Future Directions international

INDEPENDENT STRATEGIC ANALYSIS OF AUSTRALIA'S GLOBAL INTERESTS

Associate Paper

11 October 2018

Conservation and Regenerative versus Intensive Agriculture

Dr Robin Batterham AO, FREng, FAA, FTSE

Key Points

- The benefits of conservation and regenerative agriculture are well-documented in the scholarly literature.
- Those benefits include improved yields, superior water retention, cooler soils in summer, greater resilience, a reduction in runoff and erosion, and a reduction in the use of fertilisers and other farm chemicals.
- An objective, science-based approach to conservation and regenerative farming trials is necessary to fully understand the discrepancies between the scientific literature and the experience of farmers. Greater publicity of the results of these studies will also help increase awareness of conservation and regenerative agriculture.
- Australia does not have enough data to make a considered call on the carbon sequestration potential of regenerative agriculture. A campaign that focuses on measuring SOC changes for different farming practices would be beneficial.
- Satellite observations, in conjunction with other readily available farm data and ground proofing, will assist in the gathering of more information on SOC which, in turn, will enable more targeted improvements in agricultural productivity, profitability and sustainability.

Summary

In the conclusion of the two-part series on soil organic carbon (SOC), Dr Robin Batterham outlines the benefits of conservation and regenerative agriculture and calls for greater scientific analysis of these agricultural practices. He suggests that advancements in satellite observation systems could be used in conjunction with ground proofing to that end.

Analysis

There are numerous books and articles in the popular press on the advantages of both conservation and regenerative agriculture, e.g. the readable and well-referenced study by David R. Montgomery. In the scholarly literature, the case for conservation agriculture is compelling for rain fed agriculture. Yields are higher and are sustained over long periods, both in Australia and globally[1 2]. It is seen that the yield improvement is of the order of 0.5 to 5 tonnes of grain/hectare. There are also well-documented studies covering the superior water retention, cooler soils in summer, greater resilience, reduction in run-off and erosion and, of course, reduction in the use of fertilisers and farm chemicals. In dry climates 50 per cent of the rain that falls on crops evaporates, which is a powerful argument for the adoption of conservation agriculture. It is not surprising that in Australia, 90 per cent of rain-fed cropland is under conservation agriculture.

The obvious question is: why are not all farmers compelled to switch? The answers are numerous and mostly behavioural, such as ignorance and adherence to the status quo. As well, the benefits are local area, weather and crop(s) specific. Furthermore, the productivity models used by many advisers are based on intensive agriculture and do not cover the multifaceted nature of alternative practices or the nitrogen requirements being largely supplied from cover crops and not from artificial fertilisers. A piecemeal approach that only covers one aspect of the system at a time can underestimate benefits.

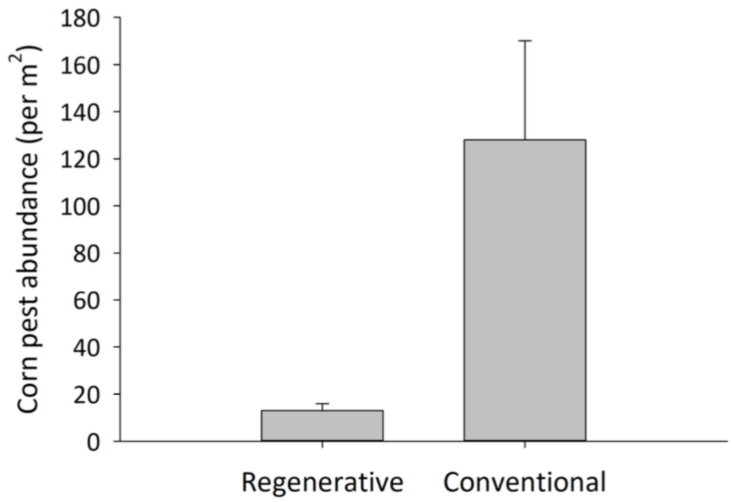
Trials are required to tailor conservation agriculture practices to local conditions before a widespread switch occurs. This takes time and the vagaries of weather can confuse results.

The case for regenerative agriculture is also compelling but more controversial, as noted in the first part of this paper. One of the most recent and comprehensive studies, conducted by LaCanne and Lundgren, examines corn production in the Northern Plains of the United States under regenerative agricultural practices. Regenerative versus intensive agriculture delivers 29 per cent less corn but 78 per cent more profit over sustained periods of time. The conclusions are telling: ‘By promoting soil biology and organic matter and biodiversity on their farms, regenerative farmers required fewer costly inputs like insecticides and fertilisers, and managed their pest populations more effectively.’ SOC ‘was a more important driver of proximate farm profitability.’

LaCanne and Lundgren’s study is also indicative of the drastic difference between regenerative and conventional farming techniques in the control of insects. This is one of many examples that could be given:

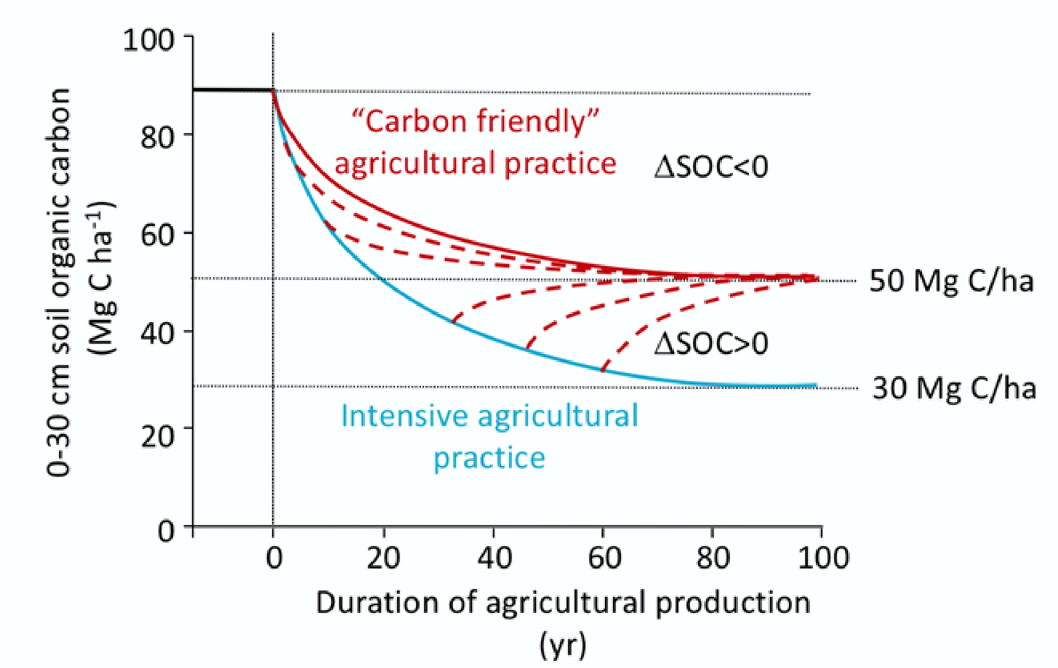
[1] 2012 W. K. Anderson, K. C. Flower and K. H. M. Siddique. “Yield and soil improvement in rain fed crop production”. Indian J Agronomy 57(3), 209-216

[2] 2016 W. K. Anderson, C. Johansen and K. H. M. Siddique. “Addressing the yield gap in rain fed crops: a review”. Agronomy for Sustainable Development 36(18)



Their results suggest that regenerative agriculture can control pest abundance more effectively than intensive agriculture in corn production.

There is a difference of opinion in Australia on the impact of regenerative agriculture on SOC. For some time, conventional approaches consider that turning native vegetation over to agriculture must reduce SOC and that the only difference between regenerative and intensive agriculture is the rate at which SOC decreases.



Schematic impact of temporal starting position on SOC[3]. *Note the decline in all cases.*

The controversy here is that several farms implementing a particular version of regenerative farming, and covering a range of soil types and crop practices showed[3] temporal gains larger than what had been reported in the scientific literature. The next step was to check the measurement and analysis methods used by the regenerative farmers against those used by CSIRO. There were no significant

[3] 2012 J. Baldock and M. Farrell. "Soil organic carbon status for 10 paddocks implementing the LawrieCo Biological Farming System. CSIRO presentation 4 October

discrepancies. Finally, the regenerative results were compared against other results from intensive agriculture in nearby farms. The regenerative results were within the statistical spread of the Soil Carbon Research Program (SCaRP) data. This is a misleading result, however, as it does not consider temporal trends and, as noted in the previous part of this paper, the whole statistical basis of the SCaRP data can be questioned. Additionally, one might comment that the reason certain farmers turned to regenerative practices was because their farms were so depleted that intensive agriculture was no longer profitable.

We need to adopt a science-based approach, recognising the complexity of the multiple interdependent systems at work, and let the data tell us the answers. Given the costs of sampling and analysis, this is not normal practice for most, and in any case, much of the data gathering has been to promote a particular outcome or self-interest (e.g. use of certain types of machinery, herbicides or synthetic inputs).

In summary, establishing the link of SOC with profitability, productivity and sustainability requires further evidence, at least in the public domain where most Australian farmers get their information. Until costs of sampling SOC come down, and agronomists use better models that fully cover all aspects of regenerative and conservation agriculture (and not just the no-till aspect), it is not self-evident that intensive agriculture will be abandoned. Interest is growing, however, through groups such as Soils for Life, Regenerative Australian Farmers and VicNoTill.

Sequestering carbon from the atmosphere

Since the 2015 United Nations Climate Change Conference in Paris, there is widespread agreement that emissions reduction and adaptation is simply not going to be enough to avoid the most severe effects of climate change. Indeed there are cogent warnings from leading scientists that we are heading towards conditions close to those that occurred in the 56 million year-old Paleocene-Eocene boundary thermal maximum and mass extinction event associated with methane-release. Those scientists call for a state of emergency to bring forward a path for negative emissions on a massive scale, specifically 4-5 gigatonnes of carbon per year (Gt C/y) or around one-third of current anthropogenic emissions.

The topic then becomes one of negative emissions and again the popular press comes to our rescue with suggestions that sequestration in soils is an obvious answer. The scholarly literature also has some large claims. The counter argument is that the capacity of terrestrial ecosystems to store carbon is finite and that the current sequestration potential primarily reflects depletion due to past land use and land use changes. This is also essentially the view behind the Sanderman work and simply overlooks that land can be used in other ways than what originally evolved. This is especially so when one considers regenerative agriculture as a total system; and estimates based on adopting only certain aspects of regenerative farming are likely to understate the potential for soils to sequester carbon.

It must be noted, however, that increasing SOC for the sake of sequestration is not a universal formula that applies to all regions, soil and crop types. Specific long-term studies targeting sequestration over whole regions show variable results, sometimes very significant and sometimes not. There are now several international efforts that are re-looking at the potential for sequestration. The combined US academies are running a series of seminars and research focus groups to better define the answers.

These studies face the head winds of reviews that argue the current "Soil carbon 4 per Mille" program, advocated at the 2015 climate conference, is misguided. Such critiques fall into some traps, e.g. pedantry, over the language of the campaign and, more importantly, not being able to explain the limited data referred to in the previous paper where sound measurement techniques are showing increases well above some of the regionally sampled studies that are the subject of much of the peer reviewed literature. As Jean-Francois Soussana of INRA Paris has pointed out, saturation must inevitably occur but the 4 per 1000 SOC target has actually been exceeded by periods of up to 50 years in many long-term studies. Soussana suggests that 1.4 Gt C/y could be sequestered in croplands, a figure similar to other estimates in the literature. Others have pointed out that even in sub-Saharan Africa, the 4 per 1000 SOC target can be exceeded on a long-term basis. Strangely, the ability of regenerative farming techniques to grow new high carbon soil stocks seems to be universally ignored.

On a global scale, a working group of the Science Advisory Council of the US Department of Energy (DoE) has come to the conclusion that harnessing the natural biological cycle is one of several approaches capable of reducing carbon emissions by several gigatonnes per year. The cost curve for carbon removal recently published by the University of Michigan notes in the literature a range from 0.1 to 1.6 Gt C/y, fully in line with the DoE estimates. Interestingly, the cost curve gives soil sequestration as the lowest cost option available. As Walter Jehne has pointed out[4], while regenerating cropping soils could give a global benefit of 4 gt C/y, the total available through changed practices is closer to 30 gt C/y.

Turning to Australia, the jury is out on the potential for carbon sequestration by targeting regenerative agriculture. We simply do not have enough data to make a considered call. This lack of data suggests that a campaign that focuses on measuring SOC changes (if any) for different farming practices would be beneficial. As with proving the benefits of regenerative agriculture and tailoring methods to specific locations, we need a cheaper way of obtaining statistically significant SOC measurements. This would then facilitate a more diverse approach to the Emissions Reduction Fund where presently eligibility requires an "approved" methodology which is developed by the Australian Department of Environment via technical working groups and then enforced by the Clean Energy Regulator under the Carbon Farming Initiative legislation.

The way forward and recommendation

Karunaratne et al have recently addressed achieving more effective monitoring of SOC. They note the two main points of this paper: that small changes in SOC can significantly alter atmospheric concentrations of CO_2, and that declining SOC negatively affects agricultural profitability and productivity. They go on to note, as is well accepted, that there are 'two common approaches to quantify the variation in SOC in space and time: statistical approaches and process-based modelling approaches' (i.e. whole paddock approaches). The first approach is time consuming and expensive if data is to be statistically reliable. The second approach is more promising in that process-based models can be used, in conjunction with satellite observations plus ground proofing of a more limited set of actual soil samples.

The satellite-based observations could be a game changer because of the high volume of data that can be captured very quickly, cheaply and comprehensively, supporting subsequent high value

[4] 2018 W. Jehne. "Regenerate Earth. The practical drawdown of 20 billion tonnes of carbon back into soils annually, to rehydrate bio-systems and safely cool climates". Healthy Soils Australia

analysis. It could also be coupled with other readily available farm data, such as management practices. Baseline data is needed for a wide variety of parameters and across statistically representative landscapes so that the artificial intelligence (AI) and machine learning software can be effective. Key elements in the proposed satellite work include willing farmers, preferably existing time-series data, baseline data (such as the SCaRP from CSIRO in 2011/12), a sufficiently large number of data sets across a number of terrains and landscape function, document management practices and controlled interventions. This is in line with the Soils for Life programme.

Depending on the project scope and size, it is estimated that $3-5 million would be required, through leveraging the already advanced state of remote sensing AI and machine learning capability. Global Surface Intelligence (GSI), an Edinburgh-based earth observation service provider, has demonstrated very successful models used for forest carbon and has applied the same principles for early stage SOC trials. The GSI approach could reduce the cost of SOC measurement from around $20/hectare to $2/hectare. Interestingly, the GSI approach[5] has already been tested against the same data set of ten farms using the LawrieCo farming approach and shown to correlate well with the CSIRO data[3].

	Field measure (tC/ha)	CSIRO SOC (tC/ha)	Gsi SOC (tC/ha)
site 1	53.2	44.3	44.4
site 2	47.6	36.1	41.3
site 3	49.2	40.5	40.2
site 4	60.6	44.3	42.1
site 5	24.2	21.3	22.6
site 6	40.1	16.2	23.5
site 7	47.7	27.3	30.8
site 8	130.7	104.3	105.2
site 9	87.5	58.9	44.3
site 10	56.0	40.7	48.7

Validation of LawrieCo Data using SCi satellite based observations[5]

More information on SOC will enable more targeted improvements in agricultural productivity, profitability and sustainability as well as improve the uptake of carbon from the atmosphere to be sequestered in our soils.

In the end, it is only long-term monitoring of SOC that can fully unravel the current challenges.

*****

5 2018 The University of Edinburgh, GSi(Global Surface Intelligence) Private Communication.

Acknowledgements

Many people have contributed to the arguments and data presented in this paper, including many of the authors cited such as Jeff Baldock, Deli Chen and Kadambot Siddique. Others (in no particular order) are all senior figures in agriculture and groups focussed on the long-term health of our soils, e.g. Michael Jeffery, Walter Jehne, Deane Belfield, Snow Barlow, Michael Crawford and John White. All have been most helpful on my journey to date in coming to grips with the potential of SOC.

Note, however, that the views expressed are mine and do not necessarily coincide with the views of those listed above.

About the Author: Dr Robin Batterham AO, FREng, FAA, FTSE was appointed Chief Scientist to the Commonwealth of Australia in May 1999. He was re-appointed in 2002, after the initial tenure expired, and held the position until 2005. Dr Batterham sits on many boards and associations and has lectured widely in Australia and overseas. After completing his PhD at Melbourne University, he took up a postdoctoral position with ICI Central Research Laboratories in England. When he returned to Australia, he was employed as a research scientist in CSIRO's Division of Mineral and Process Engineering. He became Chief of that division in 1985. He is a Fellow of the Australian Academy of Science and the Australian Academy of Technological Sciences and Engineering where he was President from 2007 to 2012.

*****

Any opinions or views expressed in this paper are those of the individual author, unless stated to be those of Future Directions International.

Published by Future Directions International Pty Ltd.
Suite 5, 202 Hampden Road, Nedlands WA 6009.
Tel: +61 8 6389 0211
Web: www.futuredirections.org.au