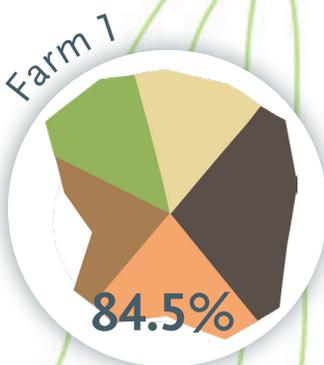
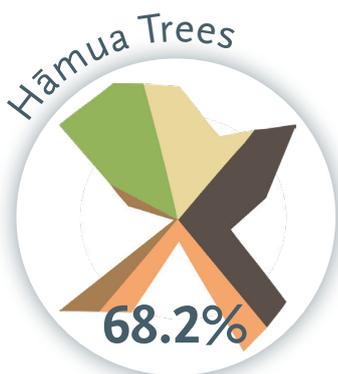
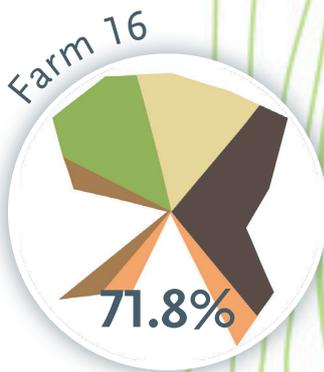
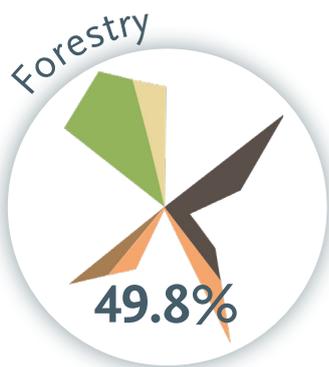


Farm Soil Health

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

He whenua, he kai

A continuous commitment to farming improvement

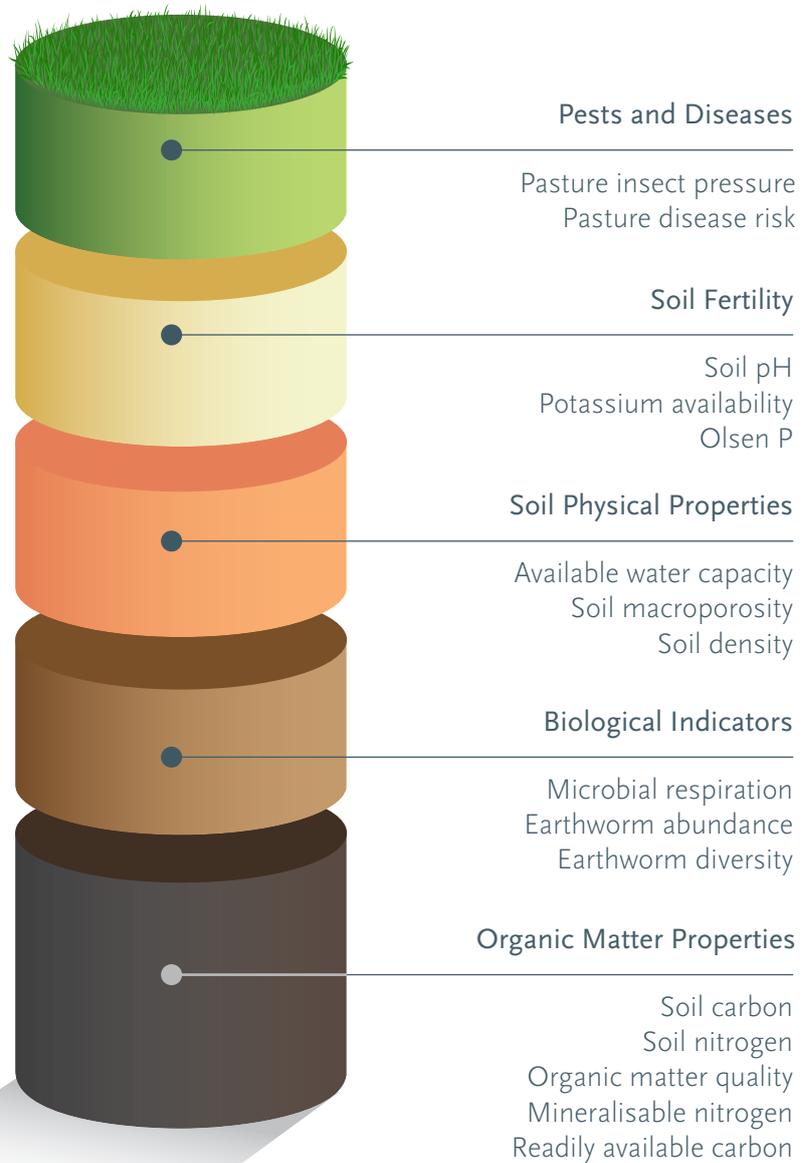
Key finding

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



Numerous indicators were used to assess soil condition.

Samples were gathered from an existing forestry site post conversion 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	<i>Pinus Radiata</i>	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 38/m²
 Hāmua Hāmua No
 Trees 2015 Trees 2012

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

Biology is slow to change and while biological additions may stimulate 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



Soil C:N ratio high under forestry



Application of N and decomposition processes lower C:N ratio



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 forestry 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/cm ³)	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 available. Information from Roberts (pers. comm) and (Roberts and Morton 2016).

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

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