%
Smallholders (KZN)	CT	Maize	1	-	60	10	10	0%	0%
Smallholders (KZN)	CA	Maize-intercropping	5,4	-	60	10	10	0%	0%

*WCC= Winter cover crop

Table 3: Further breakdown of fuel usage per region for the 2 different regimes

Regions	Conventional (CT)		Conservation Agriculture (CT)				
	Year 1	**Year 2**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
NWFS	**Maize**		**Maize**	**Soybeans**	**Cover crop**	**Sunflower**	
Soil Preparation:	37,87		5,57	5,57	5,57	5,57	
Planting:	13,99		12,41	13,80	10,70	12,73	
Harvesting:	12,55		10,00	12,55	0,00	8,00	
Total	**64,41**		**27,98**	**31,92**	**16,28**	**26,30**	
Northern FS	**Maize**	**Soybeans**	**Maize**	**Maize**	**Soybean +WCC**	**Cover crop**	**Soybean + WCC**
Soil Preparation:	22,62	22,62	2,62	2,62	2,62	1,31	2,62
Planting:	18,24	18,24	17,06	17,06	30,68	29,33	29,33
Harvesting:	12,55	12,55	12,55	12,55	12,55	0,00	12,55
Total	**53,41**	**53,41**	**32,24**	**32,24**	**45,86**		
Eastern Highveld & KZN	**Maize**	**Soybeans**	**Maize**	**Soybeans**			
Soil Preparation:	37,00	27,04	20,57	4,40			
Planting:	22,88	24,98	12,15	21,61			
Harvesting:	12,55	12,55	12,55	12,55			
Total	**72,43**	**64,57**	**45,28**	**38,56**			
Limpopo: Springbok flats	**Grain sorghum**	**Sunflower**	**Grain sorghum**	**Sunflower**			
Soil Preparation:	46,68	46,68	3,73	3,73			
Planting:	10,49	10,13	9,49	9,24			
Harvesting:	13,83	12,69	13,83	6,00			
Total	**70,99**	**69,50**	**27,05**	**18,97**			
Orange river irrigation	**Maize**	**Wheat**	**Maize**	**Wheat**	**Soybeans**	**Wheat**	
Soil Preparation:	13,63	27,13	13,63	19,61	13,63	19,61	
Planting:	13,08	10,49	13,08	10,49	13,08	10,49	
Harvesting:	15,60	13,50	15,60	13,50	15,60	13,50	
Total	**42,31**	**51,12**	**42,31**	**43,60**	**42,31**	**43,60**	

9.2 Soil Health Assessments

9.2.1 Soil sample collections

Table 4 shows the progress with soil sample collection in the various maize producing regions. Only a few sites still have to be sampled.

9.2.2 Soil health laboratory analyses

Table 4 shows the progress with soil health laboratory analyses in the various maize producing regions. Only a few samples still have to be analysed.

Table 4: Soil health sampling sites and progress, maize production regions

REGION	CA	PROGRESS	CT	PROGRESS
LIMPOPO	**WILLEM VD WALT** **Region:** Settlers	Sampling scheduled for 1 April	**DIRK DALING** **Region:** Settlers	Sampling scheduled for 1 April
NORTH WEST	**HANNES OTTO** **Region:** Ottosdal	Sampling done	**FANIE NEL** **Region:** Ottosdal	Sampling done
NORTH WEST FREE STATE	**GERHARD CRONJE** **COBUS VAN COLLER** **Region:** Bultfontein / Viljoenskroon	Sampling scheduled for April	**GERHARD CRONJE** **Region:** Bultfontein	Sampling done
EASTERN FREE STATE	**DANIE SLABBERT** **Region:** Reitz	Soil sampling and analyses done	**NEIGHBOUR** **Region:** Reitz	Soil sampling and analyses done
NORTHERN FREE STATE	**IZAK DREYER** **Region:** Vrede	Soil sampling and analyses done	**NEIGHBOUR** **Region:** Vrede	Soil sampling and analyses done
MPUMALANGA / KZN	**BRUCE SHEPHERD** **Region:** Bergville	Soil sampling and analyses done	**NEIGHBOUR** **Region:** Bergville	Soil sampling and analyses done
LOWER ORANGE RIVER	**BERTIE COETZEE** **Region:** Prieska	Sampling scheduled for June	**To be identified** **Region:** Prieska	Sampling scheduled for June
SMALLHOLDERS	**PHUMELELE HLONGWANE** **Region:** Bergville	Soil sampling and analyses done	**PHUMELELE HLONGWANE** **Region:** Bergville	Soil sampling and analyses done

10. BUDGET ON FEBRUARY 2019

Project activities	**Total Actual YTD Feb 2019**	**Total Budget YTD 2018/19**	**Available to use**
Data collection	3 220	74 510	71 290
Data Warehousing	-	13 600	13 600
Calculations & Report	-	54 400	54 400
Soil Health Assessment	-	133 720	133 720
Project close out	-	13 600	13 600
Travel & Accommodation	-	12 000	12 000
Total	**3 220**	**301 830**	**298 610**
Plus: Management fee (10%)	**322**	**30 183**	**29 861**
Grand Total	**3 542**	**332 013**	**328 471**

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