Enhancing carbon flow to soils

Christine Jones, PhD
Founder, Amazing Carbon
www.amazingcarbon.com

Soil carbon is internationally recognised as the key driver for soil health and productivity. The multiple benefits of increasing soil carbon include improvements in soil structure, water-holding capacity, nutrient availability, plant resistance to insects and disease, reduced weed burdens and enhanced plant, animal and human nutrition.

An investigation of nutritional pathways in soil indicates that very few nutrient deficiencies are absolute. Most are functional. The atmosphere is around 78% nitrogen, hence a lack of N in soil simply means that something is inhibiting the N-fixers. Similarly, most soils have sufficient total P (not necessarily available) hence a lack of P means something is inhibiting the P-solubilisers .... and so on.

The 'inhibition' can be due to over-use of agro-chemicals, lack of microbial food, or more rarely, lack of the microbes themselves. Fortunately, but not surprisingly, the solution to most nutrient deficiencies lies in

i) Reducing the use of high analysis N and/or P fertilisers such as urea, anhydrous ammonia, MAP, DAP and superphosphate - these products inhibit mycorrhizal fungi, which are 'keystone' species for soil function.
ii) Reducing the use of agro-chemicals. Herbicides such as glyphosate for example, inhibit microbial activity and restrict nutrient uptake by plants.
iii) Enhancing carbon flow to soil by implementing regenerative land management techniques such as time controlled grazing and pasture cropping and replacing high analysis water soluble fertilisers with biology-friendly fertilisers.

The photosynthetic rate of plants (ie carbon fixation) can be increased by the application of a range of products such as compost tea, compost extract, worm leachate, fish emulsion and/or seaweed extract. Increased photosynthetic rate results in increased glucose production and a greater flow of liquid carbon to soils. The dissolved organic carbon (DOC) exuded by plant roots provides the 'fuel' that enables microbes to access vitamins and minerals. This carbon flow to soil will not occur if too much water-soluble N or P has been used, as these chemicals inhibit the microbial bridge.

Soil test data show that as soil carbon levels increase in microbially active soils, availabilities of P, K, S, Ca, Zn, Se and Bo commonly increase. If plants are mycorrhizal, they don't require nitrogen in a mineralised form, that is, in the form of nitrate or ammonium. In order to transport mineralised nitrogen, mycorrhizal fungi have to convert it to glutamate, which represents an energy cost. For this reason nitrogen is preferentially transported in an organic form, generally as amino acids such as glycine and glutamine.

Utilisation of organic nitrogen by mycorrhizal fungi closes the nitrogen loop and prevents acidification, as well as preventing volatilisation of nitrogen to the atmosphere and leaching to aquifers, rivers and streams. Changes to soil chemistry and nitrogen dynamics in microbially balanced soils also reduce the abundance of 'weedy' species such as annual ryegrass, capeweed, mustard weed and thistles. The germination of these species is stimulated by the ready availability of nitrate nitrogen.

The Visual Soil Assessment or VSA Method: Seminar with Nicole Masters, Integrity Soils

The maintenance of good soil quality is vital for the environmental and economic sustainability of farming. A decline in soil quality has a marked impact on plant growth and yield, crop quality, animal health, production costs, water/nutrient holding capacities and the increased risk of soil erosion. A decline in soil physical properties in particular takes considerable time and cost to correct. Safeguarding soil resources for future generations and minimizing ecological footprints are important tasks for successful long term land management.

Often, not enough attention is given to:

the basic role of soil quality in efficient and sustained production;
the effect of the condition of the soil on the gross profit margin;
the long-term planning needed to sustain good soil quality;
the effect of land management decisions on soil quality.

Visual Soil Assessment is based on the visual assessment of key soil 'state' and plant performance indicators of soil quality, presented on a scorecard. With the exception of soil texture, the soil indicators are dynamic indicators, i.e. capable of changing under different management regimes and land-use pressures. Being sensitive to change, they are useful early warning indicators of changes in soil condition and as such provide an effective monitoring tool.

The VSA looks at the following characteristics for pasture:

Soil indicators	Plant indicators
Soil texture	Clover nodules
Soil structure	Weeds
Soil Porosity	Pasture growth
Number and colour of soil mottles	Pasture colour and urine patches
Soil Colour	Pasture utilisation
Earthworms	Root length and density
Soil smell	Area of bare ground
Potential rooting depth	Drought stress
Surface ponding	Production costs to maintain stock
Surface relief	

Site selection is important; avoid highly disturbed areas, i.e gateways, near troughs, under shelter trees.

VSA booklets, written by Graham Shepherd are available online from Landcare Research: *www.**landcareresearch**.co.nz/**research**/soil/**vsa**/fieldguide.asp* or can be ordered from Horizons or HB regional councils. Contact G.Shepherd@nutrilink.net.nz for more information.