



LAND: SOIL HEALTH

Environmental Snapshot
January 2010

Key points

- Just over one-third of monitored soils under productive land uses meet all soil health target ranges. Of these productive soils, soils under horticultural land use are most likely to meet all target ranges.
- About half of the sites under dairy land use and nearly a third of drystock sites have compacted soils. About a quarter of the sites under dairy and drystock land uses have organic reserves above the target ranges, while fertility is below the target range for many drystock sites.
- **Getting better:** Slightly more sites under productive land uses are meeting target ranges for all soil health indicators now than in the past.
- Levels of compaction, organic reserves, and fertility are generally increasing in sites under dairy and drystock land uses. Increasing compaction and organic reserves may indicate deteriorating soil health, but, up to a point, increasing fertility may improve soil health.

Healthy soils support agricultural and forest productivity, help prevent contamination of waterways, and provide for resilient soil and land ecosystems.¹

Intensive land uses can put pressure on soil. Compacted soil may inhibit pasture growth, cause soils to become water logged and increase runoff.¹ Phosphorus fertilisers are the major source of cadmium (a heavy metal) to agricultural soils. Cadmium can build up in soil and cause problems for human health as well as market access and trade if it makes its way into food products.² In contrast, land managers can help improve or maintain soil health, for example through the prudent use of fertiliser, soil tillage and/or crop rotation, and at the same time increase productivity and economic value.

This environmental snapshot reports soil health from approximately 740 sites in 12 regions, sampled by regional councils between 1995 and 2009. Close to 300 of these sites were re-sampled to determine changes over time. The samples represent soils under indigenous land cover and under five productive land uses:

- drystock (ie, sheep and beef farming)
- dairy
- forestry
- cropping
- horticulture.

Seven soil measures were monitored to provide information about the organic reserves, fertility, acidity and physical status of our soils. Collectively, these measures can tell us about the health of our soils (table 1). These soil measures also allow changes in soil health due to land management to be detected.

+ TABLE 1

SOIL MEASURES USED TO DETERMINE SOIL HEALTH INDICATORS¹

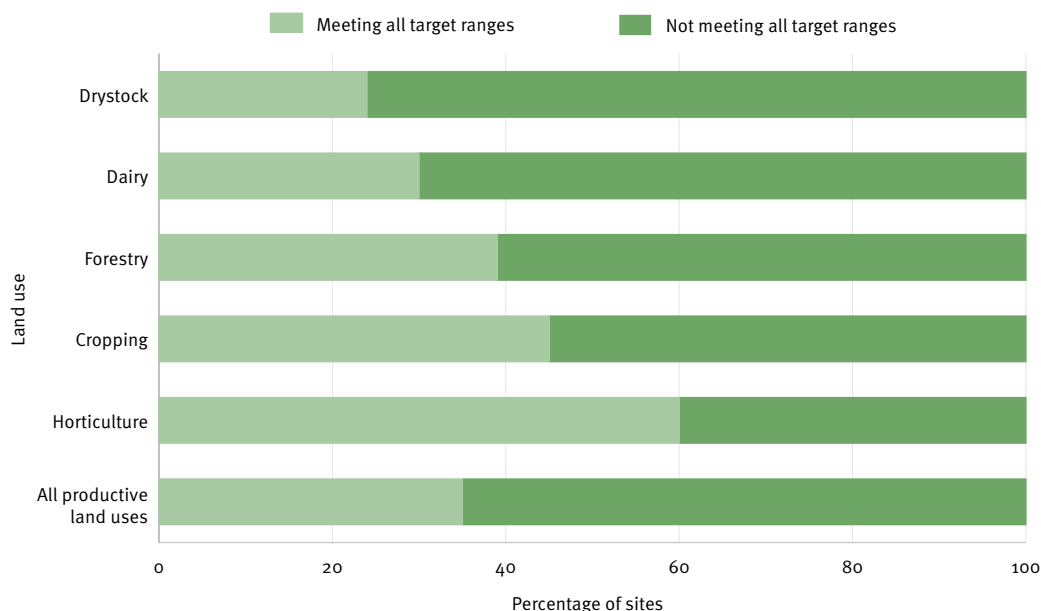
SOIL HEALTH INDICATORS	SOIL MEASURES	WHY IS THIS MEASURE IMPORTANT?
Organic reserves	Total carbon	Organic matter helps soil retain moisture and nutrients, and supports good soil structure
	Total nitrogen	Reserves of nitrogen are stored within organic matter in the soil
	Mineralisable nitrogen	Mineralisable nitrogen is a form of nitrogen that plants can use for growth and is an indication of soil organism activity and health
Fertility	Olsen phosphorus	Plants get phosphorus from phosphates in the soil, but many New Zealand soils have naturally low available levels
Acidity	pH	Soil pH controls the activity of nutrients and metals in soil. Most plants have an optimal pH range for growth
Physical status	Bulk density	Soils with high bulk density drain poorly and restrict plant root growth, while soils with low bulk density are vulnerable to erosion
	Macroporosity	Large pores allow air and water to penetrate into soil for root growth and soil biological activity, but these are easily compacted

Soils under productive land uses were assessed as either meeting, or not meeting target ranges for all of the seven soil measures. The target ranges are indicative of the optimal soil health needed for production under each land use. Note that the target ranges for cropping and horticulture land uses are not well defined because of the diversity of soil requirements for these land uses¹, but they represent the best available guidelines to illustrate soil health at present.

Soils under indigenous land cover tell us about soil health in the absence of human activity. Although target ranges were not applied to soils under indigenous land cover, the findings provide a valuable reference to unmodified natural conditions.

Figure 1 shows that about 35 per cent of sites under productive land use meet all soil health target ranges. Of these productive soils, soils under drystock and dairy land uses are least likely to meet all ranges, while 60 per cent of horticulture soils meet all ranges. The health of soils under drystock and dairy land uses are particularly important for an overall assessment of soil health, since grassland, likely to be used predominantly for grazing, covers half of New Zealand’s total land area.³

+ FIGURE 1
PERCENTAGE OF PRODUCTIVE LAND USE SITES MEETING AND NOT MEETING TARGET RANGES FOR SOIL HEALTH MEASURES, LATEST AVAILABLE YEAR⁴



Note: This figure represents the latest data for each site, determined from monitoring over a number of years.

These monitoring results differ from public perceptions surveyed in 2008. About 80 per cent of New Zealanders surveyed perceive soil health is adequate, good or very good and about 70 per cent perceive soil is adequately, well or very well managed.⁵ The main causes of damage to soil were perceived to be hazardous chemicals, solid waste and farming. More New Zealanders in 2008 perceived farming to be a cause of damage than in 2000.⁵ While soil monitoring results and the public’s perception of soil health may differ, the public are aware of the major causes of damage to soil health in New Zealand.

Key findings by land use

Figure 2 shows that soils on approximately half the dairy and a third of the drystock sites do not meet target ranges for physical status, predominantly because of compaction from livestock.⁴

Dairy and drystock soils are generally less acidic and have higher organic reserves, fertility and cadmium² than soils under indigenous land cover.⁴ This is indicative of intensive land use and the use of fertilisers and lime. Organic reserves (particularly nitrogen) and, in some cases, fertility are above target ranges on dairy sites and some intensively managed drystock sites. In contrast, other drystock sites are below fertility target ranges.⁴ Long-term grazing on those low fertility soils could lead to overgrazing, decreased pasture production, invasion by weeds, and soil compaction and erosion.⁴

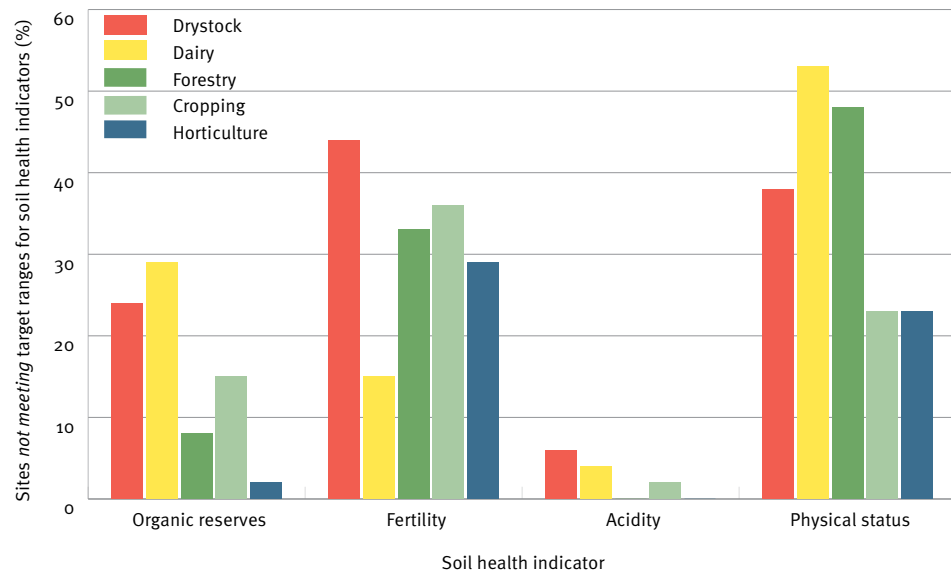
Monitoring sites under horticulture and cropping land uses generally have similar soil health, but a higher proportion of cropping sites do not meet target ranges for organic reserves and fertility (figure 2). Intensive cultivation can result in the loss of soil carbon. In addition, nitrogen and phosphorus fertilisers are generally used, sometimes to excess.⁴ These land uses may also place other pressures on soil health (eg, pesticide and chemical use), that are not measured by the soil health indicators discussed in this report.⁴

About 40 per cent of sites under plantation forestry meet all the target ranges (figure 1). Plantation forestry often occurs on erosion prone soils and its physical status is often below the target range (figure 2). Forestry can be a useful management option for reducing erosion, although harvesting and replanting must be carefully planned and executed to avoid soil erosion and nutrient loss.⁴ About a third of forestry

sites have low fertility (figure 2), although Olsen phosphorus (the measure used for fertility) is not as critical for tree growth as for other productive land uses discussed in this report.⁴

+ FIGURE 2

PERCENTAGE OF PRODUCTIVE LAND USE SITES *NOT MEETING* TARGET RANGES FOR SOIL HEALTH INDICATORS, BY PRODUCTIVE LAND USE, LATEST AVAILABLE YEAR⁴



Note: This figure represents the latest data for each site, determined from monitoring over a number of years.

Trend

Getting better

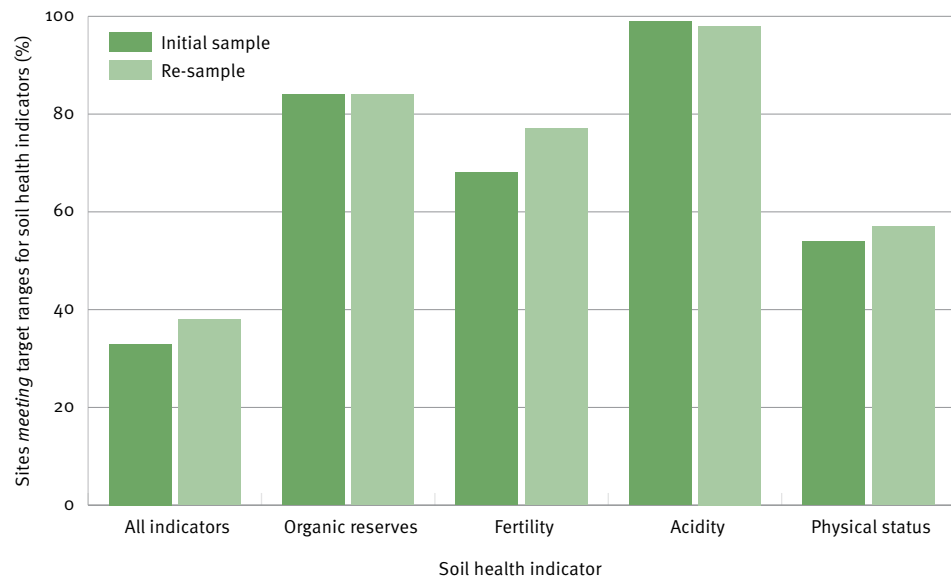
Overall, the soil health at monitored sites has improved slightly for all productive land uses.

Overall trend

Overall, the soil health at monitored sites has improved slightly for all productive land uses. Between 1995 and 2009, there was an increase in the number of re-sampled sites meeting target ranges for fertility and physical status (figure 3). Fertility improvements are likely to be due to decreasing fertility in those soils that had earlier levels above target ranges.⁴ These monitoring results match the public perception that soil health is now better than in the past.⁵

+ FIGURE 3

PERCENTAGE OF RE-SAMPLED PRODUCTIVE LAND USE SITES *MEETING* TARGET RANGES FOR SOIL HEALTH INDICATORS, BY SAMPLE PERIOD⁴



Note: This figure represents the initial and latest data for each re-sampled site, determined from monitoring over a number of years.

Trend by land use

While more sites are now meeting all target ranges, re-sampled soils under drystock and dairy land uses generally showed average annual increases in organic reserves and fertility (table 2). Increases in organic reserves, particularly nitrogen, may indicate deteriorating soil health when organic reserves are already above target ranges.⁴ However, increases in fertility, up to a point, can be interpreted as an improvement in soil health, particularly in soils below target ranges, as is the case for many drystock and some dairy sites.⁴ Physical status continues to deteriorate in soils under drystock land use due to livestock grazing.

+ TABLE 2
AVERAGE ANNUAL CHANGES IN SOIL MEASURES FOR RE-SAMPLED SITES⁴

LAND USE	ORGANIC RESERVES			FERTILITY	PHYSICAL STATUS
	TOTAL CARBON	TOTAL NITROGEN	MINERALISABLE NITROGEN	OLSEN PHOSPHORUS	MACROPOROSITY
Drystock	▲▲	▲▲		▲	▼
Dairy		▲▲	▲	▲▲	
Cropping			▲		

Notes:

(1) ▲ = Increasing, ▼ = Decreasing.

(2) The statistical strength of the trend is indicated by the number of arrows: ▲▲ = $P < 0.001$, ▲ = $P < 0.01$.

Re-sampling did not show statistically significant changes in soil health for sites under horticultural or forestry land uses.

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FOR MORE INFORMATION:

- about the state of New Zealand's environment see www.mfe.govt.nz/environmental-reporting
- about the Ministry for the Environment's reporting on New Zealand's soil health contact Brent King at brent.king@mfe.govt.nz
- about New Zealand's land see www.mfe.govt.nz/issues/land/



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