from the ground up

Australian Government | National Landcare Program

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

AgriSci

# Assessment and modelling of Soil Carbon profiles in the Hughes Creek Catchment


**Hughes Creek Catchment Collaborative - Landcare group**

**Science Partners**

- **Dr Cassandra Schefe** CPSS Soil Scientist / Co-owner AgriSci Pty Ltd
- **David Hawkey** Agronomist / Co-owner AgriSci Pty Ltd


## A brief introduction to the Hughes Creek Catchment

# The Tablelands around Ruffy


# Topsoil acidity and Aluminium toxicity effects on Sub Clover nodulation and biomass

Image Source: https://www.agric.wa.gov.au/soil-acidity/effects-soil-acidity

# How pH affects Aluminium saturation levels

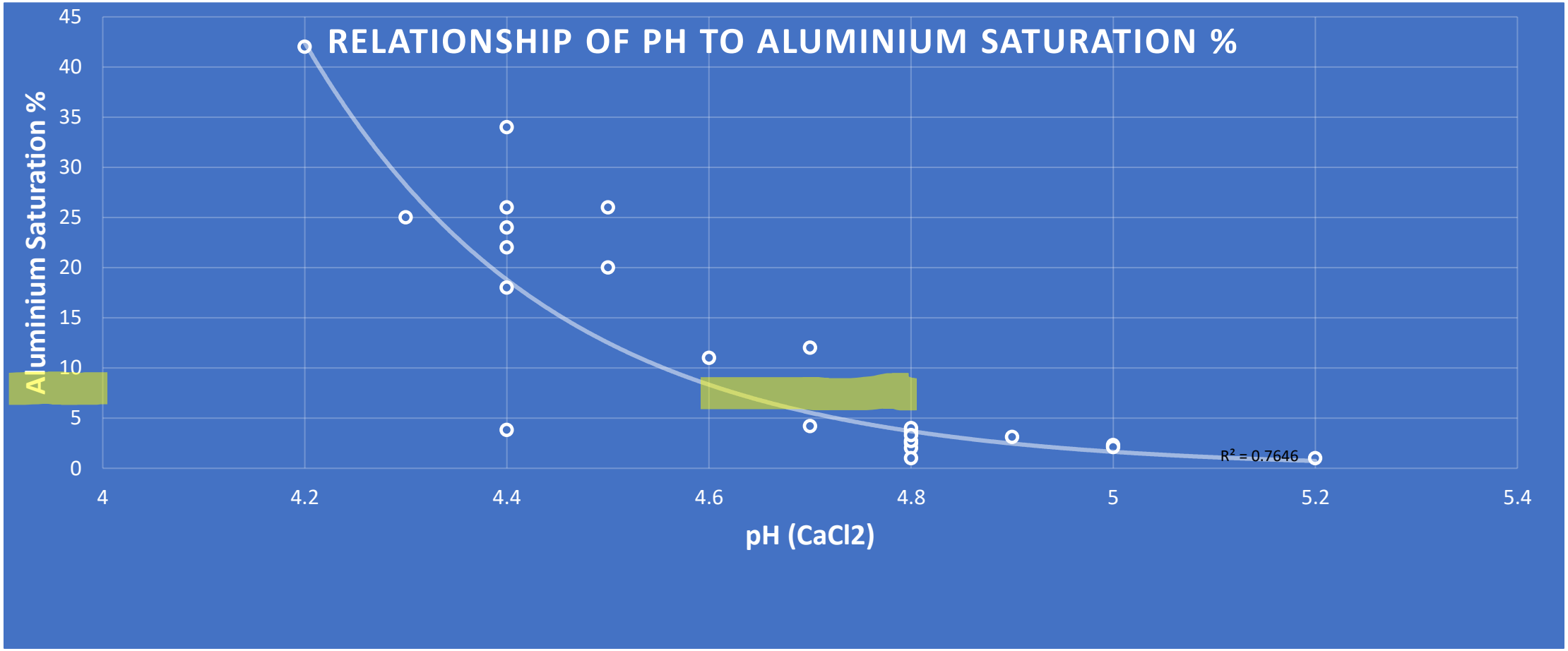
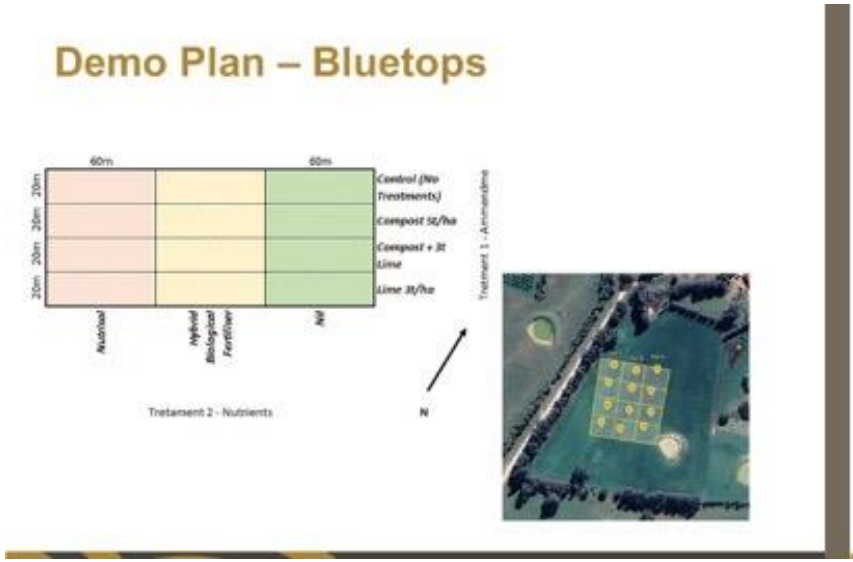



Image source: David Hawkey, AgriSci



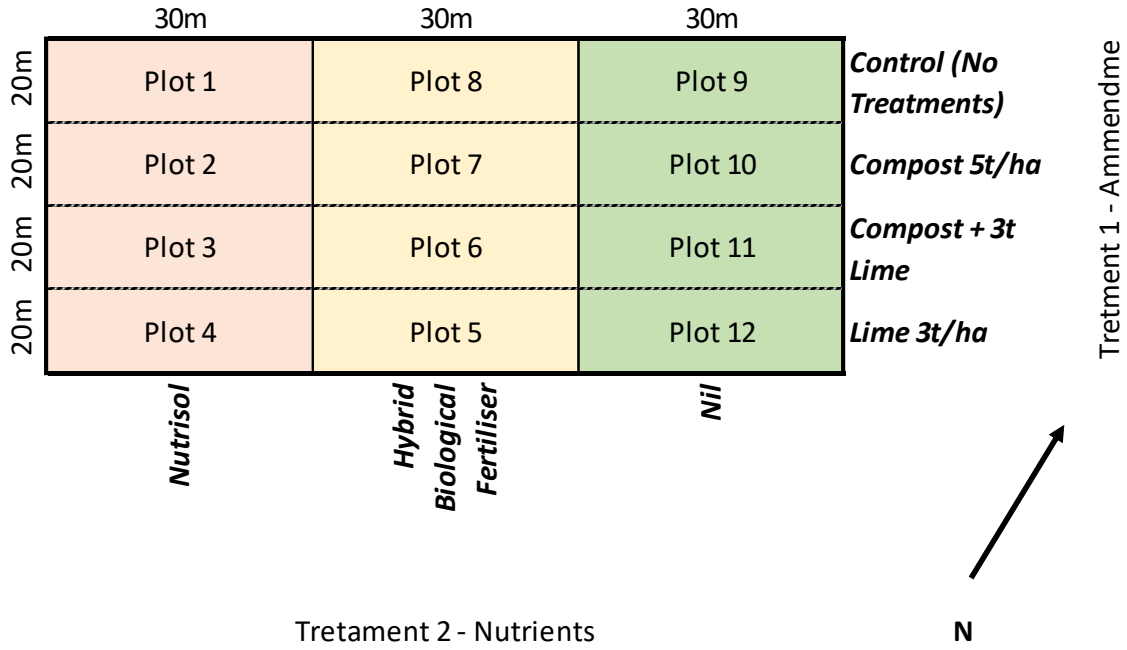



- **Lawson Farm / Bluetops:** Study paddock not very productive: abandoned, then used for hay since 1983. New pasture sown in 2019: perennial ryegrasses, cocksfoot, and annual legumes of Balansa clover and Antas sub clover. Soil test (2021) show low P, K and S; high acidity (4.3 to 5.2 in $CaCl_2$) and high aluminium (saturation 11%).
- **Tarcombe**: Well-established, deep-rooted perennial pasture, with Australian Phalaris and sub clover (variety unknown). Rock phosphate was major fertiliser input; set stocking as grazing method (cattle and sheep), now looking at rotational grazing for better outcomes. Soil test: Phosphorus, potassium and sulphur levels are low, likely to be some of the key limiters to pasture growth in this paddock.
- **Looking Glass**: degraded pasture dominated by low value annual grasses (annual winter grasses and broadleaf weeds), but with a good sub clover base. Assess pasture improvement methods over a 3-year period.

# LAWSON FARM

Addition of soil amendments → improve soil pH and nutrition → soil carbon increase?

| Application Rates | | |
|---|---|---|
| Plot | Ameliorant | Fertiliser |
| 1 | Nil | NutriSoil (label rate) |
| 2 | Compost 5t/ha | NutriSoil (label rate) |
| 3 | Compost 5t/ha + 3t/ha Lime | NutriSoil (label rate) |
| 4 | Lime 3t/ha | NutriSoil (label rate) |
| 5 | Lime 3t/ha | Hybrid Fert 300kg/ha |
| 6 | Compost 5t/ha + 3t/ha Lime | Hybrid Fert 300kg/ha |
| 7 | Compost 5t/ha | Hybrid Fert 300kg/ha |
| 8 | Nil | Hybrid Fert 300kg/ha |
| 9 | Nil | Nil |
| 10 | Compost 5t/ha | Nil |
| 11 | Compost 5t/ha + 3t/ha Lime | Nil |
| 12 | Lime 3t/ha | Nil |




Hybrid fertilizer containing **20% carbon (**poultry litter, manure, sulphate of potash and rock phosphate (N 2.025%, P 4.4%, K 9.01%, S 3.81%, Carbon 22.25%)).

# Lawson trial site
## Baseline Soil Test + Soil Health (2021)

pH (CaCl2)

CEC

Aluminium Saturation

| | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Sample Name | Sampling Date | Sample Depth From | Sample Depth To | Test Code | pH (1:5 CaCl2) | Electrical Conductivity (1:5 water) | Available Potassium | Calcium (Amm-acet.) | Potassium (Amm-acet.) | Magnesium (Amm-acet.) | Sodium (Amm-acet.) | Ca/Mg Ratio | Aluminium (KCl) | Cation Exch. Cap. | Sodium % of Cations (ESP) | Aluminium Saturation | Aluminium (KCl) | Calcium (Amm-ac |
| 2 | | | | | | | dS/m | mg/kg | cmol(+)/kg | cmol(+)/kg | cmol(+)/kg | cmol(+)/kg | | cmol(+)/kg | cmol(+)/kg | % | % | mg/kg | % |
| 3 | Plot 1 | 08/11/2021 | 0 | 5 | 2018-124 Sc | 5.0 | 0.05 | 160 | 4.0 | 0.41 | 0.7 | 0.09 | 5.5 | 0.1 | 5.3 | 1.70 | 2.3 | 11.0 | 75.0 |
| 4 | Plot 1 | 08/11/2021 | 5 | 10 | 2018-124 Sc | 4.5 | 0.03 | 55 | 2.2 | 0.14 | 0.3 | 0.06 | 6.9 | 0.7 | 3.4 | 1.80 | 20.0 | 60.0 | 65.0 |
| 5 | Plot 2 | 08/11/2021 | 0 | 5 | 2018-124 Sc | 5.0 | 0.05 | 150 | 3.9 | 0.38 | 0.8 | 0.04 | 4.9 | 0.1 | 5.2 | 0.73 | 2.1 | 9.9 | 74.0 |
| 6 | Plot 2 | 08/11/2021 | 5 | 10 | 2018-124 Sc | 4.5 | 0.03 | 56 | 1.5 | 0.14 | 0.5 | 0.06 | 3.1 | 0.8 | 3.0 | 1.90 | 26.0 | 70.0 | 51.0 |
| 7 | Plot 3 | 08/11/2021 | 0 | 5 | 2018-124 Sc | 4.7 | 0.05 | 64 | 3.9 | 0.16 | 0.7 | 0.08 | 5.5 | 0.2 | 5.1 | 1.50 | 4.2 | 19.0 | 77.0 |
| 8 | Plot 3 | 08/11/2021 | 5 | 10 | 2018-124 Sc | 4.4 | 0.04 | 45 | 2.3 | 0.11 | 0.4 | 0.05 | 6.6 | 0.8 | 3.6 | 1.40 | 22.0 | 72.0 | 64.0 |
| 9 | Plot 4 | 08/11/2021 | 0 | 5 | 2018-124 Sc | 4.8 | 0.04 | 140 | 3.2 | 0.36 | 0.5 | 0.04 | 6.7 | 0.2 | 4.2 | 0.89 | 3.6 | 14.0 | 75.0 |
| 10 | Plot 4 | 08/11/2021 | 5 | 10 | 2018-124 Sc | 4.2 | 0.03 | 52 | 1.1 | 0.13 | 0.2 | 0.03 | 6.9 | 1.0 | 2.5 | 1.20 | 42.0 | 94.0 | 45.0 |
| 11 | Plot 5 | 08/11/2021 | 0 | 5 | 2018-124 Sc | 4.9 | 0.04 | 53 | 3.8 | 0.14 | 0.7 | 0.06 | 5.8 | 0.2 | 4.9 | 1.30 | 3.1 | 13.0 | 79.0 |
| 12 | Plot 5 | 08/11/2021 | 5 | 10 | 2018-124 Sc | 4.4 | 0.03 | 31 | 1.4 | 0.08 | 0.3 | 0.06 | 5.2 | 0.9 | 2.7 | 2.20 | 34.0 | 81.0 | 51.0 |
| 13 | Plot 6 | 08/11/2021 | 0 | 5 | 2018-124 Sc | 4.8 | 0.04 | 73 | 4.3 | 0.19 | 0.8 | 0.06 | 5.2 | 0.1 | 5.5 | 1.20 | 2.5 | 13.0 | 78.0 |
| 14 | Plot 6 | 08/11/2021 | 5 | 10 | 2018-124 Sc | 4.6 | 0.03 | 38 | 2.8 | 0.10 | 0.5 | 0.07 | 5.4 | 0.4 | 3.9 | 1.70 | 11.0 | 37.0 | 72.0 |
| 15 | Plot 7 | 08/11/2021 | 0 | 5 | 2018-124 Sc | 4.8 | 0.04 | 130 | 4.6 | 0.32 | 0.9 | 0.05 | 5.2 | 0.1 | 6.0 | 0.78 | 2.0 | 11.0 | 77.0 |
| 16 | Plot 7 | 08/11/2021 | 5 | 10 | 2018-124 Sc | 4.3 | 0.10 | 76 | 2.0 | 0.19 | 0.3 | 0.05 | 5.9 | 0.9 | 3.5 | 1.40 | 25.0 | 79.0 | 58.0 |
| 17 | Plot 8 | 08/11/2021 | 0 | 5 | 2018-124 Sc | 4.8 | 0.05 | 190 | 3.8 | 0.50 | 0.8 | 0.07 | 4.6 | 0.1 | 5.4 | 1.30 | 2.7 | 13.0 | 71.0 |
| 18 | Plot 8 | 08/11/2021 | 5 | 10 | 2018-124 Sc | 4.4 | 0.04 | 62 | 1.5 | 0.16 | 0.2 | 0.05 | 7.1 | 0.6 | 2.5 | 2.00 | 24.0 | 54.0 | 60.0 |
| 19 | Plot 9 | 08/11/2021 | 0 | 5 | 2018-124 Sc | 4.8 | 0.05 | 200 | 3.9 | 0.50 | 0.7 | 0.04 | 5.5 | 0.2 | 5.3 | 0.73 | 4.0 | 19.0 | 72.0 |
| 20 | Plot 9 | 08/11/2021 | 5 | 10 | 2018-124 Sc | 4.4 | 0.04 | 90 | 2.2 | 0.23 | 0.4 | 0.03 | 6.1 | 1.0 | 3.8 | 0.84 | 26.0 | 90.0 | 58.0 |
| 21 | Plot 10 | 08/11/2021 | 0 | 5 | 2018-124 Sc | 4.8 | 0.04 | 180 | 3.4 | 0.45 | 0.7 | 0.08 | 5.2 | 0.2 | 4.8 | 1.70 | 3.3 | 14.0 | 72.0 |
| 22 | Plot 10 | 08/11/2021 | 5 | 10 | 2018-124 Sc | 4.4 | 0.03 | 69 | 1.7 | 0.18 | 0.3 | 0.06 | 6.3 | 0.5 | 2.6 | 2.10 | 18.0 | 42.0 | 63.0 |
| 23 | Plot 11 | 08/11/2021 | 0 | 5 | 2018-124 Sc | 4.8 | 0.04 | 78 | 3.6 | 0.20 | 0.7 | 0.09 | 5.5 | <0.1 | 4.5 | 2.00 | <1.0 | <9.0 | 79.0 |
| 24 | Plot 11 | 08/11/2021 | 5 | 10 | 2018-124 Sc | 4.4 | 0.03 | 37 | 1.3 | 0.09 | 0.2 | 0.08 | 6.8 | 1.0 | 2.7 | 2.80 | 38.0 | 92.0 | 49.0 |
| 25 | Plot 12 | 08/11/2021 | 0 | 5 | 2018-124 Sc | 5.2 | 0.05 | 62 | 4.8 | 0.16 | 0.7 | 0.06 | 7.2 | <0.1 | 5.7 | 0.98 | <1.0 | <9.0 | 84.0 |
| 26 | Plot 12 | 08/11/2021 | 5 | 10 | 2018-124 Sc | 4.7 | 0.04 | 34 | 2.3 | 0.09 | 0.3 | 0.05 | 7.2 | 0.4 | 3.2 | 1.70 | 12.0 | 36.0 | 73.0 |
| 27 | | | | | | | | | | | | | | | | | | | |

# Lawsons trial site
## Baseline for soil carbon and pH (May 2021)

| Site | Depth (cm) | % gravel | Bulk density (g/cm3) | Total SOC (% Oven Dry) | SOC (%) adj. for gravel | SOC (t/ha) | Total SOC per 30cm depth (t/ha) | pH (CaCl2) | CEC Meq/100g |
|---|---|---|---|---|---|---|---|---|---|
| Bluetops 1 | 0-10 | 3.05 | 1.31 | 3.39 | 3.29 | 43.04 | 68.51 | 4.3 | 3.5 |
| | 10-20 | 2.51 | 1.20 | 1.36 | 1.33 | 15.92 | | 4.1 | 2.0 |
| | 20-30 | 2.35 | 1.20 | 0.81 | 0.80 | 9.55 | | 4.3 | 1.8 |
| Bluetops 2 | 0-10 | 2.74 | 1.12 | 3.58 | 3.48 | 39.06 | 69.58 | 4.7 | 4.9 |
| | 10-20 | 3.99 | 1.30 | 1.37 | 1.32 | 17.11 | | 4.2 | 3.2 |
| | 20-30 | 3.17 | 1.21 | 1.14 | 1.11 | 13.41 | | 4.5 | 3.1 |
| Bluetops 3 | 0-10 | 8.12 | 1.18 | 3.79 | 3.48 | 41.08 | 70.56 | 4.6 | 5.1 |
| | 10-20 | 7.94 | 1.00 | 1.64 | 1.51 | 15.11 | | 4.4 | 3.0 |
| | 20-30 | 8.29 | 1.36 | 1.15 | 1.06 | 14.37 | | 4.5 | 2.5 |
| Bluetops 4 | 0-10 | 9.06 | 1.23 | 3.09 | 2.81 | 34.56 | 53.39 | 4.5 | 4.4 |
| | 10-20 | 7.44 | 1.33 | 1.00 | 0.92 | 12.31 | | 4.3 | 1.4 |
| | 20-30 | 7.58 | 1.49 | 0.47 | 0.44 | 6.52 | | 4.4 | 1.5 |

CEC

### Soil Health

Solvita® CO2-Burst test for **soil microbial respiration** activity (40-140 mg/L)

**Slaking and Dispersion**; soil aggregation and structure

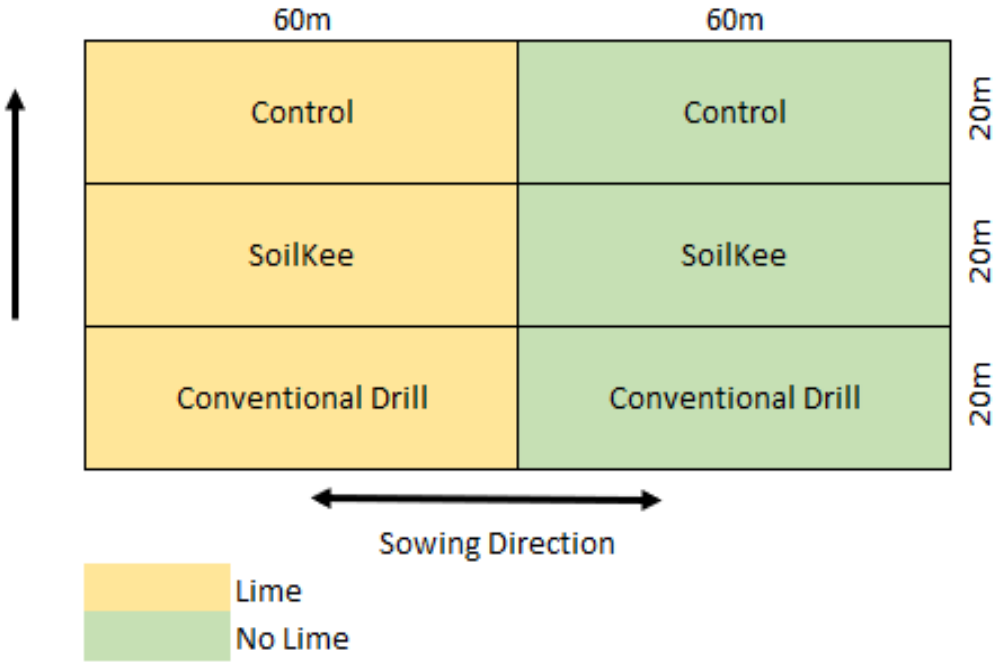
**Active Carbon** (Labile; > 4% is ideal)

**Total Carbon, Total Nitrogen and C:N ratio** for monitoring nitrogen mineralisation and immobilisation

# LOOKING GLASS

Improving degraded pastures → increase long-term biomass production
→ soil carbon increase?

| Name | Pasture Improvement | Lime |
|---|---|---|
| Treatment 1 | Nil | Nil |
| Treatment 2 | Nil | 2.5t/ha |
| Treatment 3 | Annual forage mix – Sown with Soilkee | Nil |
| Treatment 4 | Annual forage mix – Sown with Soilkee | 2.5t/ha |
| Treatment 5 | Annual forage mix – Sown conventionally | Nil |
| Treatment 6 | Annual forage mix – Sown conventionally | 2.5t/ha |

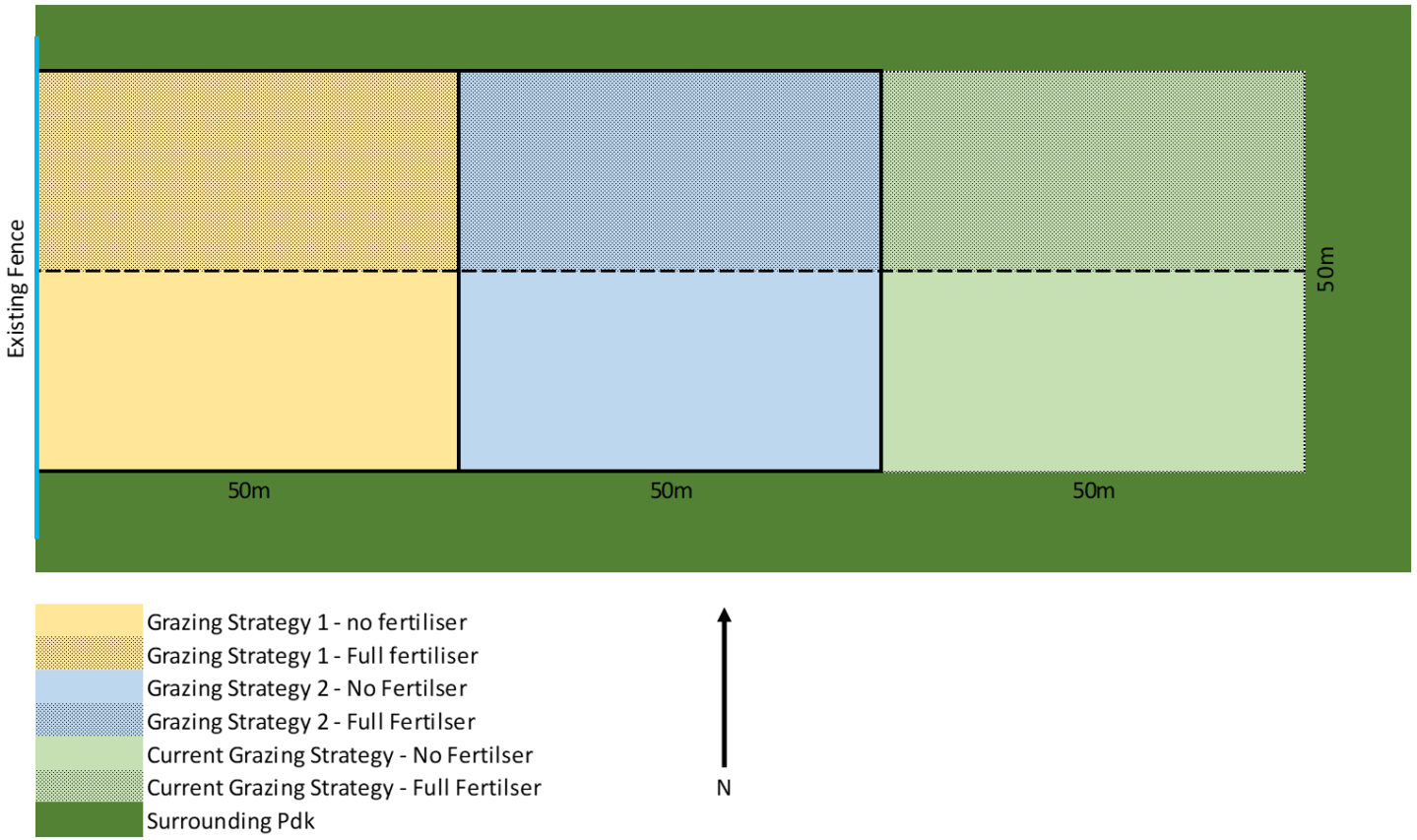


# The Soilkee Renovator in Action

# **Looking Glass** Soil Carbon trial site

# TARCOMBE HEREFORDS

## Changing grazing management practices → soil carbon increase?




NB. No fence required around the current grazing startegy block this will be marked out for testing and monitroing purposes.

Multi nutrient fertiliser (P and K) at the rate of 260 kg/ha

# What have we learnt so far?

## Results

Bluetops: overcoming Murphy's law.

Looking Glass: Soilkee back 2nd year, native pasture future goal.

Tarcombe: willingness to switch to rotational grazing. MLA pasture ruler to measure growth.

Soil pit, articles on newsletter, soil health at regen ag course: better understanding of SOC

## Challenges

- Covid → great delay→ not enough time to see change in SOC
- Hoping to get extra funds to conclude the research
- If farmers wish to maintain higher SOC levels, changes in land management will need to be continued indefinitely.
- New approach to soil as a living being

# Thank you!

**For more information**

Soil Carbon project on HCCC Landcare Website
https://www.hccclandcare.net.au/soil-carbon

HCCC Soil Carbon Project Coordinator
Vanessa@hccclandcare.net.au

AgriSci https://www.agrisci.com.au/

Online Resources: Soil Carbon Snapshot
Case studies: Soil for Life