



# What Is Regenerative Agriculture? A Review of Scholar and Practitioner Definitions Based on Processes and Outcomes

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Regenerative agriculture is an alternative means of producing food that, its advocates claim, may have lower—or even net positive—environmental and/or social impacts. Regenerative agriculture has recently received significant attention from producers, retailers, researchers, and consumers, as well as politicians and the mainstream media. Despite widespread interest in regenerative agriculture, no legal or regulatory definition of the term “regenerative agriculture” exists nor has a widely accepted definition emerged in common usage. This paper answers the research question: How have different scholars and practitioners defined regenerative agriculture? We reviewed 229 journal articles and 25 practitioner websites to characterize the term “regenerative agriculture.” Our review revealed that there were many definitions and descriptions of regenerative agriculture in usage. These were variously based on processes (e.g., use of cover crops, the integration of livestock, and reducing or eliminating tillage), outcomes (e.g., to improve soil health, to sequester carbon, and to increase biodiversity), or combinations of the two. Process-based definitions may imply that advocates or users of such definitions are open-minded about the possible outcomes of these processes. Similarly, outcome-based definitions may imply that users of such definitions are open-minded about the processes that may lead to those outcomes. We discuss the implications of these different forms of definition for policy, including for certification programs and for payments for carbon sequestration programs. More generally, wide variance in the definitions used may lead to uncertainty about what different actors mean when they talk about regenerative agriculture. We suggest that it may be helpful for individual users of the term “regenerative agriculture” to define it comprehensively for their own purpose and context.

**Keywords:** agriculture, carbon farming, certification, definition, policy, regenerative, review, sustainable

## INTRODUCTION

Agriculture has a significant environmental footprint. It is associated with approximately one third of global land use, and is a key driver of land use change globally including across the biodiverse tropics (Searchinger et al., 2019). Food production is also associated with ~15% of global greenhouse gas emissions. At the same time, global food needs are anticipated to grow, as a consequence of increases both in population and in per capita demand (Bodirsky et al., 2015). In

response to these various pressures, many actors are seeking more sustainable ways of producing food (Foley et al., 2011).

Regenerative agriculture has been proposed as an alternative means of producing food that may have lower—or even net positive—environmental and/or social impacts (Rhodes, 2017). A range of claims have been made by different parties about the potential for regenerative agriculture to enhance the sustainability of food production, including for the possibility that regenerative agriculture could form part of a climate change mitigation strategy. For example, Rhodes (2017) claimed that “regenerative agriculture has at its core the intention to improve the health of soil or to restore highly degraded soil, which symbiotically enhances the quality of water, vegetation and land-productivity.” Project Drawdown claims that “regenerative agriculture enhances and sustains the health of the soil by restoring its carbon content, which in turn improves productivity—just the opposite of conventional agriculture,” and estimates that regenerative annual cropping could reduce or sequester 14.5–22 gigatons of CO<sub>2</sub> by 2050 (Project Drawdown, 2020). Bolder claims include those that “regenerative agriculture... has the potential to reverse climate change” (Kastner, 2016) and that “we could sequester *more than 100% of current annual CO<sub>2</sub> emissions* with a switch to widely available and inexpensive organic management practices, which we term ‘regenerative organic agriculture’” (Rodale Institute, 2014). At the same time, some commentators remain more cautious about the potential for regenerative agriculture to contribute to sustainability objectives (McGuire, 2018; Ranganathan et al., 2020).

Regenerative agriculture has recently received significant attention from producers, retailers, researchers, and consumers, as well as politicians and the mainstream media. Interest in regenerative agriculture spans the public, private, and non-profit sectors. In the public sector, governments from international to local levels are exploring the possibilities for regenerative agriculture to contribute to climate action plans. Internationally, a Special Report on “Climate Change and Land” by the Intergovernmental Panel on Climate Change listed regenerative agriculture as a “sustainable land management practice” focused on ecological functions that “can be effective in building resilience of agro-ecosystems” (IPCC, 2019, p. 389). At a more local level, there are several cases of municipal governments in the US exploring the potential for regenerative agriculture to help achieve local sustainability goals (The Climate Reality Project, 2020). In the private sector, several high-profile companies are engaging with the concept of regenerative agriculture. The Regenerative Organic Alliance (a collaborative of farmers, businesses, and experts) has established a certification program for regenerative agriculture (Regenerative Organic Alliance, 2020). As a second example, General Mills has pledged to advance regenerative agriculture on 1 million acres of farmland by 2030 (General Mills, 2020). In the non-profit sector, various food and agricultural organizations are developing and advocating for regenerative agriculture. For example, Regeneration International works “to promote, facilitate and accelerate the global transition to regenerative food, farming, and

land management” (Regeneration International, 2020). Similarly, the Savory Institute works to disseminate knowledge about, and promote adoption of, production systems that incorporate regenerative agriculture on grasslands (Savory Institute, 2020).

Despite widespread interest in regenerative agriculture, no legal or regulatory definition of the term “regenerative agriculture” exists nor has a widely accepted definition emerged in common usage. Some actors engaged in regenerative agriculture have initiated attempts to gather differing perspectives on how regenerative agriculture is or should be defined (Terra Genesis International, 2020), while some authors acknowledge competing definitions (Elevitch et al., 2018). In the meantime, regenerative agriculture has been defined in a variety of ways, and as differently as “a system of farming principles and practices that increases biodiversity, enriches soils, improves watersheds, and enhances ecosystem services” (Terra Genesis International, 2020), to “a long-term, holistic design that attempts to grow as much food using as few resources as possible in a way that revitalizes the soil rather than depleting it, while offering a solution to carbon sequestration” (Rhodes, 2017), to “a form of enterprise that incorporates a community of people engaged in civil labor to produce and consume the food (and land, landscape and amenity) that they, collectively, decide to grow” (Ravenscroft et al., 2013). Clearly, there are disparities among different definitions. In part, these differences may be a product of different origins and lineages of the term “regenerative agriculture” (Soloviev, 2019), though a systematic etymological history has not been established.

The absence of an agreed definition of regenerative agriculture, and the non-overlapping or even mutually exclusive nature of alternative definitions, has the potential to create several challenges. First, absence of clarity around what the term means creates challenges for researchers who seek to study regenerative agriculture, including for those interested in testing claims about its adoption and impacts. Second, this could generate confusion among consumers who may not understand, or who could be misled about, the claims of companies seeking to sell them products labeled or marketed as having been produced using regenerative agriculture (Moon et al., 2017). Third, a poorly defined or poorly understood term could become diluted or corrupted over time, such that it loses value and credibility among a range of actors. Finally, without a widely shared understanding of what regenerative agriculture is, it may be difficult to develop and advocate for laws, policies, and publicly funded research, technical assistance, or conservation incentive programs that promote, support, or evaluate this form of agriculture.

The objective of this review paper is to summarize existing definitions and descriptions of regenerative agriculture used by scholars and practitioners. Our review may help to clarify what different individuals and agencies mean when they refer to regenerative agriculture. However, we do not define regenerative agriculture ourselves, nor do we advocate for the adoption of any one definition. Rather, we hope to shed light on the variety of ways in which the term has been used and to explore the implications of different types of definition.

## MATERIALS AND METHODS

### Data Collection

We reviewed two sets of publications, to explore and characterize uses of the term “regenerative agriculture.” The two sets of publications were (1) research articles, and (2) practitioner websites; we define both in the sections below. Our searches were designed to generate representative insights into the diversity of use of the term “regenerative agriculture.” But the searches were not designed to be completely systematic nor completely exhaustive, nor did they need to be for the purposes of responding to our research question.

### Research Articles

We reviewed research articles published in peer-reviewed journals with the aim of understanding the range of uses of the term “regenerative agriculture” by academics and researchers. We searched Google Scholar for the exact term “regenerative agriculture,” and systematically recorded the bibliographic details of every research paper published in a peer-reviewed journal between 1982 and 2019 (we found no research articles to which we had access and that used the term that were published prior to 1982). We placed no constraints on which disciplines or journals were included in the review. We did not include editorials, reports, theses, white papers, books, book chapters, and other publications since we could not be certain that they (a) had been peer-reviewed, or (b) were not replicates of the research articles that we did review. This process was conducted between October 2019 and May 2020.

### Practitioner Websites

We reviewed the website of any practitioner organization (e.g., non-governmental organization, extension agency, farm) that indicated that they were working on issues or projects directly related to regenerative agriculture in any capacity. We had no similarly systematic way to search for these groups as we did for research articles. Instead, we identified practitioners from a combination of (a) our prior knowledge of such organizations, (b) lists of participant organizations in recent regenerative agriculture conferences in the US and internationally, (c) organizations mentioned in the research articles that we reviewed, and (d) organizations discovered *ad-hoc* during the process. We searched each organization’s website for any definition or description of regenerative agriculture. If an organization gave more than one definition or description, we aimed to identify the most recent and/or most comprehensive of those. In cases where we had uncertainty about which definition or description best represented the organization’s perspective, we attempted to contact the organization by email to confirm. This process was conducted between January and May 2020.

### Inclusion and Exclusion Criteria

Research articles and practitioner websites were only included in our review if they included the exact term “regenerative agriculture” within the main body text. We did not include publications that used the term only as a keyword, in a footnote,

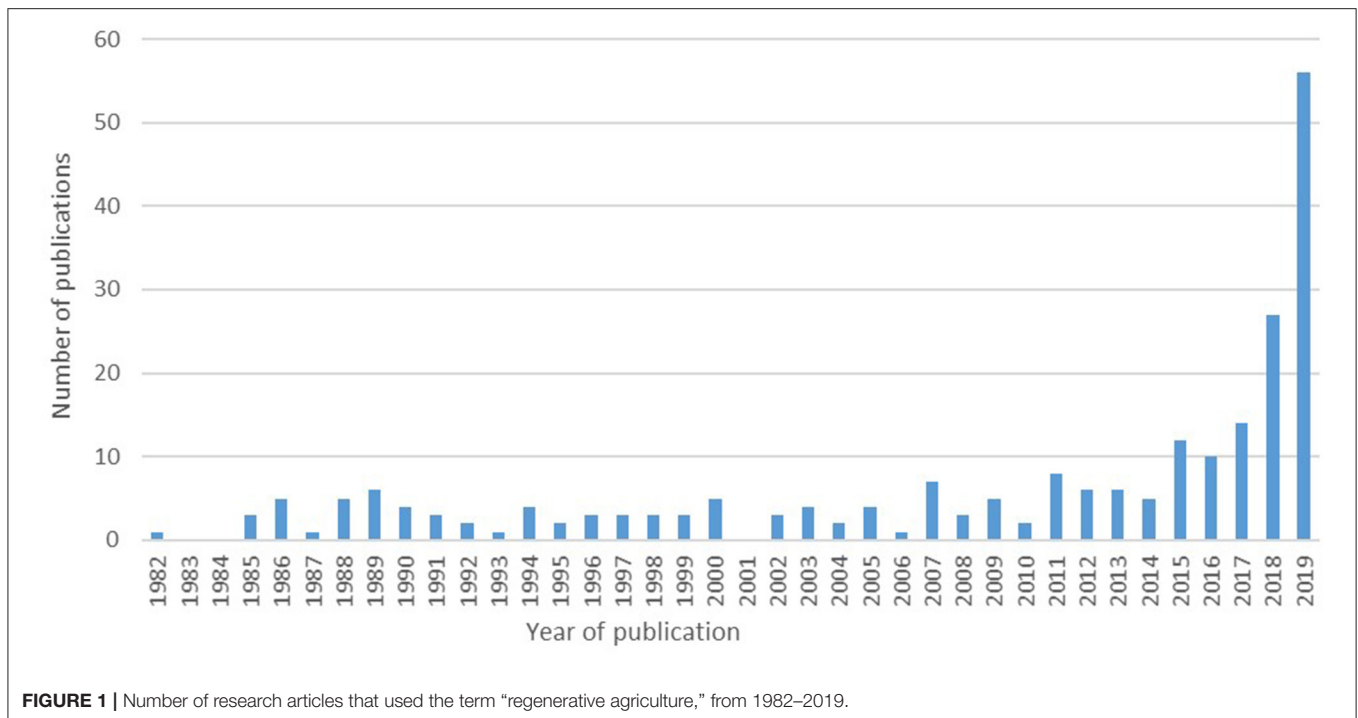
or in a cited reference. We did not include websites that only referred to regenerative agriculture in a blogpost. We did not include publications that included related terminology (e.g., “sustainable agriculture,” “carbon farming”) unless they also referred explicitly to “regenerative agriculture.” However, once a publication was included in the review, we did search that publication for very similar terms (e.g., “regenerative farming,” “regenerative agricultural practices”) and included the definitions and descriptions of those analogs. To maintain a tight focus on the meaning-through-usage of the specific term “regenerative agriculture,” we did not include definitions or descriptions of “regenerative food systems,” “regenerative economies,” “regenerative paradigm,” or any other term that referred to processes beyond the farm gate. We included publications only if a full digital text was available. We included publications only if they were written in English, as our research team did not have the capabilities to review publications in other languages.

### Data Extraction

For each publication, we used the “find” function in the PDF, Word document, or webpage to locate every use of the term “regenerative agriculture” in the document. We searched for definitions (i.e., declarative, well-formed statements about what regenerative agriculture is or aims to do) and descriptions (i.e., looser statements or suggestions about what regenerative agriculture involves, is associated with, or may be able to do). If we encountered no definition or description using the “find” function, we read or scanned the paper for other definitions or descriptions. We extracted all definitions or descriptions of regenerative agriculture, and disaggregated those characterizations into singular “dimensions” that related to a specific single aspect of the definition or description. For example, if a publication’s definition included multiple agricultural principles and/or practices (collectively: *processes*, from hereon) (e.g., no-till farming, cover crops, and integrated animal-crop production) or outcomes (e.g., improved soil health, carbon sequestration, and profitability) we separately noted each of these processes and outcomes as a different dimension. We also noted whether the author(s) of a publication cited another author’s definition as the source of their own definition or description.

### Data Analysis

We used descriptive statistics to characterize our data on different uses of the term “regenerative agriculture.” In particular, we were interested in understanding how different definitions and descriptions of regenerative agriculture varied in relation to their inclusion of different agricultural processes and outcomes. To this end, we summed the number of research papers and practitioner websites that referred to a particular process or outcome. And we summed the number of definitions and descriptions that referred to only processes, only outcomes, or to both processes and outcomes. We were also interested in other terminology that was used interchangeably with the term “regenerative agriculture.”



## RESULTS

We collected data from 229 journal articles (Table S1) and 25 organizations (Table S2) about their definition and/or description of the term “regenerative agriculture.” The term “regenerative agriculture” has been used increasingly frequently in the scholarly literature over time, with a surge of publications that use the term between 2015 and 2019 (Figure 1). A large majority of research articles that used the term “regenerative agriculture” did not provide a declarative definition. Of the 229 articles that we reviewed, only 22 provided an approximation of a definition. A further 99 research articles provided a looser description of regenerative agriculture, providing some indication of one or more aims, processes, or outcomes associated with regenerative agriculture. The remaining 108 articles used the term without providing any definition or description. All but three of the 25 practitioner organizations that we reviewed, all of whom worked on regenerative agriculture and used the term on their website, provided a definition or description of the term. Within both the research articles and practitioner websites, most users of the term did so without reference to any previous source. However, 51 of the journal articles indicated that their definitions were based on or derived from other authors (most commonly: Pretty, 1995; Rodale Institute, 2014; LaCanne and Lundgren, 2018). Of the 229 journal articles, 128 were either global in scope or had no geographic focus. The remaining 101 journal articles each had one or more geographic foci, in Africa (8); Asia (21); Australasia (13), Central America (3); Europe (15); North America (34); South America (8); and “developing countries” (1).

## Variations in Definitions and Descriptions of Regenerative Agriculture

Our review revealed that there were many definitions and descriptions of regenerative agriculture in usage. While differences in these definitions and descriptions manifested in multiple ways, one stark distinction between them was the degree to which they incorporated mention of processes (including principles and/or practices), outcomes, or both. In the following paragraphs, we discuss these distinctions as they were revealed in our data.

Our review revealed a wide range of processes that were included in one or more definitions or descriptions of regenerative agriculture (Table 1). Within the research articles, the most commonly mentioned processes were the emphasis on no or low external inputs and the utility of on-farm inputs (26% of publications), the integration of livestock (19%), not using synthetic fertilizers (12%) or pesticides (12%), and reducing or eliminating tillage (12%) (Table 1). Among the practitioner websites, the most commonly mentioned processes were reducing or eliminating tillage (41%), the integration of livestock (41%), and the use of cover crops (31%) (Table 1). Many of these processes were agricultural principles or practices whose *inclusion* defined regenerative agriculture (e.g., cover crops, crop rotations), but some were principles or practices whose *exclusion* was definitional (e.g., tillage, synthetic fertilizers).

Some definitions or descriptions ( $N = 26$  scholarly publications;  $N = 2$  practitioner websites) were based solely on processes. For example, Kamenetzky and Maybury (1989) described regenerative agriculture as being “based on the principle of working with nature” and cited Francis and

**TABLE 1 |** Summary of processes and outcomes that were included in definitions or descriptions of regenerative agriculture within journal articles and practitioner websites.

Dimension of regenerative agriculture	Journal articles		Practitioner websites	
	N	%	N	%
<b>Processes</b>				
Reduce tillage (or no-, minimal-, conservation-)	14	11.6	9	40.9
Protect/cover the soil	6	5.0	4	18.2
Use cover crops	10	8.3	8	36.4
Use crop rotations	12	9.9	7	31.8
Use crop plant diversity (including intercropping)	11	9.1	3	13.6
Incorporate perennials and trees	7	5.8	6	27.3
Restore natural habitats	3	2.5	1	4.5
Integrate livestock	23	19.0	9	40.9
Use ecological or natural principles or systems	9	7.4	3	13.6
Use no or low external inputs; maximize on-farm inputs	32	26.4	7	31.8
Use organic methods	10	8.3	3	13.6
Use natural pest control	7	5.8	2	9.1
Use no synthetic pesticides	15	12.4	4	18.2
Use organic fertilizers	8	6.6	2	9.1
Use compost, mulch, green manure, or crop residues	11	9.1	6	27.3
Use no synthetic fertilizers	15	12.4	5	22.7
Focus on localism and/or regionality	6	5.0	0	0.0
Focus on small scale systems	3	2.5	0	0.0
Rely on farm labor, including for local knowledge	3	2.5	0	0.0
Other	4	3.3	1	4.5
<b>Outcomes</b>				
To improve ecosystem health (including ecosystem services)	21	17.4	7	31.8
To increase biodiversity	26	21.5	10	45.5
To improve water health (e.g., hydrology, storage, reduce pollution)	18	14.9	10	45.5
To improve soil health (e.g., structure, soil organic matter, fertility)	49	40.5	19	86.4
To increase carbon sequestration	21	17.4	14	63.6
To reduce greenhouse gas emissions	5	4.1	3	13.6
To improve animal welfare	0	0.0	3	13.6
To maintain or increase yields	10	8.3	5	22.7
To maintain or improve farm productivity	18	14.9	5	22.7
To increase crop health and/or resilience	9	7.4	3	13.6
To improve food access and/or food security	10	8.3	3	13.6
To improve food nutritional quality and/or human health	13	10.7	7	31.8
To improve food safety	2	1.7	1	4.5
To improve the social and/or economic wellbeing of communities	21	17.4	9	40.9
To increase farm profitability	19	15.7	6	27.3
To create a circular system and/or reduce waste	14	11.6	1	4.5
Other	5	4.1	3	13.6

Values indicate the number of publications that referred to each process or outcome, out of the 229 journal articles and 25 practitioner websites reviewed. Note that of these, only 121 journal articles and 22 practitioner websites offered a definition or description. Our study was not exhaustive, but was not intentionally or likely biased with respect to any definition, and so the relative proportions of occurrences of different processes and outcomes is likely representative.

Harwood (1985) as describing “the four principal tools used by regenerative agriculture: soil fertility practices, integrated pest management, advances in plant breeding, and integrated crop-animal systems.” Soul Fire Farm (2020) described “Our regenerative, carbon sequestering farming practices, such as no-till, cover crops, mulch, compost, raised beds, agroforestry, silvopasture, and native species restoration.” These and other process-oriented definitions and descriptions did not refer to any outcomes that regenerative agriculture is expected to generate.

Our review also revealed a wide range of outcomes that were included in one or more definitions or descriptions of regenerative agriculture (Table 1). Within the journal articles, the most commonly mentioned outcomes were aspirations to improve soil health (41%), to sequester carbon (17%), and to increase biodiversity (17%). Among the practitioner websites, the most commonly mentioned outcomes were aspirations to improve soil health (86%), to sequester carbon (64%), to increase biodiversity (46%), to improve water resources (46%), and to improve the social and/or economic wellbeing of communities (41%).

Some definitions or descriptions (N = 44 scholarly publications; N = 5 practitioner websites) were based solely on outcomes. For example, Grant (2017) defined regenerative agriculture as “any and all forms of agricultural practice that actively restore soil quality, biodiversity, ecosystems health, water quality while producing sufficient food of high nutritional quality.” Steward Help Center (2020) defined regenerative agriculture as “farming practices that increase biodiversity, enrich soils, improve watershed health, sequester more carbon than they release, and enhance ecosystem services.” These and other outcome-oriented definitions did not refer to any specific processes that can or should be used to lead to those outcomes.

Finally, many definitions or descriptions (N = 51 scholarly publications; N = 15 practitioner websites) were based on some combination of processes and outcomes. For example, Gosnell et al. (2019) referred to processes (“Regenerative farmers... reduce or eliminate the use of chemical inputs such as synthetic fertilizer, herbicides, and pesticides”) and outcomes (e.g., “its focus is on enhancing and restoring holistic, regenerative, resilient systems supported by functional ecosystem processes and healthy, organic soils capable of producing a full suite of ecosystem services, among them soil carbon sequestration and improved soil water retention”). Similarly, Schoolman (2019) referred to both processes and outcomes when they described “‘regenerative’ ... practices such as cover cropping, crop rotation, reduced tillage and biological pest control, in addition to minimizing the use of chemical inputs to manage pests and maintain soil fertility.” As a final example, LaCanne and Lundgren (2018) defined regenerative farming systems as aiming “to increase soil quality and biodiversity in farmland while producing nourishing farm products profitably. Unifying principles consistent across regenerative farming systems include (1) abandoning tillage (or actively rebuilding soil communities following a tillage event), (2) eliminating spatio-temporal events of bare soil, (3) fostering plant diversity on the farm, and (4) integrating livestock and cropping operations on the land.”

## Other Terms Used to Refer to Regenerative Agriculture

Some other terms were commonly used synonymously with, or adjacently to, the term “regenerative agriculture.” These terms included “agroecological farming” “alternative agriculture,” “biodynamic agriculture,” “carbon farming,” “nature inclusive farming,” “conservation agriculture,” “green agriculture,” “organic regenerative agriculture,” and “sustainable agriculture.”

## DISCUSSION

### Summary of Results

Many of the processes mentioned within definitions or descriptions of regenerative agriculture have been used for many centuries. And regenerative agriculture as an idea has been discussed and practiced since at least 1982 (Sampson, 1982). However, the recent surge in the number of research articles that use the term “regenerative agriculture” (Figure 1) suggests that this is a topic that is gaining traction and garnering interest of scholars as well as practitioners. As such, our paper may be timely in drawing attention to the conversation around the definitions of the terminology.

Our review revealed three broad findings, which individually and collectively may lead to uncertainty about what different actors mean when they talk about regenerative agriculture. First, we found that many scholars and some organizations did not declaratively define the term “regenerative agriculture” when they used it. Only 51% of research articles that used the term either defined it or offered any kind of description. Eighty-four percent of practitioner organizations defined and/or described the term. Of those research articles that did not define or describe the term, many used it only once or in passing, and so their failure to expand on the term’s meaning may be understandable. Second, we found that the term “regenerative agriculture” has been used by many different researchers and practitioner organizations to mean very different things. That is, there was substantial diversity in the definitions and descriptions of regenerative agriculture used. In particular, some definitions focused more on processes (i.e., prescribing a set of agricultural principles and/or practices that constitute regenerative agriculture) while some focused more on outcomes (i.e., outlining a set of metrics that regenerative agriculture aims to or is expected to enhance) and some included dimensions of both processes and outcomes. Third, we found that the term “regenerative agriculture” had been conflated with and used interchangeably with other terms, suggesting that there may be overlap in research, practice, and policy-making with some of these other forms of agriculture. Together, these three findings may contribute to a degree of confusion or uncertainty around what the term means, or is being used to mean, in any given context. We discuss some of the implications of this uncertainty in subsequent sections.

### The Logic and Taxonomy of Definitions of “Regenerative Agriculture”

Some proponents of regenerative agriculture have claimed that “Regenerative Agriculture cannot be defined” (Soloviev and

Landua, 2016, p. 5). Several organizations that we contacted by email similarly expressed a reluctance to define the term. Words have no meaning without definitions, and so we suspect that such resistance to state a definition may not be a literal concern but rather more a desire not to be tied to one specific interpretation. Indeed, Soloviev and Landua (2016, p. 5) later indicate that their caution is more with “insisting on a single definition,” which seems like a reasonable concern. Our results show that “regenerative agriculture” has been defined in many different ways, and one might expect an ongoing process of coalescence to take place in finding an identity. As such, individuals or organizations might be understandably averse to adopting a single definition for strategic, political, or conceptual reasons as their thinking on this relatively new topic continues to evolve.

In the meantime, there is an important distinction between resisting the definition of a word or term at all, and resisting the universal adoption of a single agreed definition. It is extremely common for words and terminology to be defined in different ways. We suggest that it may be helpful for individual users of the term “regenerative agriculture” to define it comprehensively for their own purpose and context. This does not imply that there needs to be one agreed definition of regenerative agriculture or that it would be desirable to arrive at such a universal definition. Rather, it points to the necessity for individual users of the term to define it clearly and unambiguously for their own purposes and to state that definition in an unequivocal manner. A definition may evolve over time, and may vary between people. That does not contradict the imperative for acknowledging the importance of using words precisely and unambiguously for a given context.

### When No Definition Is Offered

Some of the publications we reviewed used the term “regenerative agriculture” but offered no definition or description. Two possible interpretations follow. First, it may be that the author is not willing or able to define the term. Their ideas may be insufficiently developed, or they may be hiding behind ambiguity for any number of reasons. In such circumstances, it may not be meaningful to make claims about regenerative agriculture. It may not be reasonable to claim that “x” causes, or is more likely to lead to, “y” if one is not willing or able to state what “x” is. Second, it may be that the author has a clear understanding of what regenerative agriculture means to them, but does not state that understanding. The effect here, which may be unintended, is to leave the reader to assume the definition. Given the preponderance of different ways in which regenerative agriculture can be and has been defined, this may create a high likelihood that any given reader will have a different interpretation of the term than that intended by the author. Again, we suggest the need for contextual clarity and precision when using this term. Alternatively, we suggest that authors explain their reasons for intentionally embracing ambiguity or flexibility when using this term.

### Process-Based Definitions

We encountered some definitions of regenerative agriculture that were *process-based*. That is, they focused on the inclusion or exclusion of one or more agricultural principles and/or practices

(e.g., the integration of crops and animals, the use of no-till agriculture, the use of cover crops) that define what types of agriculture may be considered regenerative.

An implication of definitions that are entirely process-based may be that advocates or users of such definitions are open-minded about the possible outcomes of those processes. That is, unless one can be absolutely certain that a particular practice *always and without exception* leads to a particular outcome, a definition of regenerative agriculture that is based on process(es) may imply agnosticism about the outcome(s). There may be a strong theory of change or expectation that these definitional processes will lead to a particular outcome. But the burden of proof may rest with any producer, practitioner, or proponent operating under such a definition of regenerative agriculture to test what the outcomes of those definitional processes are before making any claims about the efficacy or utility of those processes. In the absence of a rigorous program of testing that demonstrates a clear and resilient causal connection, it may not be reasonable to assume that a particular outcome always transpires. Of course, it is possible that a particular process may not immediately, linearly, or directly lead to a particular outcome, but rather that it may catalyze processes that can (over different timescales and under certain conditions) produce desired outcomes. It is also possible that outcomes will only be achieved when certain sets of processes are used in combination.

Many existing environmentally focused certification programs are similarly process-based. For example, organic agriculture, as defined by the USDA, is largely a process-based certification program. Many of the definitional processes in the USDA Organic program are exclusionary, focusing on processes (e.g., the use of synthetic fertilizers, the use of most synthetic pesticides) that are not allowed. USDA Organic agriculture is also an excellent demonstration of the principle that defining an agricultural approach by which processes are allowed or disallowed is not always a good proxy for its outcomes. Many proponents of organic agriculture claim or assume that it is universally or consistently advantageous in terms of environmental outcomes, but many studies and meta-analyses have now demonstrated this not to be the case (e.g., Seufert and Ramankutty, 2017).

A final note is that we have no data on why different users of the term chose to adopt any given definition. Our discussion above is oriented principally around the actual or perceived relationships between particular processes and particular outcomes. But at least one other explanation could be that many advocates of regenerative agriculture seek agricultural principles and/or practices that imitate natural systems. As such, the rationale for favoring particular processes may stem in part from a values relationship with the natural world rather than a belief that they will necessarily lead to a particular outcome (Chan et al., 2016).

### Outcome-Based Definitions

We encountered some definitions and descriptions of regenerative agriculture that were *outcome-based*. That is, they focused on one or more agricultural outcomes (e.g., carbon

sequestration, changes in soil health, changes in biodiversity) that define what types of agriculture are considered regenerative.

An implication of definitions and descriptions that are entirely outcome-oriented may be that advocates or users of such definitions and descriptions are open-minded about the processes that may lead to those outcomes. That is, it is possible or likely that any given outcome of interest can be generated in multiple different ways (Batie and Taylor, 1991). Grant (2017) demonstrated such agnosticism to process when they defined regenerative agriculture as “any and all forms of agricultural practice that actively restore soil quality, biodiversity, ecosystems health, water quality...” If it is only the outcome (e.g., reduced greenhouse gas emissions, greater profitability) that are of interest to the stakeholder, then they may be unconcerned about the process(es) that generate that outcome. For example, many stakeholders are interested in increasing biodiversity and in sequestering carbon. These outcomes may be achieved through using the principles and/or practices described in **Table 1**, which are commonly considered to be regenerative. But these outcomes may also be achieved by using high-yield, relatively intensive farming processes that spare land for conservation and ecosystem restoration (Phalan et al., 2011; Balmford et al., 2018). As such, some processes that many proponents of regenerative agriculture might not commonly consider to be regenerative may be useful in meeting the goals of regenerative agriculture under an outcome-oriented definition. Of course, if the definition of regenerative agriculture includes multiple outcomes, any processes used must contribute to (or at least not hinder) the accomplishment of all of those outcomes.

### Combined Process- and Outcome-Based Definitions

We encountered some definitions and descriptions of regenerative agriculture that were *based on both process(es) and outcome(s)*. That is, these definitions and descriptions incorporated one or more processes and also one or more outcomes. Such definitions and descriptions may indicate one of two things. First, they may be based on a belief that those definitional processes *always* lead to those the definitional outcomes. If that is the case, it may be incumbent on advocates or users of such definitions to be forthcoming with strong evidence that supports that belief. Alternatively, they may be indicating that regenerative agriculture *only* occurs when those processes are used *and when* those outcomes (or progress toward those outcomes) occur as a consequence. Under such a worldview, agriculture that uses the process without resulting in the outcome, or that results in the outcome without using the process, would presumably therefore not be considered to be regenerative agriculture.

If regenerative agriculture is defined as occurring when particular processes are used and when particular outcomes result, then one might expect variation in where regenerative agriculture can be practiced, over both space and time. For example, many actors pay considerable attention to the carbon sequestration potential of regenerative agriculture (**Table 1**). A frequent claim of regenerative agriculture proponents is that practice(s) “x” (and “y”) will lead to greater soil organic carbon (SOC) *via* carbon sequestration. However, even if practice “x”

can lead to greater carbon sequestration and/or sometimes *does* lead to greater carbon sequestration, that may not mean that practice “x” *always* leads to greater carbon sequestration. Many researchers believe that soil carbon will eventually saturate beyond a point at which no or little further carbon sequestration is possible (Stewart et al., 2007; Smith, 2014). As such, a given practice might be “regenerative” at a particular time (e.g., early in the process of restoring SOC to degraded land) or in a particular place (e.g., on heavily degraded rangelands with low SOC). But the same practice might not be “regenerative” at a different time (e.g., later in the process of restoring degraded land, once that soil is saturated with carbon) or in a different place (e.g., on more intact rangelands with high SOC).

### Definitions With Multiple Processes and/or Outcomes

Many definitions and descriptions (including process-based, outcome-based, and combined process- and outcome-based definitions) included reference to multiple processes and/or outcomes. These definitions and descriptions varied in the extent to which they were clear about whether agriculture would have to include one, some, or all of the listed processes or outcomes in order to meet that user’s definition of regenerative agriculture. Ambiguity on this point may add further confusion to understanding what the term “regenerative agriculture” is being used to mean in any particular context.

### Implications for Policy and Practice

Ambiguity or uncertainty about what an individual or organization is referring to when they use the term “regenerative agriculture” may create multiple challenges. First, without a clear, stated definition of regenerative agriculture, it may be difficult or impossible for researchers to test a specific claim about the benefits or outcomes of regenerative agriculture (Goswami et al., 2017). Clear definitions may be an important component of effective communication and engagement between scientists and practitioners (White and Andrew, 2019). Second, in the absence of a clear understanding of what regenerative agriculture is or is not, consumers may be misled or confused about the significance or truth basis of a claim about food produced using regenerative agriculture. In turn, confusion about eco-labels can lead to consumer distrust and dissatisfaction (Moon et al., 2017). Third, muddiness around the term may open the door for unscrupulous commercial interests to exploit the term and use it misleadingly in their marketing, potentially diminishing the value of the term to any producer who is more genuinely involved in efforts to enhance the sustainability of food production. That is, there is potential for watering down or greenwashing the use of a term to the point where it becomes universalized and loses value. For example, many products and practices are now called “sustainable” or “natural” without clarity as to what the claim means or why a consumer would pay a premium for a product marketed as such, allowing for “green washing” and other misuses to occur (Northen, 2011; Levinovitz, 2020). Formalizing terms can mitigate these issues to an extent, but it is only part of the challenge and is not necessarily the preferred outcome for all actors (Schaller, 1990; DeLind, 2000). Finally, the absence of a clear understanding of what regenerative agriculture is, and whether it is or should be process- or outcome-based, has

implications for policy and program development (Goswami et al., 2017). We explore some of these implications below, in relation to the development of certification programs and carbon payments for regenerative agriculture.

### Implications for a Certification Program

Sustainability standards can formalize definitions and expectations for a given type of agricultural practice, and have gained traction globally (Tayleur et al., 2017). To date, at least one certification program for regenerative agriculture has been created (Regenerative Organic Alliance, 2020). The stated objectives of the Regenerative Organic Certified program (to increase soil organic matter, to improve animal welfare, and to provide economic stability and fairness) are outcome-oriented, but the standards used to define and assess compliance are principally process-oriented (Regenerative Organic Alliance, 2020). Process-oriented certification programs are common, and are perhaps the norm. It is a consumer’s choice whether to buy and support the label, and (at least in principle) they can determine their willingness to accept claims or make assumptions about the causal connections between processes and outcomes. But at least one outcome-based certification program that relates to regenerative agriculture is also being developed (Savory Institute, 2019), and may arguably be more robust and generate fewer doubts. Under this Ecological Outcome Verified™ program, farmers will have to demonstrate improvements in particular outcomes (e.g., soil health, biodiversity) over time and also accept the possibility of losing certification if they cease improving along these metrics (Savory Institute, 2019). While outcome-based certification programs obviate the need for leaps of faith, potentially making them more attractive to consumers and more robust tools for market-based change, they can be more costly to administer (due to assessment expenses) and may therefore result in end-products that are less affordable for eco-conscious consumers.

### Implications for Payments for Carbon Sequestration

One proposed mechanism for incentivizing farmers and ranchers to adopt regenerative agriculture is to financially reward them for the ecosystem service of sequestering carbon in soil and vegetation on their land (Lal, 2019, 2020). Such a mechanism would effectively constitute a form of payments for environmental services (PES) program (Wunder, 2005), and has also been proposed under the title of “carbon farming.” Some groups have identified agricultural principles and/or practices that fall under the umbrella of carbon farming (e.g., Carbon Cycle Institute, 2020).

Donors, investors, or tax-payers who might fund any such carbon farming project might reasonably expect the project to be associated with a Monitoring, Reporting, and Verification (MRV) system to measure and demonstrate the carbon sequestered by a given farmer, project, or area of land. They may be less willing to pay farmers on the mere assumption that certain processes lead to certain outcomes, rather than the actual demonstration that they have done so. As such, a definition of regenerative agriculture to be applied under such a program may need to be at least partly outcome-based. Such an MRV



system and associated policy might borrow from more well-established efforts in the forest sector, such as the set of programs and policies to Reduce Emissions from Deforestation and forest Degradation (REDD+) (Herold and Skutsch, 2009). Principles that have been relatively well-explored and that might equally be important for carbon sequestration PES programs using regenerative agriculture include those of *additionality*, *permanence*, and *leakage* (Murray et al., 2007; Thamo and Pannell, 2016).

## Caveats and Limitations

We note a couple of methodological caveats that characterize our research. These relate to the types of publications that we included, and to the challenges of distinguishing processes from outcomes.

First, our review of definitions and descriptions focused on peer-reviewed research articles and on practitioner websites. These were accessible, searchable, and citable. However, we recognize that much of the innovative thinking about regenerative agriculture has been done by farmers and other stakeholders whose ideas and experiences may not be well represented in the publications we reviewed. Further, much relevant discussion has also occurred in other forums, including books and reports (e.g., Pretty, 1995), policy documents (e.g., Regeneration International, 2016), and public talks (e.g., Brown, 2016). It was beyond the scope of this study to additionally include such publications. It is possible that had we done so, they might have introduced some new dimensions (e.g., novel processes, outcomes, or combinations of these) of regenerative agriculture that we did not capture in our review. Such a finding would have only strengthened our conclusions about the need for clarity and would not have altered the implications of process- or outcome-based definitions.

Second, while it was generally straightforward to parse processes from outcomes, in a small number of cases there was some ambiguity or doubt about the most appropriate categorization. For example, Duarte et al. (2019) stated that “Regenerative farming systems can provide organic crops...” which could be interpreted as an outcome (the crops that are produced) but which also implies a process since organic certification in the US is process-oriented. In such cases, we did our best to parse processes from outcomes based on the definitions and context available.

Finally, our methodology reveals what definitions have been used, but it does not reveal anything about why or how those definitions have variously emerged, diverged, or gained traction. Nor does it explain the rise in popularity of regenerative agriculture in recent years. Additional research could usefully explore those questions.

## CONCLUSIONS

There is a rapidly growing interest in regenerative agriculture, among a range of actors in the public, private, and non-profit sectors. This includes rapid growth in the academic field of study around regenerative agriculture and the number of practitioner organizations focused on regenerative agriculture.

Our review provides an evidence-based understanding of how some individuals and organizations have defined or described the term “regenerative agriculture.” Our results show that there are tensions between definitions based on processes and/or outcomes. For example, if an outcome-based definition is agnostic to the processes that generate those outcomes, this is potentially in conflict with a definition that is based on process. There are also policy implications of each type of definition. Whether and how regenerative agriculture is defined has consequences for how this form of food production is perceived by a variety of stakeholders, including policy-makers and consumers. Given the diverse range of ways in which the term “regenerative agriculture” has been defined and described, we suggest that users of the term define it carefully for any given use and context.

We do not advocate here for any particular definition. We report on the relative frequency with which different processes and outcomes were mentioned in the publications that we reviewed, but to do so is not to suggest that those definitions are in any way more correct, better, or preferable to other definitions. Rather, our review highlights the range of choices that decision-makers might consider when engaging with ideas and policies around regenerative agriculture. We hope that our review will serve as a valuable benchmark in the continual evolution of research and practice around regenerative agriculture, as well as a useful tool for developing and evaluating the effectiveness of related programs.

## AUTHOR CONTRIBUTIONS

PN and NC: conceptualization. PN, NC, LF-G, KB, and CJ: methodology, writing—review, and editing. PN, KB, and CJ: investigation. PN: analysis, writing—original draft, project administration, and funding acquisition. All authors: contributed to the article and approved the submitted version.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fsufs.2020.577723/full#supplementary-material>

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