

FARMING IN PARTNERSHIP WITH NATURE



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What is soil health?

‘Soil health (or soil quality) is defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.’ – USDA

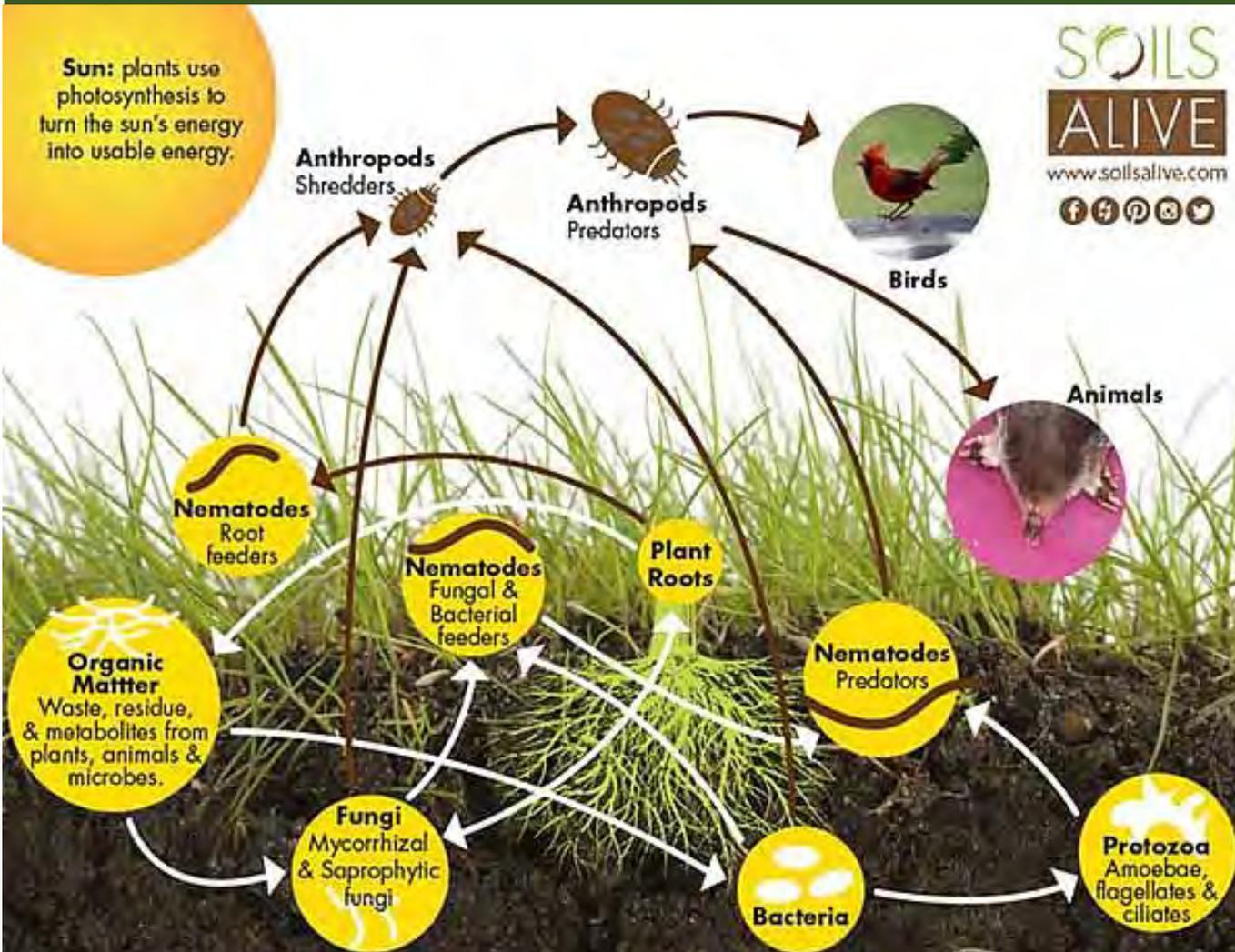




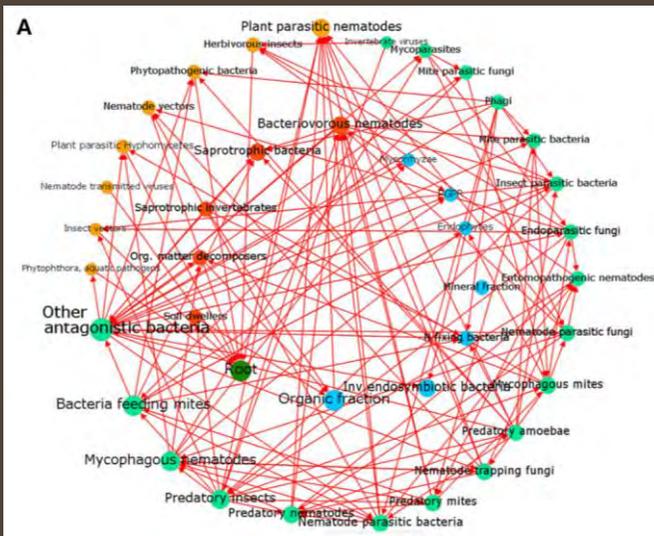
Wim van Egmond (2017)

What is soil health?

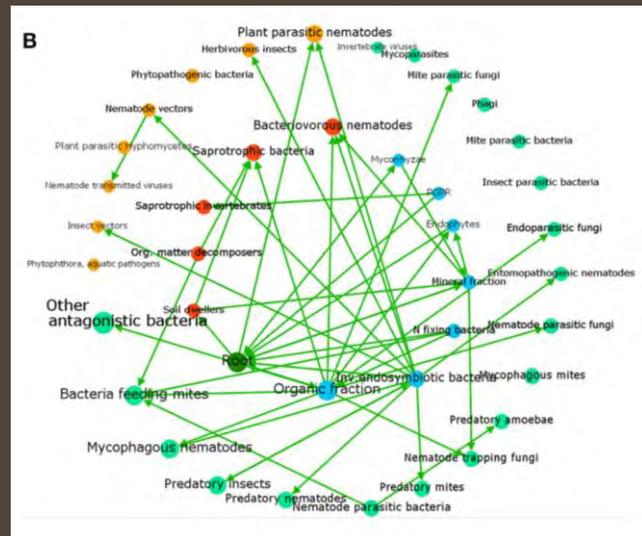
Sun: plants use photosynthesis to turn the sun's energy into usable energy.



What is soil health?



Negative links (e.g. predation)



Positive links (e.g. growth promotion)

Described as a 'simplified' network of food web interactions.

Mercado-Blanco, J., Abrantes, I., Barra Caracciolo, A., Bevivino, A., Ciancio, A., Grenni, P., Hrynkiewicz, K., Kredics, L., & Proença, D. N. (2018). Belowground Microbiota and the Health of Tree Crops. *Frontiers in microbiology*, 9, 1006. <https://doi.org/10.3389/fmicb.2018.01006>



CAUTION



Pesticides and Soil Invertebrates: A Hazard Assessment

 [Tari Gunstone](#)¹,  [Tara Cornelisse](#)¹,  [Kendra Klein](#)²,  [Aditi Dubey](#)³ and  [Nathan Donley](#)^{1*}

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Nathan Donley, at the Center for Biological Diversity in the US and an author of the new review, said: “The level of harm we’re seeing is much greater than I thought it would be. Soils are incredibly important. But how pesticides can harm soil invertebrates gets a lot less coverage than pollinators, mammals and birds – it’s incredibly important that changes.”



Pesticides and Soil Invertebrates: A Hazard Assessment

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Also, 84% of the tested parameters in earthworms were negatively affected by the most-common classes of insecticides. Some herbicides and fungicides also harmed earthworms.

Donley said: “It’s not just one or two pesticides that are causing harm, the results are really very consistent across the whole class of chemical poisons.”

ARTICLE



<https://doi.org/10.1038/s41467-021-23605-y>

OPEN

Nitrogen and phosphorus fertilization consistently favor pathogenic over mutualistic fungi in grassland soils

Ylva Lekberg ^{1,2,10}✉, Carlos A. Arnillas ^{3,10}, Elizabeth T. Borer ⁴, Lorinda S. Bullington ¹, Noah Fierer^{5,6}, Peter G. Kennedy⁷, Jonathan W. Leff ⁸, Angela D. Luis², Eric W. Seabloom ⁴ & Jeremiah A. Henning^{4,9}

Investigated the microbial community in 25 grasslands located in four continents (North America, Europe, Australia and Africa).

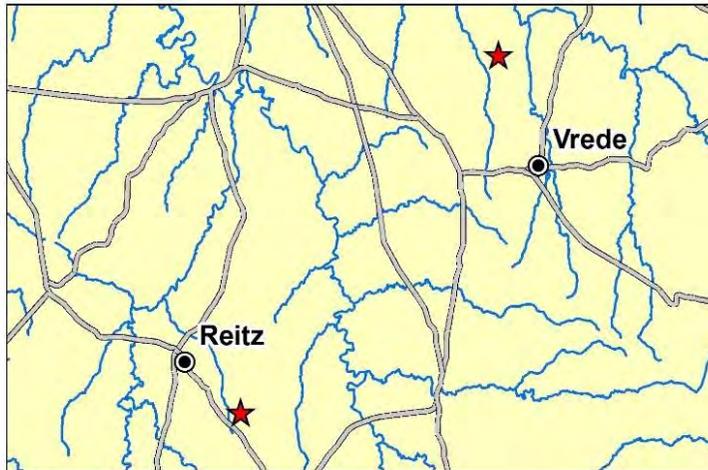
Results show that nitrogen and phosphorus increased relative abundance of pathogenic fungi and suppresses mutualists.

Likely linked to nutrient-induced shifts in plant communities.

CASE STUDY: VREDE

This project was aimed at measuring the restorative effects of Conservation Agriculture on soil (ecosystem) health.

Focused on two farmland areas in the Eastern Free State.



0 10 20 40 Kilometers

Map created by Marië J. du Toit

Legend

- Towns
- ★ Study Areas
- ⚡ Roads
- ~ Rivers



CASE STUDY: VREDE

Methods:

- Included three CA fields, as well as conventional field and natural veld as reference site.
- Sampling occurred in September 2019 (winter).
- **Nematodes and other biological indicators were used to measure soil ecosystem health.**



CASE STUDY: VREDE

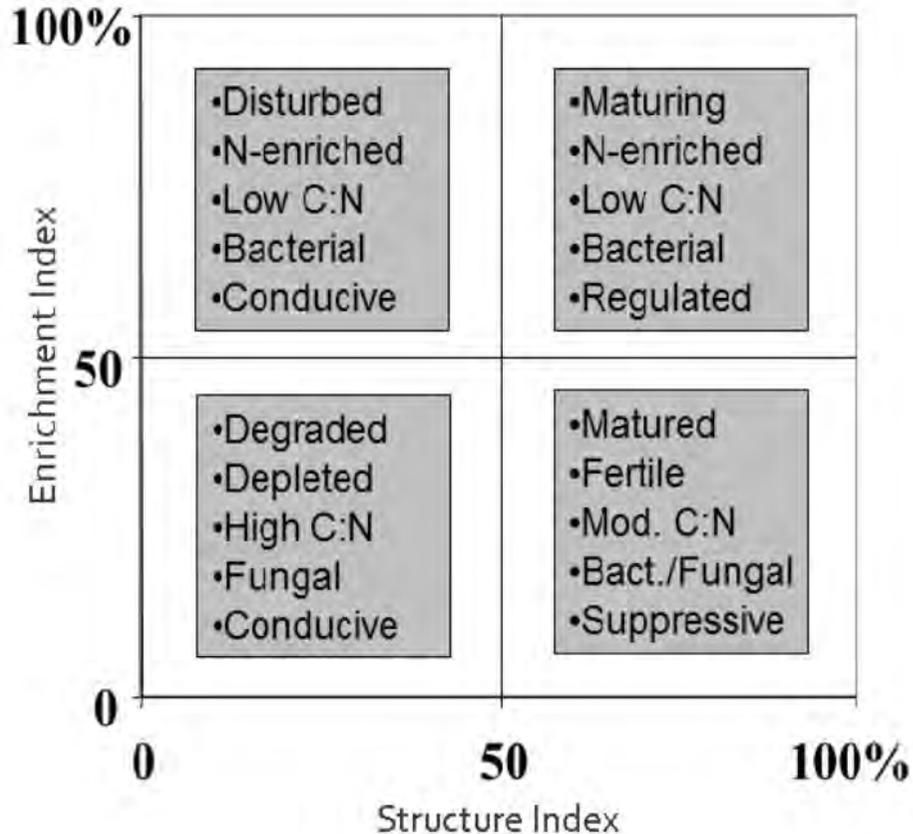
Nematode as bioindicators:

- Used to measure soil ecosystem health and functioning.
- Also recovery or restoration of soil health.
- A good indicator of recent changes in soil health status.



CASE STUDY: VREDE

Nematode as bioindicators:



CASE STUDY: VREDE

Soil respiration:

- CO_2 is respired by the soil community.
- Used as a measure the activity of the microbial community.
- Related to soil processes (e.g. nutrient transformation, mineralization and solubilization).



CASE STUDY: VREDE

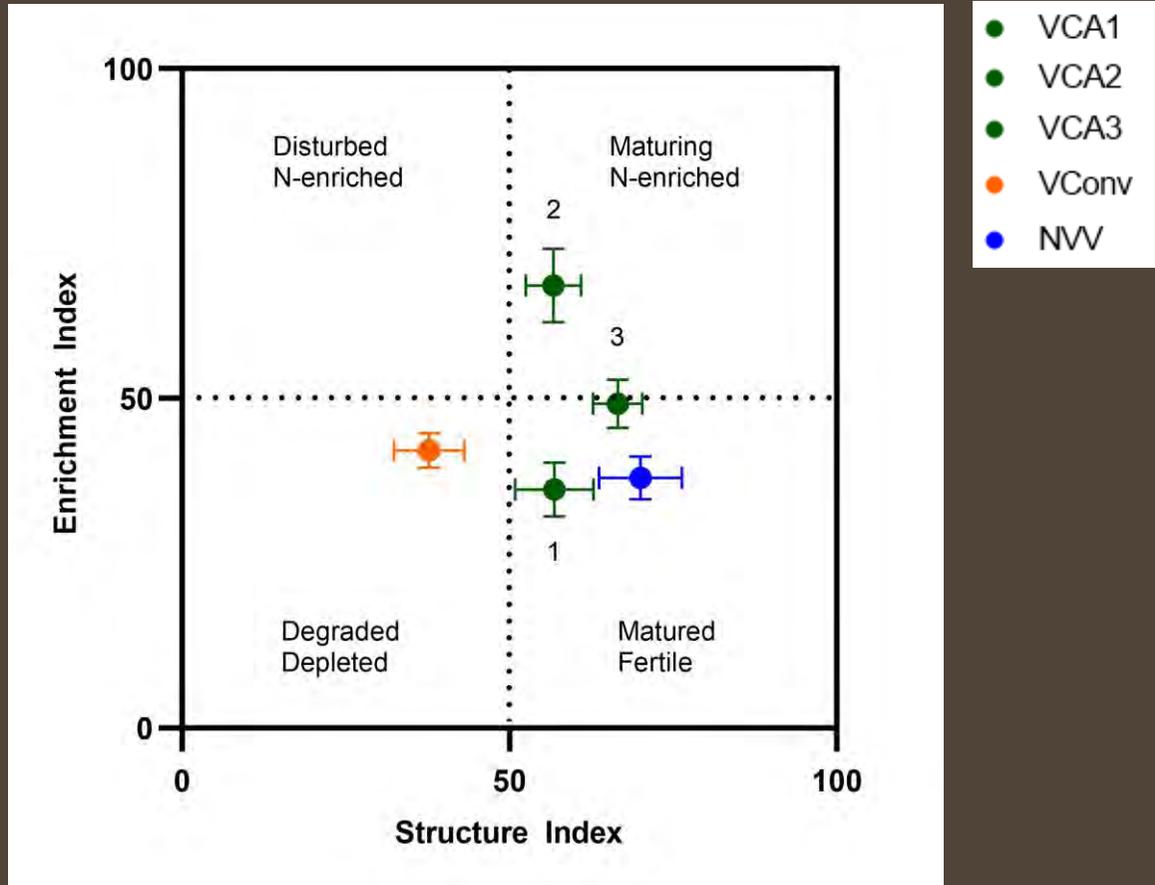
Active carbon:

- Available food and energy source.
- Sensitive to management changes (tillage, rotations, etc.).
- A good indicator of recent changes in soil health status.



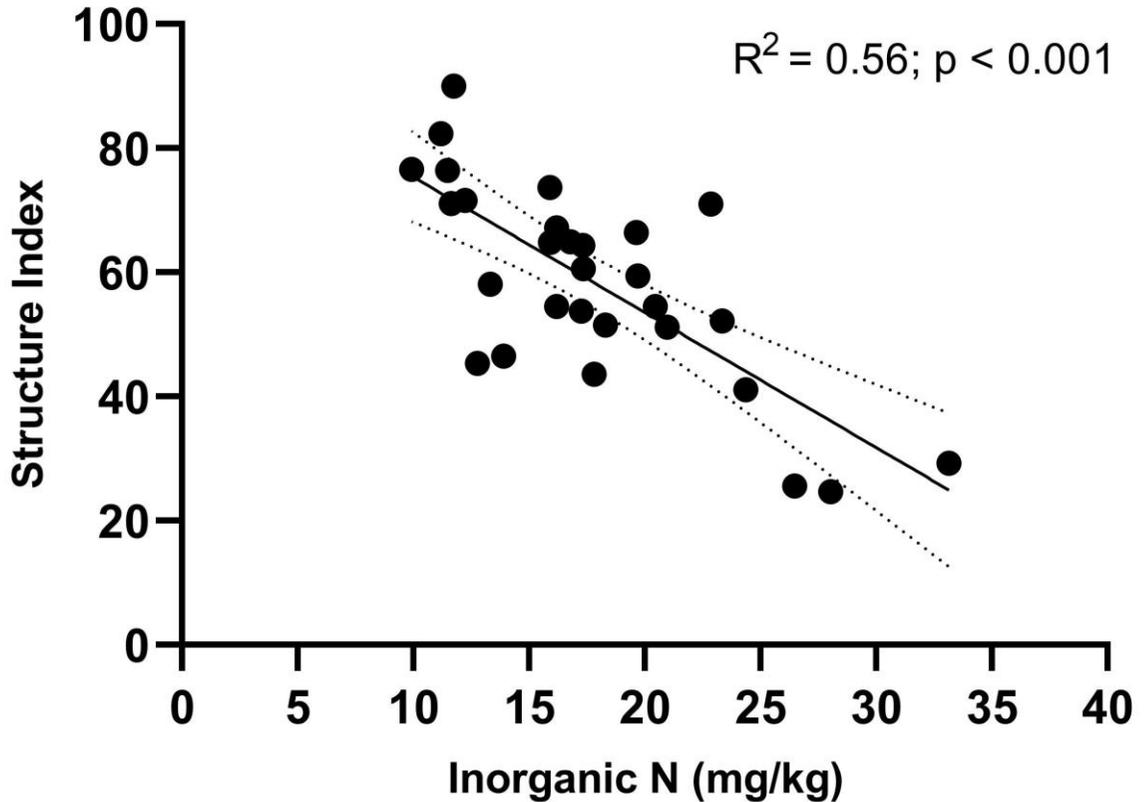
CASE STUDY: VREDE

September 2019



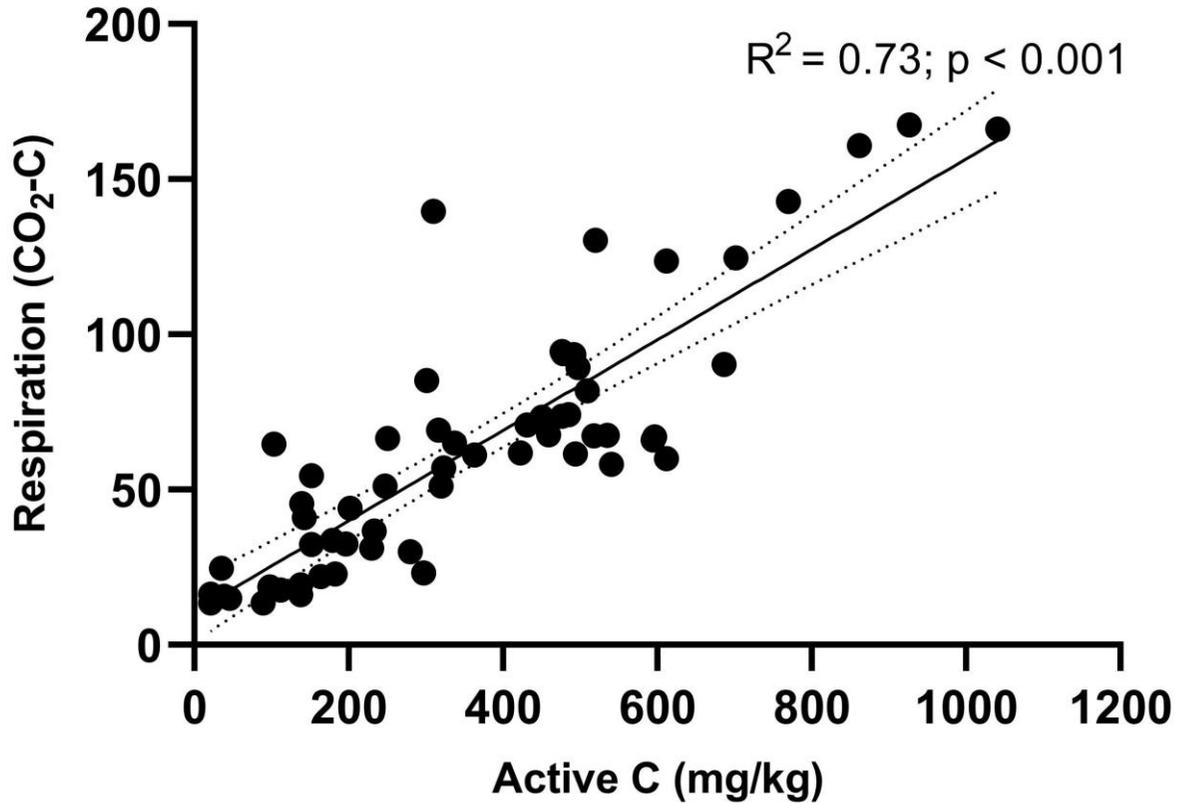
CASE STUDY: VREDE

September 2019



CASE STUDY: VREDE

September 2019



CASE STUDY: VREDE

BENEFITS OF FARMING in partnership with nature



Dr Gerhard du Preez,
Integrated Pest Management, North-West University and Tropical and Subtropical Crops, Crop Protection, ARC



Prof Diekirk Fourie,
Integrated Pest Management, North-West University



Ané Loggenberg,
MSc student, North-West University



Izak Dreyer, producer,
Dreyer en Dreyer B&B

It is likely that you have heard or read about soil health. Also, that soil health is intricately linked to the animals – big and small – that inhabit our farmlands. Maybe you have already implemented agricultural practices that restore biodiversity and improve the capacity of your soil to deliver vital services such as nutrient cycling and the control of erosion. The truth is that we all share a responsibility to ensure that coming generations can also benefit from the riches that nature offers.

Even so, farming remains a business that sustains the lives and livelihoods of more than 800 000 South Africans today. Therefore, you may wonder, what economic benefit there is in promoting soil health. Why start now if you have not done so already? To answer these questions, also keeping in mind our responsibility to protect Mother Nature, the substantial economic benefits and environmental accomplishments that were achieved by a conservation agriculture (CA) producer in the eastern Free State of South Africa will be reviewed.

SA Grain|Grain has previously published two articles in which Izak Dreyer and his team related their CA journey: the first article focussed on their experience – the successes achieved and the mistakes they made. The second related to integrating livestock in

a CA system. You can read 'Benut die natuur se grasse dienste' and '50 Integreer ons vee in 'n bewaaringstelsel' on www.sagrainsmag.co.za. The articles are also available by scanning the QR codes at the end of the article.

Izak is a third-generation grain and livestock producer in the Vrede area. After practising conventional agriculture on his farm Goedgedacht for more than 15 years, he realised in 2012 that it was time for change. It was then that Izak started in a timely and systematic manner converting his conventional farmlands to CA systems. This included planting cover crops in rotation and implementing ultra-high-density grazing (UHDG).

Economic benefits

After eight years of CA on his now fully transitioned farmlands, Izak is reaping the economic rewards of his initial decision to farm more sustainably. According to him, the biggest economic benefits is the reduced need for tillage. With no tillage as part of the CA system, the cost of working fields has drastically reduced as a result of lower fuel consumption as well as reduced hours and maintenance on farming equipment. Overall, his tillage practices have been cut by approximately 40% for the same area under conventional cultivation.

ON FARM LEVEL
Conservation agriculture



1 A winter cereal crop planted after soybeans.

ON FARM LEVEL

BENEFITS OF FARMING...

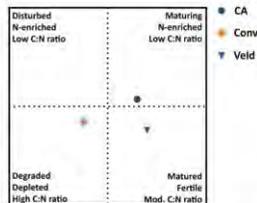


Figure 1: A nematode-based analysis indicating the food web status of conservation agriculture (CA) farmlands (overgrown) as well as two reference sites, namely a conventional farmland (Conv) and natural Veld (Veld), of the Goedgedacht farm in the eastern Free State.

Other tangible benefits of CA on Goedgedacht include increased water infiltration, decreased water evaporation rates and lower soil temperatures. Because of the subsequent increased soil moisture levels, Izak and his team are able to plant winter cover crops with great success (Photo 1 on page 59). The winter cover crops not only improve the condition of the soil, but also serve as food for livestock managed in an UHDG system. This high-quality feed has returned up to 150 kg/ha in growth for cattle during the winter months. When planting and grazing cover crops during the summer months, cattle growth rates exceeding 250 kg/ha can easily be achieved (Photo 2).

From a fertiles perspective, nitrogen is currently applied at rates 40% lower than in conventional systems. Izak is convinced that as the health of the soil continues to improve, even further reductions in inorganic fertilizer quantities will be possible in the near future. Additional benefits of CA on Goedgedacht include the suppression of weeds by cover crops and the reduced need for tilling because of lower soil acidification. However, as Izak notes, one of the greatest benefits of implementing CA and therefore promoting soil health, is the improved resilience against especially climatic extremes. It has been noted in several trials and fields in South Africa that CA systems outperform conventional systems in their years with up to 15% higher yields.

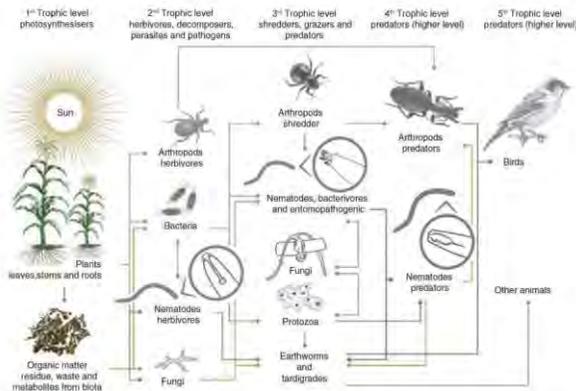


Figure 2: A food web with special reference to nematodes that occupy various trophic levels. This represents an intrinsic part of functioning soil ecosystems (from the book *Nematology in South Africa: A View from the 21st Century*, Springer).

NEW CA/RA TRIALS

Trial implemented in five ecotopes in the Maluti and Standerton regions.

	Regenerative: Ideal CA				CT: High input		CA: High input	
	1	2	3	4	5	6	7	8
2020/21	Maize + relay WD	SD + WD	Soy WD +	SD + WD	Maize CT	Soy CT	Maize CAT	Soy CAT
2021/22	SD + WD	Soy WD +	SD + WD	Maize + relay WD	Soy CT	Maize CT	Soy CAT	Maize CAT
2022/23	Soy WD +	SD + WD	Maize + relay WD	SD + WD	Maize CT	Soy CT	Maize CAT	Soy CAT
2023/24	SD + WD	Maize + relay WD	SD + WD	Soy WD +	Soy CT	Maize CT	Soy CAT	Maize CAT

Key:

- SD: summer cover crop
- WD: winter cover crop
- Relay WD: maize intercropping (6-8 leaves)
- CT: conventional tillage
- CA: conservation tillage

NEW CA/RA TRIALS



NEW CA/RA TRIALS

SOIL MEASUREMENTS

Physical

Available water capacity (modelled)

Bulk density

Surface hardness (0 - 10 cm)

Subsurface hardness (10 - 20 cm)

Aggregate stability

Soil texture

Chemical

Haney (Inorganic + organic N/P; WEOC; WEON; etc.)

Biological

Nematodes-based indices of soil ecosystem health

Enzymes (C; N; P; S)

Microbial Respiration

Organic C

Active C



TAKE HOME MESSAGE

- Soil health and its ability to deliver services to farmers are intricately linked to the health and functioning of soil ecosystems (organisms). 
- Soil health and ecosystems are deteriorating as a result of physical and chemical disturbance. 
- We need to implement more sustainable agricultural systems. 
- This will not only benefit nature, but also farmers. 
- Many producers are on the path of sustainable production and sustainable intensification. Learn from them. 
- “Nature is always right, why argue against it?” 



ACKNOWLEDGEMENTS

- Producers that form part of the Farmer Innovation Program (FIP) for access to their properties.
- Dr. Hendrik Smith and his team (AssetResearch) for continuous support.
- Prof. Driekie Fourie (NWU) for facilitating research activities and providing supervision to students.
- Ane Loggenberg (NWU) for her hard work and dedication to this research project.
- The Maize Trust for funding our research.





THANK YOU

