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What can science offer the proponents of regenerative agriculture practices?

Michael Robertson, Ben Macdonald, Mark Farrell, Hayley Norman, Lynne Macdonald, Gupta Vadakattu and Jen Taylor

CSIRO Agriculture & Food

Introduction

The growing interest and momentum surrounding the regenerative agriculture (RA) movement has generated considerable debate about motivations, definitions, stakeholders, and the role that scientific research plays (Giller et al. 2021). Amidst the sometimes-emotive debate there are some incontrovertible facts and drivers. The first of these is that most human activity is exploitative of the natural resource base upon which it relies. Agriculture is no different to other sectors of the economy in that its ability to sustain production and profits relies explicitly or implicitly on cycles of renewal and exploitation of natural resources, and no matter how diverse, the ecology of an agricultural landscape bears little resemblance to the native ecosystem it has replaced. The second issue is that one manifestation of the renewal-exploitation cycle, land degradation, is particularly acute in Australia (MacKenzie et al 2017) and arresting it is an existential issue for mainstream agriculture. Thirdly, there is growing interest and activity in carbon abatement opportunities for agriculture, reinforced by injection of capital investment. In some countries "nature-based" farming is becoming the primary expectation of society towards agriculture (UK House of Commons). The emergence of these three drivers, signifying economic, ecological and social dimensions, will continue to require science-based evidence and enquiry to support discussion and decision making. Otherwise, RA will devolve to an unhelpful mix of fact, belief and sometimes mischievous political motives, with the consequence that beneficial practices may be ignored by many producers.

The aim of this perspective article is to propose a role for scientific activity in working with the RA movement. This is not to imply that regenerative agriculture is simply defined by on-the-ground practice and factors related to sustaining productivity and provision of ecosystem services. We

recognise that regenerative agriculture also includes recognising increase in wellbeing and empowerment of practitioners. The intent in this article is to look specifically at those questions where agricultural or data sciences have salience.

We begin the article with our perspective on what we perceive to be the essential characteristics of RA, at least in the Australian context. We then move on to elaborate four key roles we see science playing in both supporting and critiquing the RA movement. Our underlying motivation for this article is to help bridge an emerging divide we see between the science community and practitioners and supporters of RA (Francis 2020, Giller et al. 2021). Our belief is that the RA movement is well-intentioned and seeks to see agriculture thrive rather than tear it down. Given the level of farmer, political and community support we contend that the regenerative agriculture movement is unlikely to disappear anytime soon and this behoves us to address it as a feature of agriculture in Australia and around the world. By encouraging a role for science, we hope we will clarify objectives and claims for RA and form the basis for a partnership between scientists and supporters of RA. Our audience for this article is primarily agricultural scientists, but also others interested in the RA movement.

Characteristics of regenerative agriculture

The term "regenerative agriculture" seems to either alienate or motivate stakeholders. For example, critics of RA have asked what the RA movement seeks to regenerate (Giller et al 2021). Landholders object to the implication that their current farming practices are inherently destructive. Others point out that RA can focus on only one driver for ideal farming practice and de-emphasise profitability. Some point out that RA may lead to a decline in productivity and this may have flow-of effects for less food secure nations. There are practitioners who mix belief with elements of science, which can alienate other landscape managers. Another criticism is that RA does not offer new advice on farm practices beyond what is well known and currently considered best practice.

To understand the nature of RA, we propose to set aside the vexed issue of definitions and semantics and instead examine the characteristics of RA, informed by the Australian context. By examining what RA "does" we hope this can create points of contact with those in the scientific community who are alienated by the term "regenerative agriculture".

Here is our list of five characteristics:

1. ***Whole-of-system changes.*** While much of agronomy, grazing management and even farming systems innovation tends to focus on "components" of the farming system, RA argues for what it calls "a whole-of-system" approach. For example, a change in grazing management away from set stocking to cell or rotational grazing will involve adjustments to labour, fencing, paddock layout, positioning of watering points, earthworks to manipulate overland flow, choice of pasture species, even the livestock enterprise employed. The whole-of-system approach of RA gives a prominent focus to utilising landscape scale processes to help restore land condition. An obvious example of this is diverting overland flows so that water can help rejuvenate native and agricultural vegetation, particularly on grazing farms, otherwise known as "natural sequence farming" and previously Yeoman keyline farming system. In the extreme this can involve substantial earthworks. These interventions are implemented at the scale of a whole farm (and ideally whole catchment) and not paddock by paddock. So, implementing and testing RA in a commercial farming context tends not to be based on a stepwise approach to single interventions, but rather an integrated "package". This raises interesting challenges about how the impact of such an implementation can be tested, including the difficulties of managing the transition to a new system, and we address this later in the article.
2. ***Focus on "ends" rather than "means".*** Newton et al. (2020) point out that much RA is inconsistent in whether it is defined

by outcomes or processes. Unlike other ecologically-based farming movements like organic agriculture, biodynamic farming and permaculture, our observation is that RA in Australia tends not to prescribe what farming practices are acceptable or not. In doing so it places the focus on the ends rather than the means. So, if increasing soil carbon, reducing soil erosion, or fostering biodiversity are the ends, then RA tends not to dictate the means to get there. In this sense it is agnostic of specific farming management practices. A strength of this is that appropriate farming practices can be selected according to agroecological circumstances and the socio-economic context of the farmer(s) concerned. A range of beliefs and associated practices are utilised to achieve positive outcomes for the natural resource base and farm productivity. RA can be likened to a "broad church". We do note that Giller et al. (2021) documents a long list of endorsed RA practices, mostly informed by North American and European literature. Many of these may not be broadly appropriate/available across the continental scale of Australian agriculture. RA in Australia and New Zealand (Grelet et al 2021) seems, to us at least, to be less prescriptive.

3. ***Non-farmers as stakeholders.*** The RA movement plays strongly to groups supporting a change to agriculture, such as consumers who are concerned about how the food and fibre products they consume are produced, investors who have funds to invest on behalf of those seeking particular outcomes on farm, and governments who wish to see a more "sustainable" form of agriculture being practiced. All types of groups are using their decisions, be it purchasing or investing, to influence change. While many may see this as a threat to the sovereign rights of farmers, the emergence of these non-farm stakeholders is being exploited positively by some in the farming and agribusiness communities. Witness the "direct to consumer" approach to marketing, and the emergence of green-influenced pension funds who are investing in Australian agriculture.

4. ***Explicit reference to natural capital and its management.*** For many in the RA movement "regeneration" refers to active management of the stock of natural capital upon which productivity relies. In most Australian farming contexts "natural capital" amounts to soil, water and biodiversity of native species. For many investors referred to in the previous point, the maintenance/enhancement of natural capital is the key performance indicator of interest. Some Australian banks already use a form of trajectory analysis of farm performance, implying a focus on natural capital – and then use this as a basis for lending decisions. So, there is an increasing onus on agriculture to show that capital stocks are being managed responsibly and ethically. The use of "capital" to refer to the foundational natural resources that support agricultural production opens the door to the use of economic concepts and analytical frameworks integrated with biological understanding to inform the management of the stock. For instance, stocks of natural capital can be drawn down and built up at varying rates and with different costs involved. The time-based dimension invokes concepts like return on investment, and the choice of appropriate discount rates when conducting valuation of future benefits and costs. A key science challenge to which we elaborate below is the fuzzy and inconsistent nature of standards for natural capital accounting, including the fact that a natural capital baseline is not generally measured due to difficulty and cost. Another significant challenge is that most Australian farmers do not "farm" natural capital in order to sell it on a market – unless what they really mean by natural capital is actually soil carbon on the carbon market. So, the link between the dynamics of natural capital, and production and profit are poorly elaborated (Francis 2020).

5. ***Incorporating broader sets of knowledge beyond western science.*** In some forms of RA, particularly in extensive agriculture, there are attempts to draw upon traditional indigenous knowledge of landscapes and their management. For example, this can involve fire management, the performance of native vegetation mosaics, and identifying ecological

indicators. We note that a recent analysis of RA in New Zealand addresses the role of indigenous partners (Grelet et al. 2021). Many forms of RA acknowledge and incorporate local farmer knowledge of landscape function, which may not have been derived from conventional scientific enquiry.

Given the above five characteristics we contend are at the essence of RA (in Australia), we would like to propose an elaborated definition of RA. The intention of offering this definition is not to impose a normative view but rather create a boundary object to foster dialogue between supporters and critics.

Regenerative agriculture is a form of farming in which explicit attention is paid to the state and trajectory of the natural capital base (soil, water, biodiversity) underlying farm production and acknowledgement that there are non-farm stakeholders interested in its responsible management. It is not a prescriptive recipe of farm practices, but rather has a focus on positive outcomes for the natural resource base, particularly soil health, and farm productivity and profitability.

Science challenges for regenerative agriculture

Here we list five challenges that we identify for the scientific community if it were to support the regeneration agriculture discourse. No doubt there are more challenges that can be identified, but we hope that by starting this list a dialogue can be fostered.

1. ***Elaborating causal relationships between intervention and effect.*** Because RA has a focus on outcomes (rather than the means to get there) and that a set of practices may be implemented as an integrated set at a farm or catchment scale, there are formidable challenges in ascribing cause and effect. These outcomes are often likely to be most clearly seen years hence, or most evidently during extreme events such as droughts. This means that supporting evidence for practice change may be hard to obtain. The discipline of farming systems research has something to offer here: the use of farm- and catchment-scale models together with monitoring of system function and underlying key drivers on long-term experiments can go some way towards dissecting main effects, interactions, lags, and causes (rather than associations). Models can also assist with "what ifs" and transferring insights to other seasons, locations and management regimes. Monitoring change in relation to a reference is essential and the emerging use of sensing systems will lessen the burden of running monitoring programs. Many RA "experiments" lack the conventional notion of a "control" for comparison. Long-term studies over multiple paddocks and farms, preferably with controls for comparison, is the ideal. Failing that, there is an opportunity for agricultural science to adapt "space-for-time" approaches from ecology and geography and deep-time approaches from geology to compensate for the lack of classical controls in most implementations of RA.
2. ***Elucidating the demonstrable connection between soil health and productivity and productivity footprint.*** RA typically embodies soil health as a key outcome, often implying, for ease of measurement, that soil health equates to soil carbon and organic matter, and is positivity associated with productivity and food quality and a reduced footprint. One aspect of below-ground function we see as an emerging frontier for science to work on with RA, is the role of the soil-plant microbiome and how it can be manipulated to good effect for resource use efficiency and plant and livestock performance.
3. ***Using frameworks of natural capital to conceptualise stocks and flows of natural resources.*** As outlined above, the disciplines of economics and accounting can provide useful concepts and analytical frameworks to view the dynamics of natural capital. A significant challenge is the quantification of "natural capital" and devising meaningful and adoptable monitoring systems. We suspect the definition of what constitutes natural capital will need to be flexible and negotiated with stakeholders, particularly if they are farmers, according to the local context, and thus require transdisciplinary

approaches. On the other hand, consumers and investors will be looking to international frameworks and definitions. Although there will be no universal definition and method, developing strong science-based principles to inform robust framework for market-based mechanisms will be important.

4. ***Learning from indigenous and other local knowledge systems.*** The incorporation of indigenous understandings about cycles of nature (e.g., phenology patterns of native vegetation) and how they indicate changes in the biophysical environment that western systems of science may overlook or discount, is a significant science challenge. It must be more than a gesture of reconciliation or the involvement of traditional custodians. Indigenous knowledge will have more salience in intact landscapes such as the rangelands. In addition, it is important to consider local learnings from generations of land managers.
5. ***Helping build a wider set of integrated monitoring and evaluation techniques*** (ex-post and ex-ante) that look at the implications of practices, institutional arrangements and economic mechanisms on social, environmental, cultural and economic outcomes. This will support a broader conversation about the role of agriculture and food systems in supporting prosperity, equity and wellbeing.

Final comments

The regenerative agriculture discourse has arisen due to dissatisfaction with agriculture not delivering a fuller set of outcomes. The pathway to achieve sustainability in agriculture is not clear given the competing demands for land, the many participants with different aspirations, a moving climate and environmental operating space. Many of these problems are pressing now and changes can't wait for perfect knowledge. Experimentation in particular farm contexts is useful to form the basis for a set of practices that can be evaluated for scaling up. It is through the accumulation of experience by a range of participants in agriculture with different motives and values that the set of acceptable pathways can be uncovered and then pursued or supported through broader investments or policy frameworks. We have proposed ways that mainstream agricultural science can support farmer and placed-based research under the regenerative agriculture banner, thereby assessing them for generality and scalability.

References

Francis J 2020. *Regenerative agriculture – quantifying the cost.* Australian Farm Institute. Occasional Paper 20.01.

Giller KE et al. 2021. *Regenerative agriculture: An agronomic perspective.* Outlook on Agriculture. DOI: 10.1177/003072702199806

Grelet G, Lang S et al. 2021. *Regenerative agriculture in Aotearoa New Zealand – research pathways to build science-based evidence and national narrative* (Available at https://ourlandandwater.nz/news/regen-ag-white-paper_feb-2021/).

McKenzie NJ, Hairsine PB, Gregory LJ, Austin J, Baldock JA, Webb MJ, Mewett J, Cresswell HP, Welti N, Thomas M 2017. *Priorities for improving soil condition across Australia's agricultural landscapes.* Report prepared for the Australian Government Department of Agriculture and Water Resources. CSIRO, Australia.

Newton P et al. 2020. What is regenerative agriculture? A review of scholar and practitioner definitions based on processes and outcomes. *Front. Sustain. Food Syst.*, 26 October 2020, https://doi.org/10.3389/fsufs.2020.577723

UK House of Commons 2020. *The Agriculture Act 2020.* https://commonslibrary.parliament.uk/research-briefings/cbp-8702/ (accessed 26 April 2021)

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