

The Science Behind Sustainable Soil Management

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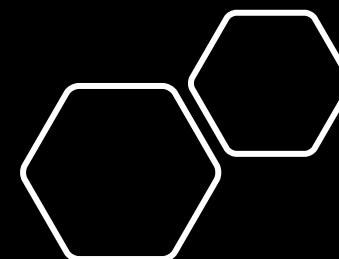
📍 NELSPRUIT

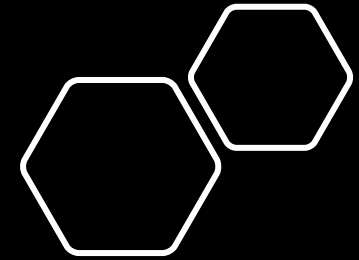
📍 STELLENBOSCH

📍 TZANEEN



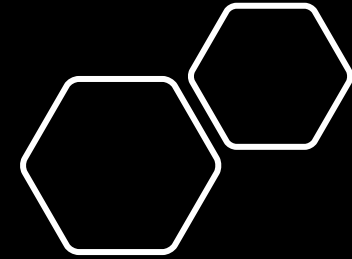
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LABORATORIES





10 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000

x 40



10 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
x 40

The \$20 million DUCK

“Sustainable” in Perspective

“Sustainable” in Perspective

Well-being of the Soil



Productivity
potential of the soil



Environmental
quality in the present
& future

Well-being of the Soil

Well-being of the Soil

Manage
Soil Chemistry
Responsibly

Fertilise
Responsibly

Irrigate
Responsibly

Cover Soil
Responsibly

Manage C
Responsibly

Manage Soil Chemistry Responsibly

Sample Name	Depth (cm)	Soil Text.	pH (KCl)	Resist. (ohm)	H (cmol/kg)	Stone (v/v) %	P (mg/kg)	K	Exchangeable cations (cmol/kg)				Cu	Zn	Mn	B	Fe	S	C
									Na	K	Ca	Mg							
1	30	Sa	5.75	1020	0.240	15	29.1	51	0.16	0.13	4.1	0.5	0.8	1.4	1.3	0.25	86	31	0.55
2	60	Sa	5.37	1134	0.320	30	22.3	36	0.21	0.09	3.4	0.7	0.6	0.7	0.5	0.19	79	21	0.30
3	90	Sa	4.71	1372	0.460	40	5.2	37	0.17	0.09	1.7	0.4	0.5	0.5	0.4	0.16	80	10	0.21

Sample Name	Depth (cm)	Base saturation (%)				T-Value (cmol/kg)	EC mS/cm
		Na	K	Ca	Mg		
1	30	3.02	2.52	79.53	10.29	5.18	0.223
2	60	4.44	1.96	72.27	14.53	4.70	0.218
3	90	5.88	3.38	58.93	15.43	2.81	0.178

Manage Soil Chemistry Responsibly

[illegible]

Manage
Soil Chemistry
Responsibly

No value using
inoculants if soil
P is optimal/high

Analysis	Physical properties	Biology	Nutrient uptake
pH	YES	YES	YES
Salinity (Na)	YES	YES	YES
Soil P	NO	YES	YES

Manage
Soil Chemistry
Responsibly



Analysis	Physical properties	Biology	Nutrient uptake
pH	YES	YES	YES
Salinity (Na)	YES	YES	YES
Soil P	NO	YES	YES
Soil K	NO	YES	YES

Can cause
excessive
salinity if over-
fertilise

Manage
Soil Chemistry
Responsibly



Analysis	Physical properties	Biology	Nutrient uptake
pH	YES	YES	YES
Salinity (Na)	YES	YES	YES
Soil P	NO	YES	YES
Soil K	NO	YES	YES
Soil Ca	YES	YES	YES

Manage
Soil Chemistry
Responsibly



Analysis	Physical properties	Biology	Nutrient uptake
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Soil P	NO	YES	YES
Soil K	NO	YES	YES
Soil Ca	YES	YES	YES
Soil Mg	YES	YES	YES

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Soil Chemistry
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Soil Ca	YES	YES	YES
Soil Mg	YES	YES	YES
Micro-nutrients	NO	YES	VARIED

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Soil Chemistry
Responsibly



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Soil K	NO	YES	YES
Soil Ca	YES	YES	YES
Soil Mg	YES	YES	YES
Micro-nutrients	NO	YES	VARIED
Soil C	YES	YES	YES



Soil C = 0.7%
C:N ratio = 12:1

Total N in 0-30 cm =
2 333 kg/ha



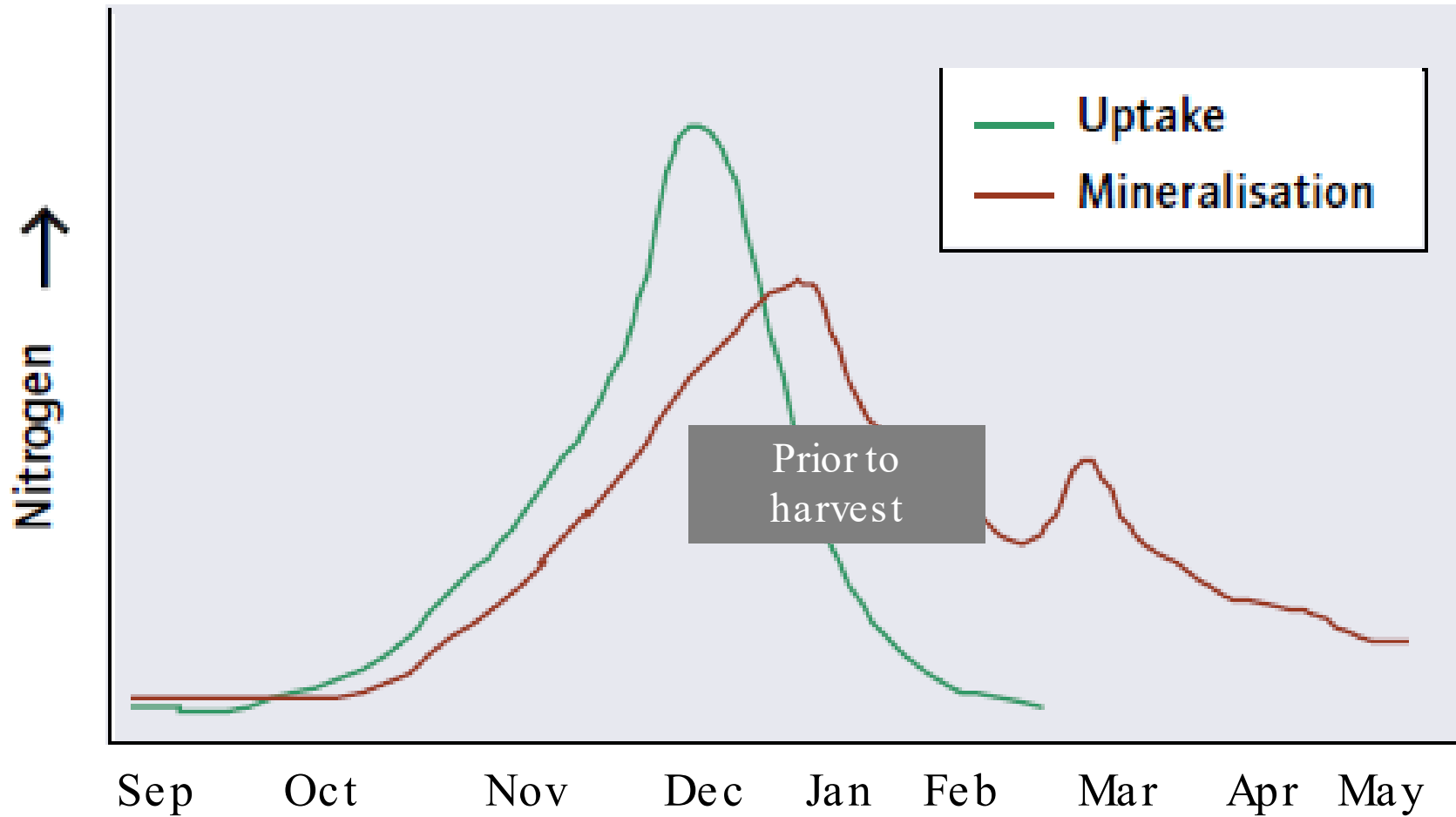
Mineralisation



Minimum of
70 kg mineral N/ha



50% of surface,
then 20- 35 kg N/ha
at any time available



Relationship between rate of N uptake and rate of N-mineralisation

Soil C = 0.7%
C:N ratio = 12:1

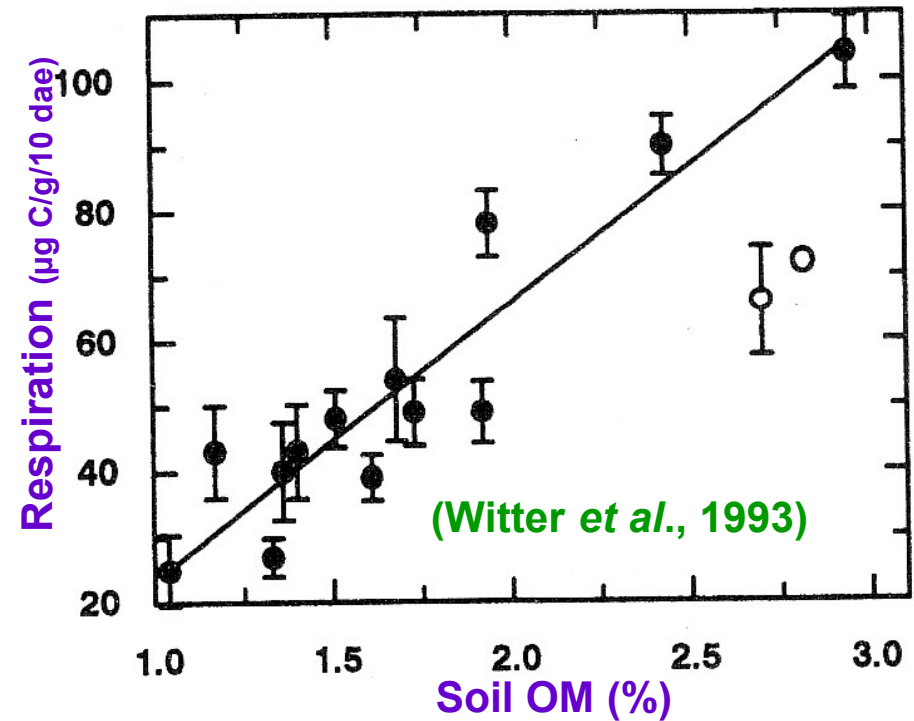
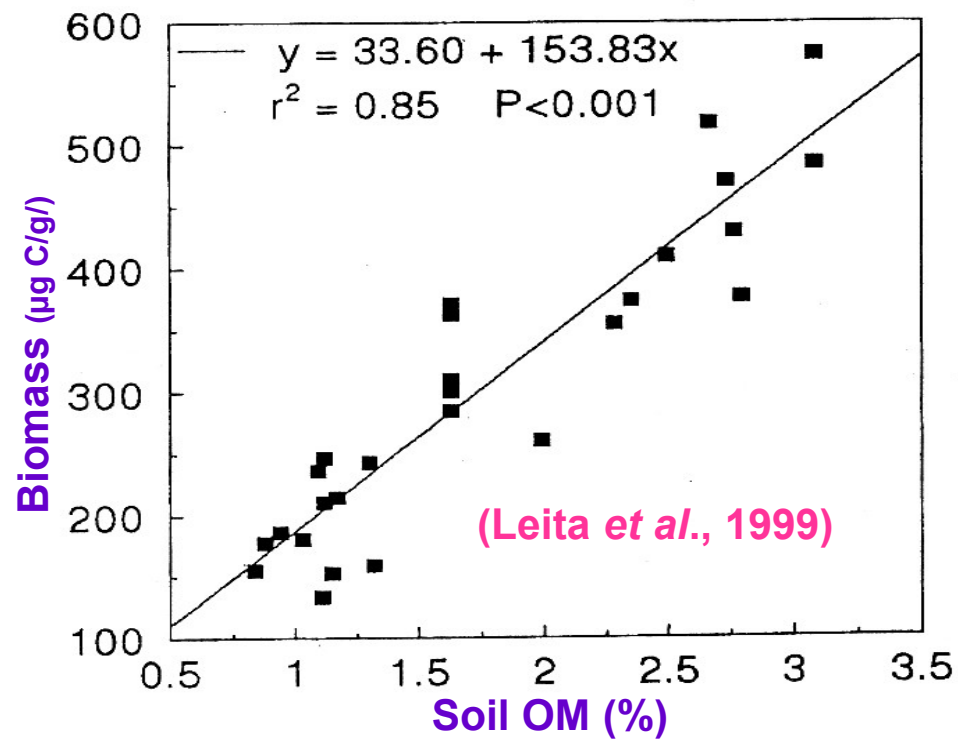
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↓
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The main factor affecting microbial activity is substrate availability, i.e. soil organic material content (Buneman *et al.*, 2006)



Proposed optimal levels of soil C per region and soil texture class

Texture	Percentage clay		
	< 5%	5-10%	>10
Limpopo	0.8%-1%	0.9-1.3%	1.0-1.5%
Orange River	0.7-0.9%	0.8-1.1%	0.9-1.3%
Western Cape	0.8-1.1%	0.9-1.3%	1.1-1.5%

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Analysis	Physical properties	Biology	Nutrient uptake
pH	YES	YES	YES
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Soil P	NO	YES	YES
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Soil Ca	YES	YES	YES
Soil Mg	YES	YES	YES
Micro-nutrients	NO	YES	VARIED
Soil C	YES	YES	YES
Texture	YES	YES	YES

Texture affect
susceptibility to
soil compaction

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Well-being of the Soil

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Soil Chemistry
Responsibly



Fertilise
Responsibly

Irrigate
Responsibly

Cover Soil
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Fertilise Responsibly

Absolute maximum annual fertilisation required, based on production achieved

Aimed production		N	P	K	Ca	Mg
		kg/ha				
25 t/ha	5000 cartons/ha	100	18	80	50	20
30 t/ha	6000 cartons/ha	120	20	100	60	25
40 t/ha	8000 cartons/ha	160	28	130	80	30

Fertilise Responsibly

Absolute maximum annual fertilisation required, based on production achieved

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25 t/ha	5000 cartons/ha	100	18	80	50	20
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How does this
change if the
soil C is
>0.7%?

**Irrigate
Responsibly**

Salinisation
Waterlogging
Leaching
Erosion
Soil Compaction

Irrigate Responsibly

Salinisation
Waterlogging
Leaching
Erosion
Soil Compaction

Minimise
vehicle traffic!!
Especially on
wet soil!!

Cover Soil Responsibly



Effect of long-term use of cover crops on the C-content of vineyard soils – 0 to 30cm depth (adapted from Fourie et al., 2007)

Treatment	Soil organic C content (%)		
	1993	1998	2003
Rye	0.47	0.61	1.05
Oats	0.45	0.56	0.75
Grazing Vetch	0.46	0.49	0.72
Paraggio Medics	0.44	0.58	0.77
Average	0.46		0.82

→ 0.36 % →

0.36 % C = 14.4 ton C/ha/30 cm or 24 ton OM/ha

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→ 0.36 % →

0.36 % C = 14.4 ton C/ha/30 cm or 24 ton OM/ha
 Minimum of 10% of OM is HA = 2 400 kg HA/ha/30 cm
 ±240 kg HA/ha is added per year

Cover Soil Responsibly



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Manage C
Responsibly

6 Core Principles of **REGENERATIVE AGRICULTURE**

“Sustainable” in Perspective

Source: LEAF

6 Core Principles of **REGENERATIVE AGRICULTURE**



“Sustainable” in Perspective

Source: LEAF

Soil texture

Soil Chemistry

Fertilisation

Irrigation

Cover cropping

Soil organisms

MINIMIZE
SOIL DISTURBANCE

KEEP THE SOIL
COVERED

INTEGRATE
LIVESTOCK

UNDERSTAND CONTEXT
OF YOUR FARM OPERATION

MAXIMIZE
CROP DIVERSITY

MAINTAIN LIVING
ROOT YEAR-ROUND

Organic C



SUSTAINABLE SOIL MANAGEMENT

Soil Well-Being Management

- Chemistry
- Texture & Fertilisation
- Irrigation
- Cover (crops) and avoid soil compaction
- Maintain C

SUSTAINABLE SOIL MANAGEMENT

Soil Well-Being Management

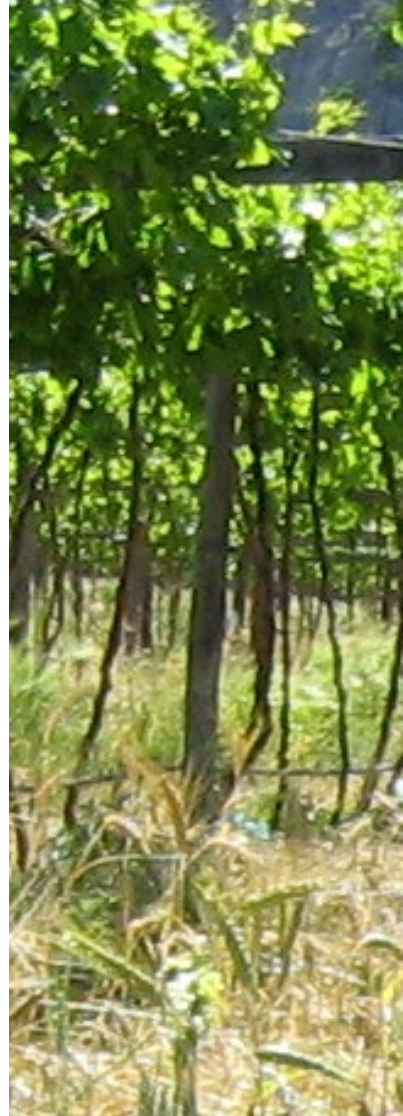
- Chemistry
- Texture & Fertilisation
- Irrigation
- Cover (crops)
- Maintain C



Thank you for your attention

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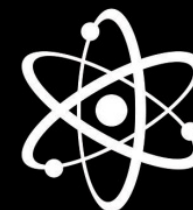
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