Valuable lessons from rangeland research

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Hotter and drier soils contain less carbon and nitrogen and have lower fertility than cooler soils with more moisture.

They also have higher levels of plant-available phosphorus.

These are the key findings from a recently-completed world-wide examination of the impacts of soil temperature and moisture on soil nutrients.

The study team of 54 scientists, who analysed soil samples from 224 sites in 16 countries in South America, China, Africa, the US, Europe and Australia, included Dr Matthew Tighe, a soil scientist who lectures in ecosystem modelling at the University of New England.

An article reporting the findings of the research, undertaken to provide insights to the likely impact of climate change on soil fertility and productivity was published in the October 2013 edition of the Journal 'Nature'.

While the study used samples from rangeland, not cropping soils, Dr Tighe has little doubt the principles identified by the scientists apply in cropping country as well as rangeland.

He also has little doubt that maintaining vegetative cover on the soil will become increasingly important as a means of keeping soils cool and recharging reserves of soil carbon.

MATTHEW TIGHE

MATTHEW TIGHE'S RESEARCH 'TOOLS OF TRADE' INCLUDE THIS RAINFALL SIMULATOR.

The researchers found that drying and heating like that expected in many regions as a result of climate change break the linkages between soil carbon, nitrogen and phosphorus and can be expected to lead to severe nutrient depletion in arid areas.

Ironically, productivity is higher with some bare areas to shed water than if there is a full cover of vegetation.

And, they found, this 'decoupling' of the biological cycles and reduction of nitrogen can accelerate suddenly as soil conditions become hotter and drier.

These trends, which were consistent across all the environments from which soil samples for the study were taken, mean dryland ecosystems will be able to store increasingly less carbon above and below ground, Dr Tighe said.

This will reduce the potential to use them farmland and natural landscapes to sequester carbon to counter or buffer the effect of greenhouse gas emissions and their ability to support crop and livestock production.

"Reduction in nitrogen availability as a result of these changes will limit plant growth and so the capacity of rangelands and other plant communities to buffer human-induced increases in atmospheric CO_2 concentrations," he said.

Dr Tighe, who also works in the field of crop nutrition, with a particular interest in phosphorus nutrition, said the changes identified in the study suggest nitrogen availability will replace phosphorus availability as the limiting factor, after water availability, in many soils as conditions become more arid.

"Nitrogen and carbon cycling falls as soils lose moisture because those cycles are driven largely by soil biology, which slows or shuts down as soils dry. That, combined with the loss of soil organic matter, which contains the biologically available pools of carbon and nitrogen in the soil, means nitrogen levels will fall.

"Phosphorus availability, on the other hand, increases in hotter, drier soils because phosphorus cycling is driven more by geo-chemical mechanisms that

FOOD FOR THOUGHT ON PHOSPHORUS

Crops may be making more use of phosphorus reserves in cropping soils than previously thought, according to UNE soil scientist Matthew Tighe.

"We are exploring why growers get such a low return from the phosphorus fertiliser they are applying.

"We are only about mid-way through the project, but at this stage it seems that the crops are drawing on soil reserves previously thought to be inaccessible to them.

"The challenge now is to work out exactly what is occurring and how, and whether it might be possible to select varieties of wheat and other crops with enhanced ability to access phosphorus from the soil reserves."

are accelerated by higher soil temperatures, whether or not the soil is moist."

In fact, he suggests, 'good' soil conditions, with adequate moisture and moderate temperatures, can reduce phosphorus availability for plants because high levels of biological activity in the soil can reduce the level of plant-available inorganic phosphorus by complexing it into organic compounds that are unavailable to plants.

In hotter and drier soils the level of biological 'tie up' of phosphorus is

The principles identified by the scientists apply in cropping country as well as rangeland.

reduced while the release of inorganic phosphorus increases, resulting in a real increase in the amount of plant-available phosphorus in hotter, drier soils, he said.

In addition to his cropping work Dr Tighe is also involved in research in rangeland grazing country in western NSW, where temperature and rainfall conditions are similar to those in many parts of northern and eastern SA, including cropping areas in those regions.

His rangeland work has included projects exploring the role and impacts of ground cover, which in the rangeland environment is closely linked with soil moisture, a factor that could be a pointer for growers looking to establish summer cover crops.

Some of the moisture management and groundcover he has been involved in has similarities with the Yeomans Keyline system detailed in Ken Yeomans' book 'Water for Every Farm'.

In a comparison of western NSW flood-plain properties on which 'water spreading' had been used for periods ranging from two years to 40 years, he found big differences in soil biology and rapid changes after rainfall events large enough for the 'water spreading system' to take effect.

This system uses contour banks to retard water that, once it reaches a pre-determined level, is able to flow through a low point in the bank into a shallow channel running immediately below and parallel with it. This distributes the water evenly along the length of the bank until the channel overflows and the water flows evenly across the landscape until it is held up by the next bank, where the process is repeated.

While sufficient rain to enable such thorough wetting is infrequent in the arid flood-plain environment, the effects of this periodic wetting are significant in the long and short term, with significant changes in the communities of soil organisms and the level of activity of those biological communities, he said.

From a production perspective, landholders are able to capitalise on the improved soil conditions resulting from the 'water spreading' with opportunistic cropping and more intensive, managed grazing systems.

In the pastoral country the issue of ground cover feeds into 'patching' – the balance between bare areas – which shed water – and areas covered by vegetation.

Ironically, productivity is higher with some bare areas to shed water than if there is a full cover of vegetation, he said.

However, if the bare patches become too big, productivity – vegetation for grazing – falls and surface erosion becomes an issue. If this occurs rangeland managers move in with a light cultivation to break up some of the surface crust – usually around the perimeter of a large patch – to provide a seed bed for natural regeneration and to improve water infiltration which aids plant establishment on the previously bare area.

CONDUCTING A PH TEST IN THE FIELD.