Regenerative agriculture – the need for site-specific guidance

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Before we start, I need to make an admission – I wasn't familiar with the term 'regenerative agriculture' until very recently. But I've certainly been familiar with the general concept of 'healthier soil' for a long time. Call it 'land management for improved ecosystem services', or whatever you like. The concept is the same. Here I'm writing about the idea in relation to Scotland, but I'll do my best to make it relevant to Australia, and everywhere else in between.

My own understanding of Regenerative Agriculture is that it involves the improvement of one or more soil functions/ecosystem services through the application of one or more management practices. None of these practices are exotic or particularly surprising – most are fairly common sense and require little explanation for how or why they work. As an academic firmly embedded in my ivory tower, it would be *very* naughty of me to encourage you to have a look at the Wikipedia page on the subject, or for me to endorse what is written there….

So why do you need the likes of me, or my knowledge? I'm a soil scientist, working at the James Hutton Institute in Scotland for the last ten years (the Institute formed from two other organisations in 2012, but that's ancient history). And what really, really gets me excited is how important soil is and how much it changes from place to place. We're very lucky in Scotland to have a huge amount of variation in our soils, reflecting the wide variety of climatic conditions, geology, topography and historical land use. Any map of our soils is guaranteed to be a migraine-inducing riot of colour.

This concept of variation is important. Soils are not all the same, and they won't all respond the same way to how you manage them. It is important to look at the same management options on different soils under different conditions, and to look at individual soils with multiple management options. Only then can we get enough information to know which options might work at any one place. This, basically, is what a lot of soil scientists do.

Enter Dr Chrissie Valluri at Scottish Natural Heritage (SNH), who is one of these people. She is working to identify small under-performing areas of landscape in Scotland where small changes in land use would deliver substantial benefits. This will accomplish two things: firstly, these underperforming areas will demonstrate the most rapid transformations, and can be used to demonstrate the effectiveness of the approaches used; secondly, measuring the success rate in these areas will allow management options to be identified and applied to larger areas of the country.

The first step in Chrissie's project is identifying a list of possible management options, through engagement with a range of experts. Next is mapping where these could be carried out and working out the costs and benefits of each. This will allow the 'best' candidate

options to be identified. Finally, stakeholder workshops will allow her to put some local detail onto specific sites, looking into practicalities and places to carry out trials.

This approach of identifying 'possible' options and then fine-tuning them to the 'practical' ones is very clever and extremely important. It also points to a possible way of developing a menu of options for land managers anywhere in the world to improve the health of their soils through regenerative agriculture. But at the same time, it raises another question that often gets ignored – what exactly *is* soil health? It turns out that there's no single answer to this, because it depends on what you want from your soil.

For example, change one soil property (let's say pH) and you'll change some of that soil's natural processes. If you make it more acidic, then some of the nutrients will become more soluble and will get flushed out of the soil more easily when it rains. Also, the microbial activity will be reduced once you get to low pH values, meaning that organic matter won't break down as rapidly. So, your soil will start to accumulate more organic matter – meaning that if you want to store carbon, then your soil is healthier. But if you want to have high nutrient concentrations during the growing season, it might now be considered less healthy.

So, can the 'correct' management option be identified? In classic scientist fashion, my answer would be a question: *maybe, but what's 'correct'?* The answer to this might seem obvious, but let me ask further: *can you define what you want from your soil?* And by that, I mean **really** define it – you don't get any marks for saying 'better soil health'. Do you want improved yields? Reduced erosion? Better moisture storage? Reduced inputs? Or maybe a combination of all of these?

A lot of my recent research has focussed on how changes to soil properties can lead to changes in soil functionality. I've been trying to find a simple way to predict the effects of different land management activities on the multiple functions soil performs. This has led to an interesting idea: what if instead of wanting to know what the effects of your management actions are, you wanted to achieve a specific functionality in your soil? What if you wanted to increase soil carbon storage, or improve the water holding capacity?

Turns out, it is possible to identify which management options are best for achieving a desired outcome. In fact, for specific soil properties and functionality, management options can be given a score for how closely they will achieve the outcome you're looking for. Some of this is complicated by the fact that soil functions tend to be 'bundled' together. There's a mountain of evidence that increasing your soil organic matter will improve water holding capacity and cut down on erosion, for example. So, if you take action to change one soil function, some others are going to change. This means that sometimes, combinations of activities are needed to produce a specific 'soil health' outcome.

One massive issue here is how long these changes take. So far, I've been focussing on the endpoints and pretending that the transition is unimportant. But a major factor in all this is that some functionality will change fast, and some will change slowly. Farmers might find that it takes a long time to see the positive effects of a change (e.g. productivity increase,

less fertiliser needed, erosion reduction) but that the negative effects happen more rapidly (e.g. short-term yield loss).

To let landowners and farmers make changes that might not be immediately profitable but that will benefit them and everyone else, a government subsidy/payment system is needed to provide a level playing field. To use a phrase that's been around for a few years, farmers can't be green if they're in the red. Too many unprofitable years and the land gets sold, with the risk being that whoever buys it has more money for one simple reason – they've been putting short-term profit first.

There's an Agriculture Bill going through the first stages of becoming law in the UK Parliament right now, and it's a massive change from the current system of how farmer subsidies are paid. Firstly, there's a strong focus on payments for environmental benefits (yay!) and secondly, there's a deliberate and stated intent to improve soil health (double yay!).

This Bill will take a long time (possibly years) to go through the system before it becomes law. And it signals a significant loss of subsidy income for some farmers, particularly the ones with the largest or most intensive (i.e. profitable) farming practices. There's a big risk of it coming under fire from the landed gentry, who still hold a lot of power in the UK's undeniable and ever-present class system. But if it survives relatively unscathed, this new law could drive a massive shift towards regenerative agriculture in the UK. Well, in England at least – agriculture policy is largely devolved in Scotland and Wales. It's complicated 😊.

If a farmer makes changes to how they manage their soil, that's an important step. But it's also important that they can demonstrate the impacts of those changes. In the future, farming subsidies might depend on consequences as well as actions. Sampling and chemical analysis are expensive and time-consuming but until now have been the only option. I'm also working on methods of estimating soil properties using a smartphone. This involves taking a photograph of the soil to get colour and textural information. Combined with information about topography, climate and geology, this can provide a lot of information on soil properties.

We're approaching a lot of really important changes in how farming works: payment systems that promote regenerative agriculture; models that allow farmers to identify best practices for a desired outcome; and rapid, low-cost methods of verifying that these outcomes take place. Taken together, these changes could revolutionise farming and soil health, and transform agriculture's environmental impact.