Improving Soil Health for Yield and Profit in Vegetables

Vegetable Disease Program IPM

Soil health management shows economic and environmental benefits

KEY MESSAGES

- To date, field trials have demonstrated that profit gains up to $6,000/ha can be obtained by the use of more environmentally-friendly fertilisers and organics.
- A computer-based tool ('C-Calc') has been developed to help estimate the amount of organic matter that is being returned to the soil from different rotations and amendments.
- A series of information leaflets on use of organic matter and soil health has been developed.
- Overall the use of organic amendments has beneficial impacts in reducing soil-borne diseases, but this effect may vary for different organic materials, soil types, crops and pathogens.
- Further research is needed to better understand and manipulate organic amendments for more consistent disease control.

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Researchers at the Victorian Department of Primary Industries are finding that a range of different soil health practices have both environmental and economic benefits to growers. By measuring biological, physical and chemical properties in soil they are identifying which methods improve soil quality, whilst providing good yields and maximum profit.

Measuring & Monitoring Soil Health

Good soil health is largely driven by the amount of carbon in the soil, which provides food for soil organisms (good and bad) and helps build the good soil structure required for root growth and water storage. Agricultural practices tend to reduce soil carbon levels, and the greater the intensity of cultivation, the greater the loss in soil carbon.

Figure 1 illustrates the decline in carbon levels measured at a grower's property following 0, 1, 3, and 7 years of vegetable production after pasture.

A range of tests can be used to estimate whether your soil has a soil health problem, and whether it is principally a soil physical, chemical or biological issue (Table 1). A benchmarking trial using these tests compared more than 50 sites in the temperate vegetable industry and showed that many growers were overusing fertilisers. Seventy percent of sites recorded high or excessive levels of phosphorus and 90% of sites recorded excessive levels of potassium.

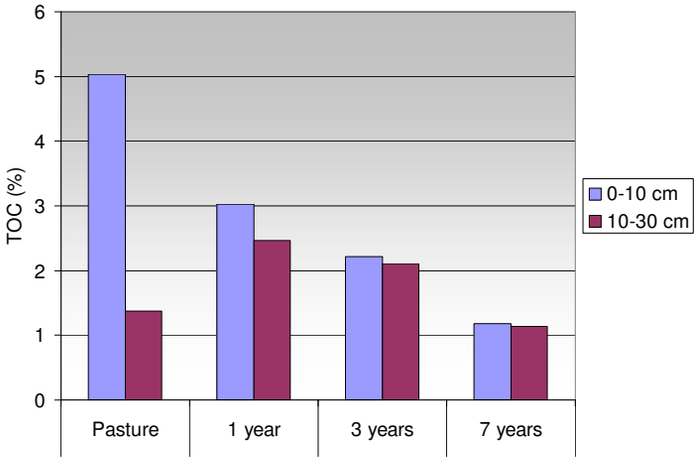


Figure 1. Reduction in total organic carbon (TOC) levels after increasing years of vegetable cropping (Sandy soil, Cranbourne, Vic.).

Table 1. Examples of some physical, chemical and biological tests of soil health.

Soil Physical Tests	
Penetrometer resistance	Identifies potential compaction issues that lead to poor root growth and water infiltration.
Water infiltration	Poor water infiltration can lead to poor root growth and poor water uptake by the plant.
Soil Chemical Tests	
Nutrient analyses	Ensure measured nutrients fall within an acceptable range for your crop as oversupply can leach nutrients into water ways.
Labile carbon	A good measure for carbon as it is the fraction of soil organic matter readily available as food for soil microbes. Particularly useful for monitoring management practices that build up soil organic matter.
Soil Biological Tests	
Biological activity (FDA hydrolysis and CO_2 respiration)	Measuring total soil microbial biomass can identify soils that contain high levels of microbes that can recycle nutrients from organic sources, 'glue' soil aggregates together, and may reduce some disease problems by out-competing soil-borne pathogens.
Nematode community structure	Provides an indication of the impact of management on soil microbial diversity and disturbance within soil systems.

Economic Benefits of Soil Health

In a 3-year field trial a wide range of soil amendments with different soil health impacts were tested. Encouragingly, most of them resulted in a positive financial return for growers. Particularly, slow release ammonium fertilisers such as Alzon® increased broccoli yields by 15% above standard grower practice, translating to increased profits of up to $6,000/ha, depending on the year and season (Figure 2). Organic amendments also had positive effects, but due to the slower breakdown of these products, positive profits occur more slowly.

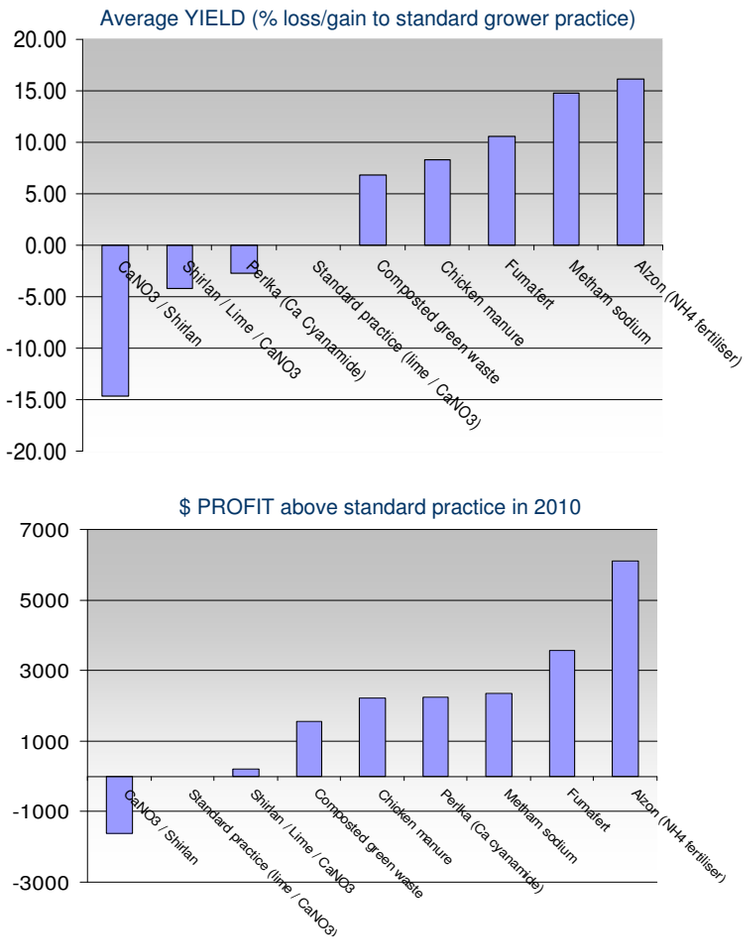


Figure 2. Average % yield of broccoli over 3 seasons from 2008-2010.and $ profit in 2010 gained or lost compared with the standard grower practice from different treatments in a sandy loam in Boneo, Victoria.

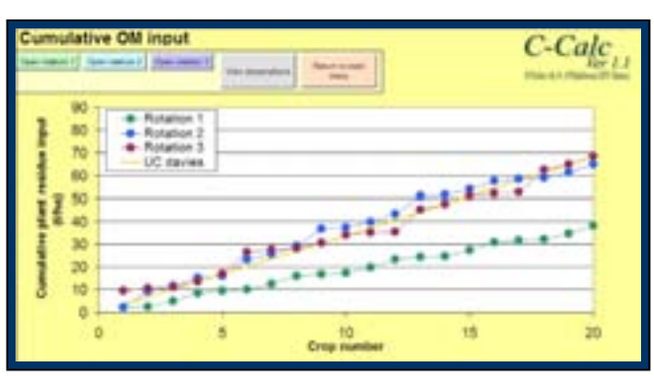
Effect of Soil Carbon on Disease

The interaction of organic amendments with soil-borne diseases is multifaceted. Organic matter can decrease soil-borne pathogens, either by chemical processes (e.g. production of toxins) or by biological processes (e.g. through changes in soil microflora that make soils more disease suppressive). At the same time organic matter, particularly undecomposed residues, can increase disease by acting as a food source for certain pathogens. For example, amending field soils with silage reduced the severity of clubroot of broccoli in trials, but amendments with chicken manure, compost and lignite increased it. In pot trials, amending infested soils with lignite, compost and humate tended to decrease damping off of radish (caused by *Rhizoctonia solani*), but biochar increased it. These differences in control were related to the C:N ratio of the organics, the breakdown rate and products of the material, and the effect of the amendment on soil pH. More research is needed to better understand and manipulate organic amendments for consistent disease control. This may include the use of different forms of organic matter, integrated with nutrient inputs or more strategic fumigant and fungicide use.

‘C-Calc’ -

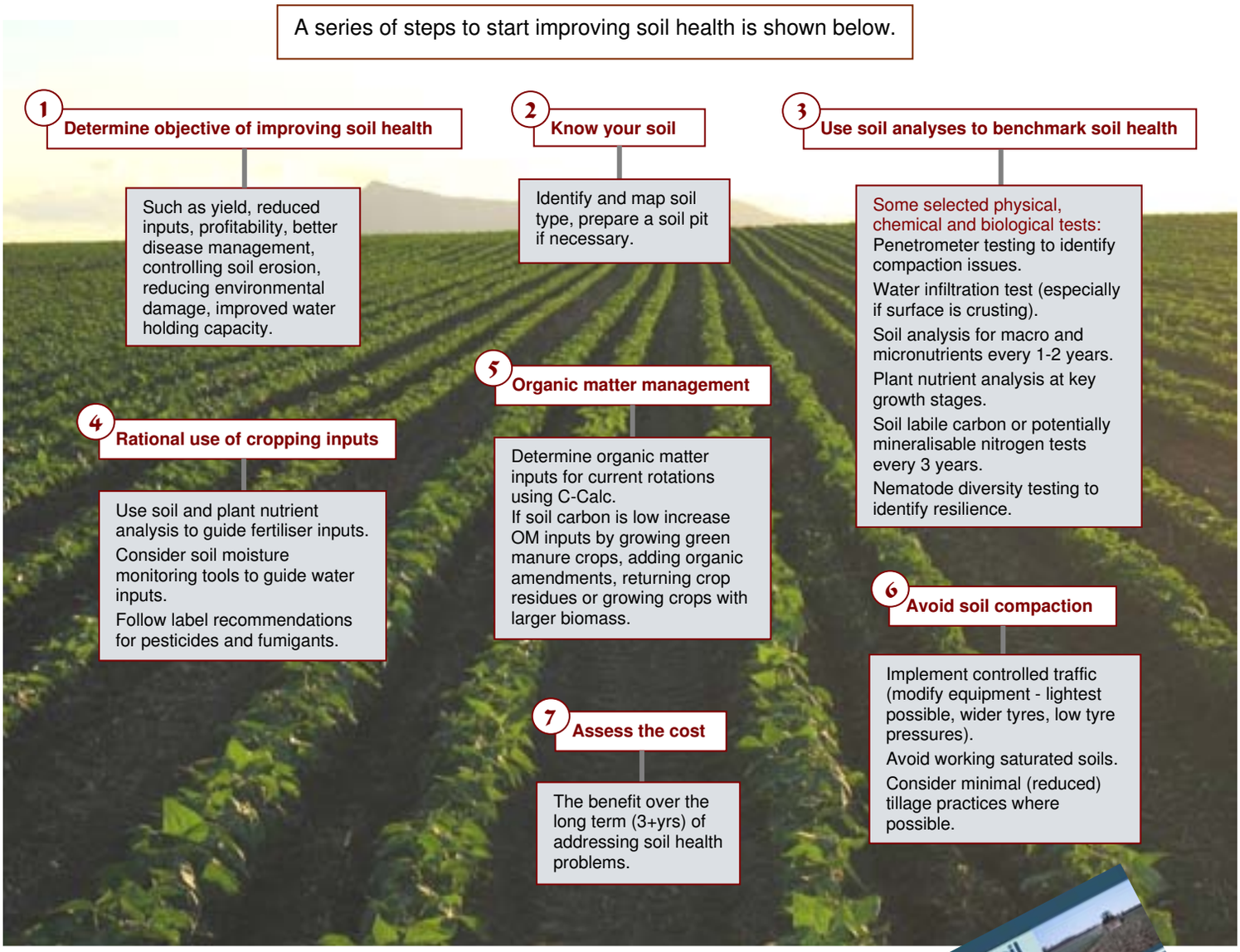
A Tool to assist Calculation of Organic Matter added to Soil

The amount of organic matter (OM) being returned to the soil is an important factor which influences soil carbon levels and soil health. DPI has developed a computer tool called ‘C-Calc’ that estimates the carbon contribution added to soil from rotations or organic amendments. C-Calc allows growers to compare different practices without actually growing a crop, helping to choose more effective crop rotations and practices.



Soil Health Management Guide

A series of steps to start improving soil health is shown below.



1 Determine objective of improving soil health

Such as yield, reduced inputs, profitability, better disease management, controlling soil erosion, reducing environmental damage, improved water holding capacity.

2 Know your soil

Identify and map soil type, prepare a soil pit if necessary.

3 Use soil analyses to benchmark soil health

Some selected physical, chemical and biological tests:
Penetrometer testing to identify compaction issues.
Water infiltration test (especially if surface is crusting).
Soil analysis for macro and micronutrients every 1-2 years.
Plant nutrient analysis at key growth stages.
Soil labile carbon or potentially mineralisable nitrogen tests every 3 years.
Nematode diversity testing to identify resilience.

4 Rational use of cropping inputs

Use soil and plant nutrient analysis to guide fertiliser inputs.
Consider soil moisture monitoring tools to guide water inputs.
Follow label recommendations for pesticides and fumigants.

5 Organic matter management

Determine organic matter inputs for current rotations using C-Calc.
If soil carbon is low increase OM inputs by growing green manure crops, adding organic amendments, returning crop residues or growing crops with larger biomass.

6 Avoid soil compaction

Implement controlled traffic (modify equipment - lightest possible, wider tyres, low tyre pressures).
Avoid working saturated soils.
Consider minimal (reduced) tillage practices where possible.

7 Assess the cost

The benefit over the long term (3+yrs) of addressing soil health problems.

Further Information

General information on soil health is available from:

- DPI Vic: www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/soil-home
- Soil Health Ute Guide http://www.ausveg.com.au/healthy-soils.cfm
- Soil Quality: www.soilquality.org.au/
- Soil Health Knowledge Bank: www.soilhealthknowledge.com.au

A series of "Soil Organic Matter Info-Leaflets" have been developed by DPI Victoria to bridge the gap between general information and the scientific literature. They are available by contacting peter.fisher@dpi.vic.gov.au or nick.ohalloran@dpi.vic.gov.au

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