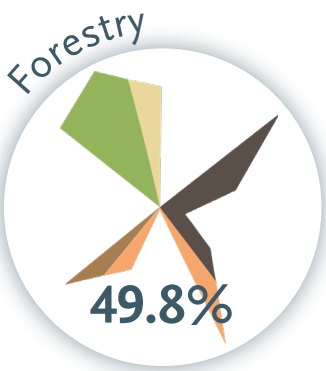
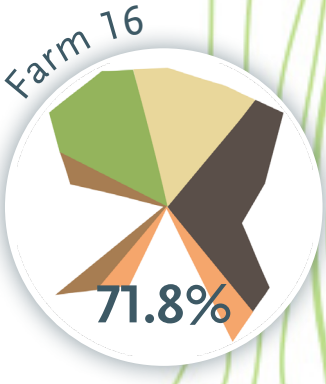
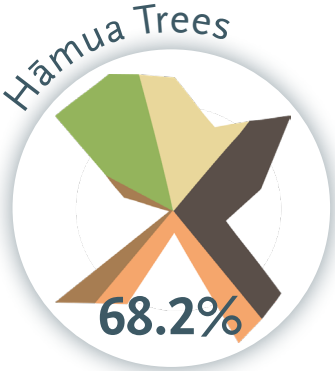
Farm Soil Health

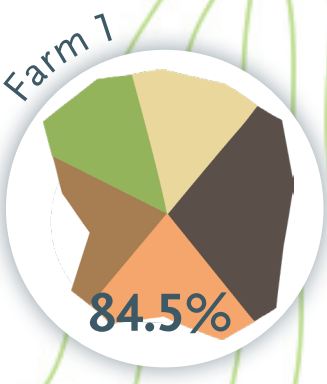
Healthy soil, healthy plants, healthy people.

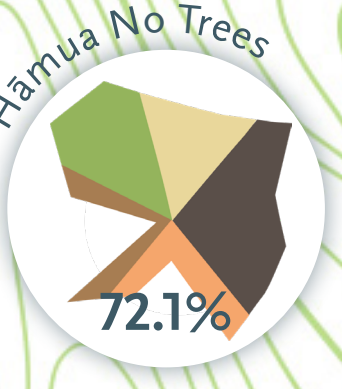
Total Soil Health Scores

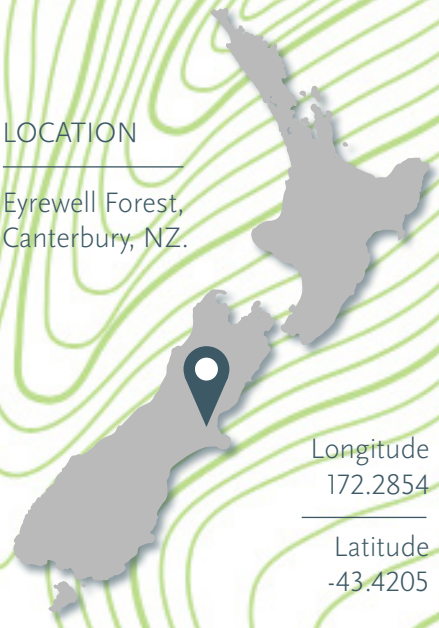












LOCATION

Eyrewell Forest,
Canterbury, NZ.

Longitude
172.2854

Latitude
-43.4205

Pests and Diseases

Soil fertility

Soil physical properties

Biological indicators

Organic matter properties

agresearch
āta mātai, mātai whetū

OUR LAND AND WATER
Toitū te Whenua, Toiora te Wai
National SCIENCE Challenges

ravensdown

He whenua, he kai

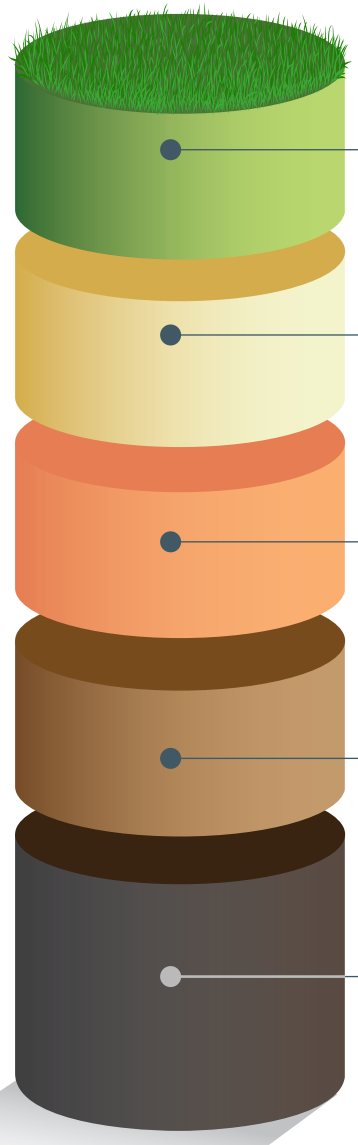
A continuous commitment to farming improvement

Key finding

There is a general improvement in soil health as land-use changed from forestry to pasture. Monitoring and management is required to reach optimal soil health and maintain these levels including targeted fertiliser application to stay within economic and environmental limits. All soils rated poorly in soil biological indicators, and may require action beyond standard practice to create an environment to enhance soil biology and the services they provide.

Cutting to the core

What we tested and how



Pests and Diseases

Pasture insect pressure
Pasture disease risk

Soil Fertility

Soil pH
Potassium availability
Olsen P

Soil Physical Properties

Available water capacity
Soil macroporosity
Soil density

Biological Indicators

Microbial respiration
Earthworm abundance
Earthworm diversity

Organic Matter Properties

Soil carbon
Soil nitrogen
Organic matter quality
Mineralisable nitrogen
Readily available carbon

Numerous indicators were used to assess soil condition.

Samples were gathered from an existing forestry site post conversation to irrigated dairy production at differing intervals.

Sites were selected from land that was previously in Eyrewell Forest, north of the Waimakariri River near Christchurch.

	Forestry	Farm 16	Hāmua trees	Farm 1	Hāmua no trees
Landuse	*Pinus Radiata*	Dairy Support	Dairy Production	Dairy Production	Dairy Production
No. of sites	5	8	5	5	5
Years since irrigation	0	3	2	7	2
Years since forestry	0	3	4	7	10+

Report Summary

Overall health score is **highest** at sites that have been **out of forestry** the longest.

Soil properties differ **most** during that initial conversion to pasture, but **change continues** under pasture agriculture.

BIOLOGY
Earthworm Abundance

No earthworms found under forestry

Earthworms found

3/m² Hāmua Trees 2015

38/m² Hāmua No Trees 2012

Farm 1 had the highest number of earthworms at 195/m²

Biology is slow to change and while biological additions may stmulate populations, it is essential to enhance their habitats

FERTILITY
Olsen P

Olsen P low under forestry

Olsen P increases with conversion

Targeted fertiliser application across a variable landscape to stay within economic & environmental limits

SOIL PHYSICS
Macroporosity

Soil macroporosity high indicating a loose soil susceptible to erosion

Pasture conversion decreases soil macroporosity

Not a concern at this stage but will need to be monitored as soil compaction can be a problem under pasture

ORGANIC MATTER
Carbon:Nitrogen Ratio

C C C N

Soil C:N ratio high under forestry

C C N

Application of N and decomposition processes lower C:N ratio

C N

Soil will be more responsive to N application but need to be careful for losses into waterways

Soil properties in soils sampled, May 2019

Shown along gradient of time since foresty ceased

	Optimal Range [1]	Target High Producing Pasture [2]	Forestry	Farm 16	Hāmua Trees	Farm 1	Hāmua No Trees
Soil fertility							
pH [2]	5.5-6.3	5.8-6.0	5.2	6.2	6.3	5.7	6.6
Olsen P (µg/ml)	20-30	30-35	7.6	51.0	18.2	29.0	22.8
Potassium (QT)	7-10		9.4	14.1	10.2	11.8	13.0
Calcium (QT)	>1		3.2	13.3	11.4	7.8	11.0
Magnesium (QT) [3]	8-30		23.4	26.4	25.8	26.6	25.2
Sodium (QT)	>3		9.8	8.9	9.8	10.2	10.8
Cation exchange capacity (me/100g)	<12		17.6	24.0	22.0	20.0	19.8
Organic matter properties							
Total nitrogen (%)	0.25-0.7	0.6-0.7	0.31	0.40	0.36	0.53	0.42
Total carbon (%)	>2.5	>6	8.6	8.3	8.6	8.9	7.4
Carbon to nitrogen ratio	8-12	9-11:1	27.0	20.5	23.5	16.5	17.7
Hot water carbon (mg/kg)	>1400		4034	3271	2708	2796	2586
Anaerobically mineralizable nitrogen (kg/ha)	50-250	180-200	78	158	165	209	244
Soil physical properties							
Bulk density (g/cm³)	0.7-1.4	0.7-0.9	0.91	0.80	0.86	0.99	1.01
Macroporosity (%)	8-30	10-15	41.7	40.3	34.7	26.9	32.0
Available water capacity (%)	6	>20	8.8	11.6	14.2	15.5	11.1
Stones (%)			11.5	9.8	13.2	14.3	15.2
Soil moisture (%)			11.1	22.7	33.7	31.5	27.7
Biological indicators							
Microbial respiration (µg/g/h CO^2-C)	3-12		1	1.18	1.32	1.08	0.95
Earthworm abundance (incl. juveniles) (m^{-2})	>400		0	5	3	195	38
Epigeic earthworm (m^{-2}) [4]	>25		0	0	3	41	1
Endogeic earthworm (m^{-2}) [4]	>350		0	4	0	122	29
Anecic earthworm (m^{-2}) [4]	>25		0	1	0	0	0
Pests and Diseases							
Pasture disease risk (AMN:TN)	>2		1.7	3.9	3.1	2.7	3.9
Porina (m^{-2})	<20		1	0	2	2	0
Grassgrub (m^{-2})	<150		0	0	0	2	0
Clover root weevil larvae (m^{-2})	<130		0	2	87	32	76

Key: Below optimum | At optimum | Above optimum

1 Optimal ranges from Sparling et al. (2008), Roberts and Morton (2016), Drewry et al. (2017), van Groenigen et al. (2014) and Schon et al. (2012), Ferguson et al. (2019), Doran et al. (1997), Houlbrooke et al. (2011), *www.smap.landcareresearch.co.nz*, *www.hilllaboratories.co.nz* and *www.dairynz.co.nz*. Please note some target ranges are provisional and may change as science and our understanding improve.

2 Target ranges for a deep, free draining friable soil formed from allophanic tephra under highly productive dairy farm conditions where information availale. Information from Roberts (pers. comm) and (Roberts and Morton 2016).

3 8-10 optimal for pasture, 25-30 optimal for animal health.

4 Epigiec species include *Lumbricus rubellus*, *Dendrodrilus rubidus*. Endogeic species include *Aporrectodea caliginosa*, *Aporrectodea trapezoides*, *Octolasion cyaneum*. Anecic species include *Aporrectodea longa*.