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Moving towards an anti-colonial definition for regenerative agriculture

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Abstract

Regenerative agriculture refers to a suite of principles, practices, or outcomes which seek to improve soil health, biodiversity, climate, ecosystem function, and socioeconomic outcomes. However, recent reviews highlight wide heterogeneity in how it is defined. This impedes our ability to understand what regenerative agriculture is and has left the movement open to strategic repurposing by diverse stakeholders. Furthermore, the conceptual franchising of the regenerative agriculture debate by Western culture has omitted discussions surrounding social justice, relational values, and the contribution of Indigenous and local knowledge that does not align with Western-centric producer-consumer frameworks. This is a continuation of injustice by creating barriers to representation and participation, and its confrontation will ultimately be necessary for regenerative agriculture to achieve its transformative potential. This article demonstrates that the farming techniques associated with the regenerative agriculture movement today have been practiced for centuries, and in some cases millennia, by Indigenous and local communities around the world. We propose that current Western academic attempts to define

regenerative agriculture have resulted in long lists of practices, principles, and outcomes which fall short of describing the whole, because they lack the relational values component that is so integral to these Indigenous and local knowledge systems. We take an urgently needed, Indigenous-informed approach to defining regenerative agriculture, which confronts current epistemic injustice and prioritizes sociocultural and relational values. Finally, we propose an anti-colonial definition that draws on diverse knowledge systems including Indigenous ecophilosophies and published scientific analyses.

Keywords: Indigenous epistemologies, relational values, regenerative practices, nonmaterial, industrial agriculture.

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Introduction

The number of research articles using the term regenerative agriculture has increased exponentially in the last 7 years (Newton et al. 2020; Daverkosen and Holzknecht 2021). The concept has gained increasing popularity amongst consumers, producers, academia, industry, and media. The intensification of agriculture towards large crop monocultures and intensive livestock systems requires high inputs of chemical pesticides and fertilizers, erodes biodiversity, and has depleted the natural capital upon which food systems depend. Broadly, regenerative agriculture refers to a suite of alternative principles (Brown 2018; LaCanne and Lundgren 2018; Fenster et al. 2021), practices, or outcomes (Newton et al. 2020; Shreefel et al. 2020) which seek to actively build back soil health, biodiversity, climate, ecosystem function, and improve socioeconomic outcomes. However, recent reviews highlight that there is wide heterogeneity in how it is defined, with various combinations of principles, practices and/or outcomes interpreted as regenerative (Newton et al. 2020; Shreefel et al. 2020; LaCanne and Lundgren 2018; Fenster et al. 2021). Struggles in advancing our understanding of what regenerative agriculture is has left the movement open to strategic repurposing by diverse stakeholders. For example, layering regenerative practices on top of resource-intensive farming and omitting discussions surrounding social and cultural justice, which have the potential to reduce sustainability and further compound issues relating to justice and fairness (Ryan 2022).

Attempts to reconcile global food production with planetary conservation have fallen into two categories— land sparing and land sharing. Land sparing sits wholly within the Western epistemic view of nature as separate from humans, and proposes that intensive agriculture, cities, and human developments are concentrated into small areas, leaving large wilderness areas for nature to recover (Dudley and Alexander, 2017). Land sharing takes a more relational view; it advocates for the integration of agroecological approaches that simultaneously produce food whilst conserving, restoring, or regenerating the natural environment. Advances in our academic understanding of these issues highlight that dominant global conservation policies which abstract humans from the rest of the world, in conceptual alignment with a land sparing approach, are problematic for several reasons (Fletcher et al. 2021). This prevailing mode of “colonial conservation” (Domínguez and Luoma 2020) is characterized by the creation of protected areas by actors vested in shaping mainstream, transnational, conservation strategies (lawmakers, academics, conservation scientists, NGOs, governments, international agencies, and donors). Local people who depend on these natural resources must be excluded, and only tourism and

scientific research are considered appropriate uses (Domínguez and Luoma 2020). Where administrative procedures that do recognize Indigenous and local land rights have been established, in practice there are intractable legislative hurdles. However, evidence from up-to-date, spatially explicit global reconstructions of historical human populations show that even 12,000 years ago, nearly three quarters of Earth's land was inhabited by human societies (Ellis et al. 2021). Many highly biodiverse landscapes have long been shaped by Indigenous and local people. For example, in sub-Saharan Africa Indigenous rangeland management practices, including fire, periodic grazing and herding strategies, have been used since pastoralism emerged 5,000 years ago (Notenbaert et al. 2012). Similarly, millennia of Indigenous people's intervention in the Amazon Forest system has promoted and maintained biodiversity, forest structure, and highly fertile soils (Neves et al. 2003; Montoya et al. 2020). Clearly, lands currently viewed as natural or pristine may have long histories of use by Indigenous communities.

In theory, regenerative agriculture is in alignment with a land sharing approach, and rejects colonial conservation (Collins et al. 2021) which denies Indigenous and local people's access rights, agency, and knowledge of the land. It does not involve protecting nature from the influence of humans by excluding them, but seeks to achieve positive outcomes for the soil, water, climate, and both human and nonhuman life, through careful intervention. Regenerative practices such as diversified crop rotation, cover cropping, and no-till have been shown to increase soil health parameters including carbon storage and microbial activity, as well as crop yield in the long term (21-36 years) (Chahal et al. 2021). However, these agricultural practices have in fact been used by Indigenous communities for centuries and millennia globally (Rajaram et al. 1991; Eilittä et al. 2004; Neves et al. 2003; Akullo et al. 2007; Notenbaert et al. 2012; Degaga and Angasu 2017). In this sense, regenerative agriculture is nothing new with regard to the knowledge it represents, yet Indigenous knowledge has been excluded and profoundly marginalized through the dispossession of land and culture during Western colonization. Land management under post-colonial production has been a key contributor to the climate and biodiversity crises of the Anthropocene, and industrial agriculture remains dominated by Western scientific knowledge.

This article aims to provide evidence that while regenerative practices themselves are often framed as novel or innovative, their use can be traced back to Indigenous cultures and pre-colonial knowledge systems around the world. We propose that current Western academic attempts to define regenerative agriculture have resulted in long lists of practices, principles, and outcomes which fall short of describing the whole, because they lack the relational values component that is so integral to these Indigenous and local knowledge systems. The present Western hegemonic framing is unable to capture the holistic, reciprocal, loving, and mutually respectful socioenvironmental value systems which are common to diverse Indigenous cultures across the world (Zent and Zent 2022). This is a continuation of injustice by creating barriers to representation and participation, and its confrontation will ultimately be necessary for regenerative agriculture to achieve its transformative potential. Transformation refers to deep and sustained structural and systematic change to the drivers eroding agricultural systems, not limited to change in material systems and landscapes, but in socio-cultural structures and 'mindscapes' - the discourses that shape our reality (Gordon et al. 2021). The use of language associated with relational values (such as 'respect' and 'loving') can evoke a negative or dismissive reaction in those operating within Western values systems, however we argue that this must be overcome, itself being a symptom of the marginalization and continued colonization of Indigenous worldviews. Finally, confinement to a Western conceptual framework is an inadequate response to climate, biodiversity, and socioeconomic crises, which stem from deeper systemic issues and require radical cultural shifts. We propose an anti-colonial definition for regenerative agriculture which acknowledges and prioritizes matters of sociocultural and epistemic justice, drawing on diverse knowledge systems including Indigenous ecophilosophies and published scientific analyses. We suggest this definition will be dynamic as the movement evolves.

Contextualizing regenerative agriculture as an agricultural counter-movement

In the 1940s, a research project began in Mexico (the International Maize and Wheat Improvement Centre, CIMMYT due to its Spanish name) supported by the Rockefeller Foundation (Cleaver 1972; Boyer 2012) to increase agricultural production, specifically grain, through the application of technical and scientific advancements. This would become the template for the Green Revolution, transforming landscapes, economies, and societies around the

world with a package of technologies upon which expanding production would be integrally dependent (Boyer 2012). To achieve results, specially bred grain varieties were reliant on inputs of new chemical fertilizers and pesticides, irrigation systems, and machinery (Evenson and Gollin 2003). Despite its immediate successes (notably, dramatically reduced human hunger), over time the unforeseen ecological impacts of the Green Revolution have become a matter of environmental crisis. Broad-spectrum, environmentally persistent pesticides, herbicides, and inorganic fertilizer applications have resulted in environmental toxicity and biodiversity loss (Sud 2020). Monoculture crops and oversimplified ecosystems lack resilience making them vulnerable to pests and diseases, resulting in further reliance on chemical pesticides (Putra et al. 2020). Heavy machinery and repetitive soil disturbance exacerbate compaction, erosion, and loss of topsoil (Lal 2005). In addition, by integrating developing countries into the capitalist agricultural market, and rendering them dependent on this market, regional and social inequalities have been exacerbated (Cleaver 1972; Sebby 2010). In response to these environmental, social, and food sovereignty injustices, agricultural counter-movements began to arise.

Arguably the oldest of these alternative agricultural movements is ***agroecology***, a term first used by Bensin (1928) almost 100 years ago to describe the use of ecological methods in research on commercial crop plants (Wezel et al. 2009). The idea behind agroecology is to "apply ecological concepts and principles to the design and management of sustainable food systems" (Gliessman 2007: 369; Altieri 2018; Francis et al. 2003). By leveraging naturally occurring ecological processes and integrating them into agricultural systems, it is possible to attain functions such as pest and disease control, nutrient cycling, and soil conservation without (as much of) the need for external inputs. Because of this, from the earliest days of the Green Revolution, agroecology was at odds with many of the technological packages that were offered, which relied heavily on synthetic, off-farm inputs in order to actualize their full benefits. In addition, as agroecological methods were implemented, especially in Latin America, agroecology came to entail not only an alternative way to practice agriculture, but also a way to structure food systems that attends to important ecological, economic, and social considerations (Wezel et al. 2009), including re-valuating traditional ways of practicing agriculture (Lara and Santiago 2017).

Because of its multidimensional approach to food systems, agroecology in practice has strong overlaps with other alternative agricultural movements, in particular ***food sovereignty***. Like agroecology, food sovereignty challenges the rubric of conventional agricultural production (Rosett 2006; Rosset et al. 2006), seeking to restructure power relations within the current political economic context, by reclaiming sovereignty at the local scale. Perhaps the most well-cited definition of food sovereignty comes from the Nyéléni Declaration:

> "Food sovereignty is the right of people to healthy and culturally appropriate food produced through ecologically sound and sustainable methods…It puts the aspirations and needs of those who produce, distribute and consume food at the heart of food systems and policies rather than the demands of markets and corporations" (Nyéléni 2007).

While food sovereignty may be an inherently more political movement than agroecology, the two frameworks both oppose conventional agricultural practice and share many values (Machado 2017). Their synergies stem from a shared pair of two primary concerns as crucial elements of food systems: agriculture's ecological functioning and socio-economic justice.

There are a number of other agricultural frameworks, however, which while acknowledging the need for improved sustainability, aim to do so without engagement with the underlying social and economic dimensions. Approaches such as climate smart agriculture (Lipper et al. 2018), sustainable intensification (Tilman et al. 2011), and smart sustainable agriculture (SSA) (Alreshidi 2019) build upon many of the precepts of the Green Revolution, especially in their technocratic approach and continued reliance on external inputs. These frameworks generally rely on technological improvements, such as artificial intelligence, improved forecasting, and climate-tolerant crop varieties, to both mitigate the effects of climate change on agricultural production and limit the associated environmental externalities (Taylor 2018). Such framing, which effectively decouples the ecological concerns of agricultural sustainability from the socio-economic concerns of justice and equity (Karlsson et al. 2018), makes these approaches much more amenable to the agri-food industry.

Regenerative agriculture occupies an interesting position between the more radical agricultural movements (agroecology and food sovereignty), and the more industry-friendly alternatives just described. The term regenerative agriculture traces back to the work of Robert and J.J. Rodale from the Rodale Institute (Rodale Institute 2018), who were among the early modern pioneers of

the organic and sustainable agricultural movements (Leu 2020). It was seen as a "holistic systems approach to farming that encourages continual innovation for environmental, social, economic and spiritual well-being" (Leu 2020). At its inception, therefore, regenerative agriculture was much more aligned with the multidimensional priorities and values inherent in agroecology and food sovereignty. In the intervening decades, however, as regenerative agriculture has entered contemporary discourse, varying definitions of the term have proliferated (Newton et al. 2020; Shreefel et al. 2020). Some of these definitions have maintained the socio-economic underpinnings present in early definitions, while others have jettisoned these for more ecologically narrow interpretations, or those which equate the socio-economic dimensions of agriculture with profit (LaCanne and Lundgren 2018). There has emerged a divide between a more holistic view, described by Daverkosen and Holzknecht (2021) as the "agroecological-ruralist movement pursuing a fundamental restructuring of food systems", versus a more dissected, practice-based view represented by a "techno-economic movement… that aspire[s] to increase production". Tittonel et al. (2022) describe more than one type of regenerative agriculture and highlight the neglect of the political and social dimensions of sustainability as compared to agroecology. While there is arguably some merit in being able to speak to different elements and communities within the agricultural system, this inherent variability also makes regenerative agriculture vulnerable to being co-opted by industry, for example through greenwashing, in ways that undermine its more radical transformational potential.

Methodological approach

This critical interpretive review combines systematic methodology with a qualitative tradition of enquiry, taking a diachronic, interactive, and iterative approach that is intended to contextualize discussion and generate theoretical insights rather than as a comprehensive analysis (Grant and Booth 2009; Palmer 2022). Critical theorizing as a review process aims to extend the body of knowledge and critique key ideas from existing literature, often addressing questions based in conceptual analyses (Mc Dougall 2015). In contrast to systematic review methodology where engagement with all available data is necessary to answer a question or aggregate existing arguments, a strong ethical, conceptual, or normative analysis offers more qualitative insights

into the “contours of the literature as a whole”, or “question[s] the epistemological and normative assumptions of the literature” (Mc Dougall 2015).

Our search strategy used recognized terms relating to regenerative agriculture and the associated practices, principles, and outcomes, and was refined iteratively through key terms identified from relevant articles and sources. Electronic searching was conducted using Google Scholar, ScienceDirect, SpringerLink, Web of Science, Wiley, and Google searches, and was expanded by reference-chaining, and contact and discussion between co-authors, colleagues, and experts. Finally, critical interpretive review does not exclude research using the narrow inclusion criteria of a systematic review (Mc Dougall 2015). This is particularly important in the context of academic bias and the underrepresentation of Indigenous and local knowledge in mainstream literature. We therefore did not exclude articles based on a predetermined quality assessment, but rather considered the strengths and weaknesses of insights from a wide range of sources as part of our synthesis.

As researchers, our team collectively represents a variety of professional and personal identities that are important for contextualizing our positionality. Egleé Zent is a Venezuelan mother with an eclectic academic formation (conservation biology, art, anthropology, botany) that emphasizes the collective construction of knowledge. She conducts biocultural participatory action-research with Indigenous groups in two tropical areas: the páramos of the high Andes among Parameros, and lowland Amazonia among the Jotï. Mario Reinaldo Machado is a U.S. white male Hispanic whose training and research in geography typically employs a variety of critical, feminist, and Marxist lenses to analyze issues related to sustainable agriculture, agrarian transitions and political ecology in Latin America and the U.S. Northeast. Rachelle Gould is a white cisgendered woman who conducts interdisciplinary research on human-nature relationships, ecosystem services, and environmental values; her work draws on anthropology, psychology, ecology, and philosophy, among other disciplines. Bryony Sands is a white female from the U.K. who works with livestock farmers to investigate the impacts of regenerative agriculture on beneficial insect biodiversity, soil health, and sociocultural outcomes. She is part of the CCERN Nature Relations Research Collective who take a posthuman relational approach to challenge dominant discourse on issues regarding education, climate, and the environment. Alissa White is a white female agroecologist who uses participatory action research and

transdisciplinary approaches to support research on environmental problem-solving in agricultural communities of the Northeastern US. Her work is informed by frameworks of cognitive justice, post-positivist constructivism, sustainable livelihoods, and ecosystem services.

Colonialism and regenerative agriculture

Colonialism refers to the dispossession, exploitation, or appropriation of first land, and then resources, culture, epistemologies, or identities of one group of people by another (Nadasdy 2005; Domínguez and Luoma 2020). In analyzing what this means for regenerative agriculture, we follow the work of Tuck and Yang (2012) and Liboiron (2021), who argue that decolonization is about the repatriation of Indigenous land and life and is not a metaphor for other anti-colonial struggles. This is particularly relevant to the academic discourse of "decolonizing" the curriculum, university courses, panels, and other nouns, while colonial Land relations remain securely in place (Tuck and Yang 2012; Liboiron 2021). While these goals are important and benevolent, they involve settler and colonial access to Indigenous land, concepts, and worldviews in order to advance settler and colonial goals. This is incommensurable with decolonization, which involves repatriating land and life to sovereign Native tribes and nations. We therefore view our methodology here as anti-colonial, as we attempt to remove settler and colonial entitlement from definitions of regenerative agriculture and de-emphasize the knowledge systems of dominant science. We acknowledge that "no phraseology can be a substitute for reality" (Tuck and Yang 2012). Many environmental solutions in agriculture assume access to Indigenous land and the production of value for settler and colonial desires, maintaining the dispossession of Indigenous peoples for the "common good of the world" (Liboiron 2021). We invite future discussion of what this means for practicing regenerative agriculture on colonized land.

Current attempts to define regenerative agriculture

To date, definitions of regenerative agriculture can be placed into three broad categories: practice-based, outcomes-based, and principles-based (although specific studies may use different terms). There is some overlap between the practices and principles outlined in these

studies, however the principles are generally more context-independent and could be achieved through the application of various practices. In their systematic review analyzing 28 peer-reviewed articles involving definitions of regenerative agriculture, Shreefel et al. (2020) found 214 objectives and 77 activities, which were broadly categorized into 13 outcome themes and seven practice themes. Examples of practices were minimizing tillage, crop rotation and use of manure or compost. Outcomes involved enhancing soil health, alleviating climate change, and improving biodiversity (Shreefel et al. 2020). Overall, 18 of these themes were focused on the environment (largely soil health), one on human health, and one on economic benefits. Another review included practitioner websites (n=25) as well as peer-reviewed articles (n=229) (Newton et al. 2020). Similarly, this revealed a broad distinction between process-based definitions (including principles and/or practices), and outcomes-based definitions. Nineteen principles and practices, and 17 outcomes, were identified. The most common examples of principles and practices were reducing external inputs, integration of livestock, cover crops, and reducing tillage, while outcomes focused on improving soil health, sequestering carbon, and increasing biodiversity.

An approach which has been taken by both academics and farmer innovators is to define regenerative agriculture using a set of principles. In his book *Dirt to Soil* (Brown 2018) North Dakota regenerative farmer Gabe Brown outlines five principles of soil health: 1) no – or minimal- till, 2) keeping the ground covered, 3) diversity in plant and animal species, 4) keeping living roots in the soil, and 5) integrating animals. Similarly, LaCanne and Lundgren (2018) outline four unifying principles consistent across regenerative farming systems: 1) abandoning tillage, 2) eliminating bare soil, 3) fostering plant biodiversity, and 4) integrating livestock and cropping operations. They suggest that further characterization is problematic due to the myriad combinations of practices which target the regenerative goal. Fenster et al. (2021) added a fifth principle to the formula proposed by LaCanne and Lundgren (2018): 5) to reduce or eliminate synthetic agrichemicals. They distill these further to two central principles: 1) reduce uniform disturbance (such as tillage and agrichemical use) and 2) increase diversity (biodiversity and revenue stream diversity), the latter highlighting the importance of economic wellbeing. Finally, Fenster et al. (2021) proposed a regenerative scoring system based on the five principles. They tested their scoring system against regenerative outcomes on farms (soil health, water infiltration, plant and insect biodiversity, yield, and profit) and found that it scaled positively with many of

these. This is the closest to a clearly defined technical framework for regenerative agriculture but needs further validation in various environmental and management contexts.

On the whole, academic research articles tend to emphasize the biophysical dimensions of regenerative agriculture (Fig. 1) while the socio-economic dimensions are lacking.

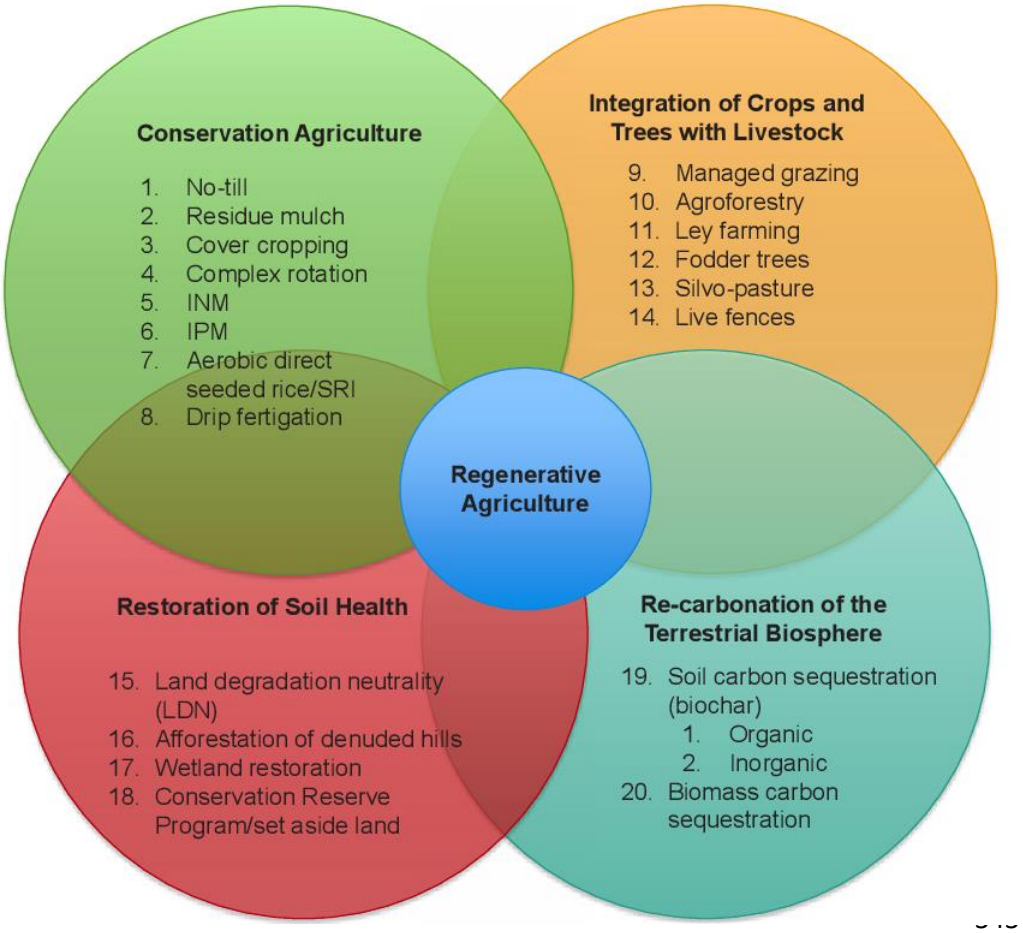

Fig. 1 An example of a conceptual diagram of regenerative agriculture from an academic paper. Note the overwhelming emphasis on biophysical dimensions (Source: Lal 2020).

Interestingly, practitioner websites placed greater emphasis on the importance of improving social and economic wellbeing as an outcome compared to academic research articles (Newton

et al. 2020). For example, a general conceptualization from one practitioner website integrates principle-based understandings of regenerative agriculture alongside outcomes-based understandings (Fig. 2). It emphasizes both the socio-economic and biophysical dimensions that underpin regenerative agricultural systems, however nonmaterial dimensions, including values, cultural beliefs, spirituality, and norms of reciprocity are absent.

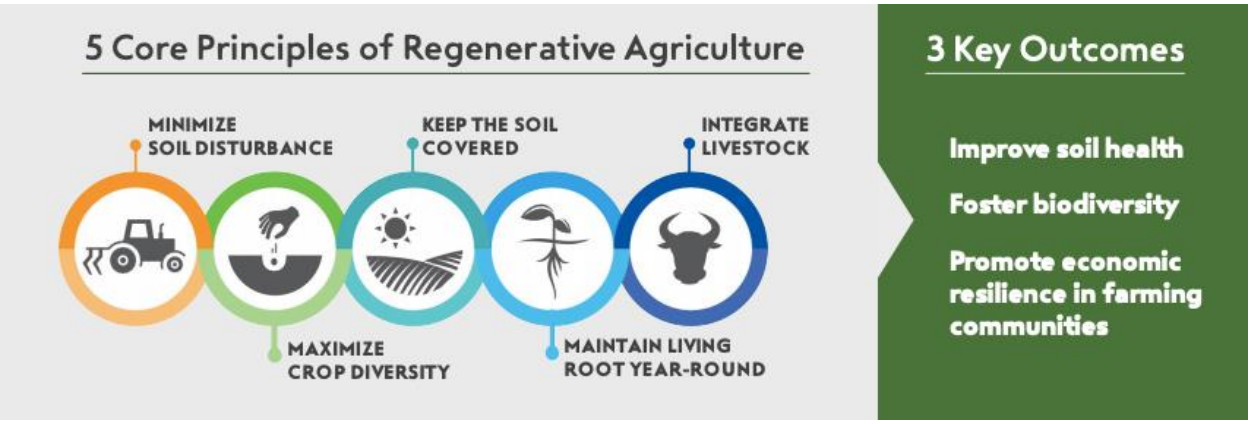

Fig. 2 An example of a conceptual diagram depicting both principles- and outcomes-based understandings of regenerative agriculture. Note the presence of biophysical and socio-economic dimensions of agricultural systems and the absence of nonmaterial dimensions, including values, cultural beliefs, spirituality, and norms of reciprocity. (Source: General Mills 2019)

With regard to a coherent definition of regenerative agriculture, Shreefel et al. (2020) provisionally propose:

> "an approach to farming that uses soil conservation as the entry point to regenerate and contribute to multiple provisioning, regulating and supporting ecosystem services, with the objective that this will enhance not only the environmental, but also the social and economic dimensions of sustainable food production".

Notably, cultural ecosystem services, i.e., the nonmaterial benefits afforded by ecosystems, are not included in this definition despite explicit mention of the other three groups of ecosystem services (provisioning, regulating, supporting) (Millennium Ecosystem Assessment 2005). This

conspicuous absence speaks to the missing part of the story for most of the recent conceptualizations of regenerative agriculture: nonmaterial dimensions (e.g., values, norms) that do not align with Western-centric producer-consumer frameworks (Gould et al. 2020) (Fig. 3).

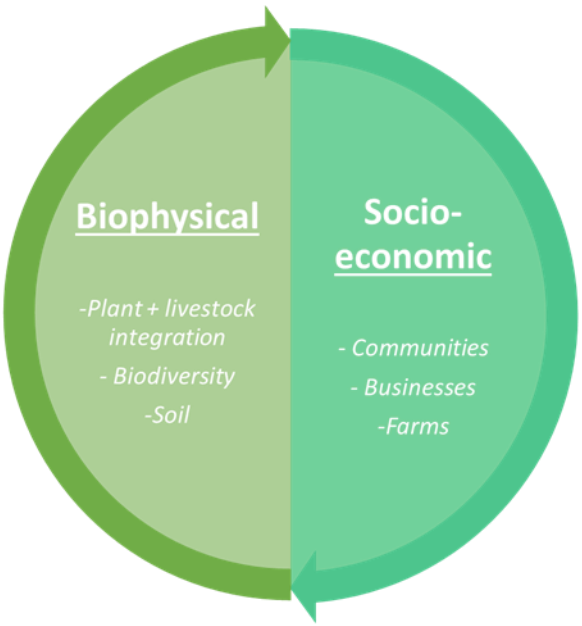

Fig. 3 Conceptualization of regenerative agriculture through a Western scientific lens. Emphasis is on biophysical regeneration with considerations for socio-economic regeneration, while little

Omitting discussions surrounding social justice and relational values in regenerative agriculture may reduce sustainability and compound issues relating to economic, cultural, racial, gender and epistemic justice and fairness (Ryan 2022). The conceptual franchising of the regenerative agriculture debate by Western culture (Santos 2014) risks further disempowerment and delocalization for farmers and limits its environmental and sociocultural potential by avoiding deeper systemic problems. However, a more-than-human ethic of care has recently been demonstrated in regenerative farmers in New Zealand (Seymour and Connelly 2022). Farmers described becoming attentive to non-human species in their environment and creating relationships which embody mutuality, reciprocity, trust, and interdependency with their human and non-human environments. A sense of responsibility relating to intergenerational stewardship

was described, extending to inanimate non-humans such as the soil. Through this, the colonial mentality of agriculture dominating over the natural environment, based in constructions of human/nature binaries, can be re-framed. These relational aspects are crucial to transformation because they contain the mindset shift which is vital to making long-term, permanent change in human behavior and human-nature relations (Seymour and Connelly 2022).

This mindset shift in relation to regenerative agriculture has been described as an emergent, radically evolving, and diverse discursive alternative to industrial-productivist agriculture (Gordon et al. 2021). Shifting *mindscapes*, or the discourses that shape the way that people conceptualize reality, can be viewed as more integral to transformative change than prescriptive definitions involving practices, principles, or outcomes relating solely to *landscapes*, which "demonstrate the lack of theoretical depth and consistency" (Gordon et al. 2021). Discourses are a way of understanding the world through shared meanings, practices, stories, and relationships that influence our behavior. Regenerative agriculture discourses have been shown to inhabit a different set of storylines to industrial-productivist agriculture, characterized by relationality between human and nonhuman biota (Gordon et al. 2021). In *The Call of the Reed Warbler* (Massy 2018), nonindigenous Australian sheep farmer Charles Massy portrays the divergence of what he terms the "organic mind" and the "mechanical" or industrial mind, the latter being responsible for "landscape illiteracy" and the resulting climate, biodiversity, and social justice crises of the Anthropocene. This dilemma is epitomized in the dual definitions proposed by Daverkosen and Holzknecht (2021), who present a holistic definition of regenerative agriculture to encompass theoretical ideologies and philosophies, alongside a working definition of explicit statements which can be tested with scientific hypotheses. What these authors are describing is essentially the dichotomy between Indigenous, traditional, relational, ontologies and the Western conceptualization of nature and humanity as separate ontological spheres (Zent and Zent 2022). To Massy, regenerative agriculture is "ultimately a story about renewing Mother Earth and her systems and our deep, co-dependency on these" (Massy 2018).

Disaggregating regenerative agriculture from its Indigenous origins and from the socio-cultural context in which it is based may, on one hand, seem like a way of making it more objective, rationalist, or scientific. In reality, this disaggregation means that regenerative principles and practices are in fact re-embedded in an entirely different socio-cultural context, that of Western

419 science and capitalism. Figure 4 represents a conceptualization of regenerative agriculture based
420 on Indigenous and traditional worldviews, and through such perspectives, it can be seen that both
421 the biophysical and socio-economic dimensions of regeneration are embedded and inextricably
422 linked to an overarching cultural context.

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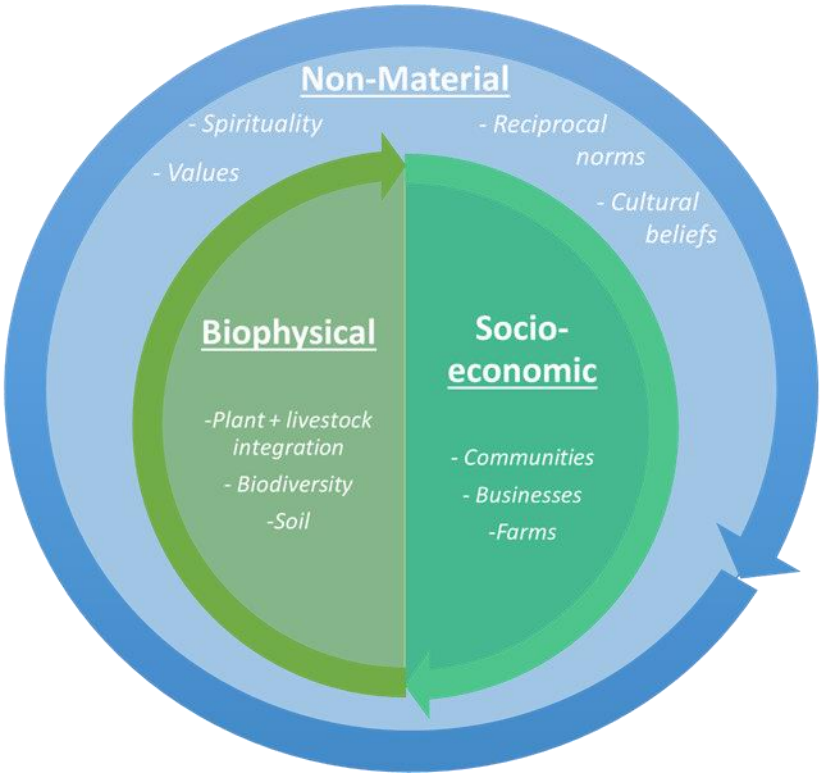

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425 **Fig. 4** Conceptualization of regenerative agriculture based on understandings of Indigenous and
426 local knowledge systems. Both biophysical and socio-economic dimensions are relational in
427 terms of material regeneration, but these systems are also embedded in and inextricable from a
428 broader cultural context which entails nonmaterial dimensions, such as spirituality, values,
429 cultural beliefs, and reciprocal norms.

430

431 This context provides not only a framework for grounding regenerative practices in a particular
432 place through reciprocal norms (i.e., local knowledge systems), but it also provides a value-
433 system for implementing these practices founded in culturally-specific and spiritual
434 understandings of the world. The reality of all knowledge systems, whether Indigenous,

traditional, or Western scientific, is that they are unavoidably embedded in a broader socio-cultural context. The values and practices associated with regenerative agriculture should therefore be viewed as co-constitutive.

In their review, Newton et al. (2020) do not advocate for any single definition of regenerative agriculture but highlight the "range of choices that decision-makers might consider". Although this reluctance to define the term may reflect tensions around limiting its accessibility and ongoing evolution, the "range of choices" along with neglect of the nonmaterial aspects or relational values, has left the movement open to strategic repurposing by diverse stakeholders. For example, the layering of regenerative practices on top of resource-intensive farming benefits agribusinesses and tech companies by subverting economic benefits, and may be why older agricultural movements such as agroecology, which implicitly value farmer participation, matters of socio-economic justice, and Indigenous and local knowledges (Utter et al. 2021), have not achieved such unprecedented popularity with industry. Agroecology has also experienced definitional plurality over its evolution, from an early emphasis on ecological processes in agricultural systems, to its emergence as a multidimensional approach to broader agri-food systems, through a "gradient of interpretations and applications" (Méndez et al. 2013). Wezel et al. (2009) describe "confusion in the use of the term 'agroecology'", and how its use is affected by the geographical, scientific, and contextual background. For example, one perspective applies agroecology as a framework for scientific research grounded in Western tradition, while another expands a broader perspective which engages with social sciences and agri-food system issues (Méndez et al. 2013). Méndez et al. (2013) argue that an unclear depiction of agroecology explicitly ignores important aspects of its evolution as a field of knowledge and justifies the application of narrow definitions that suit particular perspectives, such as those that privilege positivist science over other ways of knowing (e.g., Indigenous or local knowledge). To counter this, they propose a transformative agroecology characterized by a transdisciplinary, participatory, and action-oriented approach (Méndez et al. 2013).

Another perspective, and one that we acknowledge, is that defining a movement can itself be a political act, or an act of power, which both restricts ideas of what that movement should be and excludes participation by restricting access points (for example for broad-acre conventional farmers, or for Indigenous communities). The push to define regenerative agriculture has been

described as an act of colonization (Haslet-Marroquin 2022; Loring 2022), which "reduces it to the limitations of our colonizing minds". Others argue that definitions can create boundaries and exclude minority interpretations (Gordon et al. 2021). These tensions highlight unavoidable trade-offs, and clearly any definition focusing on narrow dimensions of regenerative agriculture can perpetuate inequalities. While recognizing these dangers, our author collective agrees on the benefits of coherence at this time, when action is so necessary alongside critical theory. We therefore propose that an anti-colonial definition of regenerative agriculture is needed as a way of intervening in the current discourse, and (as with agroecology) to precipitate transformative change. However, we suggest that this will be dynamic and itself regenerate as the movement evolves (Gordon et al. 2021).

In the next section of this review, we will demonstrate that the farming techniques associated with the regenerative agriculture movement today have been practiced for centuries, and in some cases millennia, in Indigenous and local communities around the world. This highlights the urgent need for a previously missing, Indigenous-informed approach to defining regenerative agriculture, that confronts current epistemic injustice and prioritizes relational values.

The Indigenous foundations of regenerative practices

Regenerative agriculture has recently gained attention in academic literature and popular press as a new solution for food systems, in place of the concept of sustainability which is deemed inadequate if we are seeking to restore, rather than maintain, degraded ecologies (Rhodes 2017). It has been framed as part of a "bold new agricultural business model" (Lane 2021). While it is crucial to recognize the adaptability and creativity of farmers applying regenerative solutions to the environmental and economic injustices of the industrial agricultural market, the practices themselves are largely founded in pre-colonial knowledge systems around the world. These practices have emerged independently in different cultures, times, and places, and the examples given here are not exhaustive.

No-till

Reducing or eliminating tillage is universally included in definitions of regenerative agriculture as either a practice or a central principle. Limiting soil disturbance is understood to be of key importance for outcomes relating to soil health, structure, biological activity, organic matter, and carbon sequestration (Pittelkow et al. 2015; Newton et al. 2020). The conservation tillage technologies developed in recent non-Indigenous agriculture have many characteristics of Indigenous tillage systems. For example, practices in India that have been used for centuries include the use of implements designed to stir the soil rather than turning it over (Rajaram et al. 1991), similar to a single-point cultivator in which a small iron point digs into the earth in a narrow furrow. The farmers using these tools place importance on leaving plant mulch on the surface to preserve essential moisture in the seedbed, as well as their suitability for family and community labor, so the village carpenter can fit the plow pole and the family themselves can make repairs to the equipment (Rajaram et al. 1991). This demonstrates the importance of the cultural value systems in which Indigenous tillage practices are embedded.

In the late 19th century Western plow technology, designed to overturn the upper layer of soil and bury surface mulch, was introduced to India by colonial officers but was met with resistance from local farmers. In addition to depleting soil moisture and structure, this technology displaced rural labor in colonized nations (Rajaram et al. 1991). Similarly, European colonizers introduced the Western plow to North and South America, Asia, and Africa (Derpsch 2004), only to discover that temporary increases in productivity and wealth would bring soil erosion and land degradation. A well-known account from the late 19th century describes an Indigenous American who observes white settlers plowing a field for the first time and simply says “wrong way up” (Jackson 1987). Ironically, as a solution to these problems, no-till technologies began to be promoted by government organizations (Derpsch et al. 2010). The concept of no-till within Western industrial agriculture first emerged as a response to the severe erosion of soils and dustbowl of the 1930s in the USA, but its most widespread expansion occurred since the 1990s facilitated by support from industry thanks to market opportunities for specialist machinery and herbicides (Pittelkow et al. 2015). Initially, no-till conflicted with Western tradition and the “practice of turning the soil before planting a new crop” (Huggins and Reganold 2008). However, the economic advantages relating to decreased production costs and reduced soil erosion have resulted in increased adoption, and by 2014, over 35% of all cropland in the USA was managed under no-till (Dobberstein 2014).

Crop rotation

There are many examples of Indigenous farmers using crop rotation, and the majority of traditional agriculture is based on periods of rest or fallowing to improve yields and rejuvenate the soil (Akullo et al. 2007). For example, the Bayyo Community of the Philippine Uplands practice a variety of strategies based on local ecological knowledge to sustain crop productivity, including different systems of rice, sweet potato and peanut rotations (Magcale-Macandog and Ocampo 2005). During the growth of sweet potato, these farmers observed that nutrients were drained from the soil, but when peanuts were relayed (a type of rotation where the second crop is planted into the first before harvest) higher production was achieved. In these systems, *Katualle* fields are perennially harvested with sweet potato in relay rotation with maize, peanut, squash, and beans. In *Payew* terraced irrigated rice fields, rice and sweet potato are relayed and the land is prepared by incorporating bunches of wild sunflower stems into the soil as fertilizer (Magcale-Macandog and Ocampo 2005). In *Uma* fields, rotations are used for 3-4 years followed by a fallow period of up to 20 years. The local people state that these long fallow periods allow the soil to rest, rejuvenating fertility for vigorous and robust crop growth, and result in environmental and socioeconomic benefits including beautiful scenery, and materials for medicines and tools (Magcale-Macandog and Ocampo 2005).

In Papua New Guinea, Indigenous Enga people have intensified their agricultural systems in the past 60 years and use a number of techniques to increase productivity and maintain soil fertility (Bourke 2003). These include a legume/root crop rotation between winged beans or peanuts and sweet potatoes. Fallow periods were traditionally as long as 50 years, but to intensify land-use villagers have begun reducing these periods to around 15 years, relating the height of fallow vegetation to stages of their own lives, such as youth, marriage and their children's marriages. Villagers reported that successful sweet potato yields can be maintained for extended periods using this technique (Bourke 2003). Examples from Africa include communities in the Masindi, Hoima and Kibaale districts of Uganda where crop rotation, mulching, and fallowing are Indigenous practices (Akullo et al. 2007). Beans are the first crop in the rotation and cassava is the last because the leaves are known to decompose and add nutrients to the soil. These farmers expressed that the use of Indigenous knowledge creates social harmony and cohesion, and while

554 they appreciate the advantages of modern technologies, Indigenous knowledge must be promoted
555 in all farming practices (Akullo et al. 2007). Diverse crop rotation practices, motivated by
556 environmental, economic, and nonmaterial values, have therefore been developed through
557 generations of experience, observation, and adaptation, as a matter of survival in Indigenous
558 communities across the world.

559

560 Intercropping

561 Intercropping involves the cultivation of two or more crops simultaneously in the same field,
562 with the rationale that the different crops are unlikely to share the same pests, pathogens, and
563 nutrient requirements (Degaga and Angasu 2017), and will grow better in mutualistic
564 relationships with other crops. This is an important feature of cropping systems in the tropics, for
565 example in densely populated areas of Eastern Africa such as the highlands of Hararghe,
566 Ethiopia. Of 149 households surveyed in this area, all of them were using intercropping (Degaga
567 and Angasu 2017). The major crops were maize with haricot bean, sorghum with haricot bean,
568 and coffee and khat intercropped with various others. The local people described the reasons for
569 intercropping as maximizing profit and minimizing risk (Degaga and Angasu 2017). However, in
570 some areas in Ethiopia research has shown that farmers are practicing continuous cropping
571 methods with dedicated plots separating maize, haricot beans and other crops (La Rose 2014).
572 These farmers had a negative perspective of intercropping as an outmoded or primitive practice,
573 because of the promotion of intensive monoculture by governmental and non-governmental
574 agencies. Paradoxically, locally led community development projects like NURU Ethiopia are
575 now working with small-holder farmers to demonstrate the environmental and economic benefits
576 of intercropping.

577 The ‘three sisters’ or ‘milpa’ intercropping system is one of the most widely studied Indigenous
578 cropping systems, identified as the backbone of pre-colonial agriculture spanning from northeast
579 North America to southern Central America (Lopez-Ridaura et al. 2021). Indigenous people
580 from at least 15 different nations in this area have practiced three sisters agriculture, which
581 involves maize intercropped with beans and squash, and there is evidence that corn and beans
582 were planted together about 6000 years ago in the Mexican lowlands (Ngapo et al. 2021).
583 Complementary aspects of these three crops enhance soil nutrient availability, improve soil

health, and suppress pests, weeds, and disease. In the classic maize-bean-squash milpa, the maize stalk structurally supports the climbing bean, increasing its access to light, while the bean plant fixes additional nitrogen in the soil (Lopez-Ridaura et al. 2021). The squash vines shade the soil surface, acting as a living mulch to reduce moisture loss and weed growth. Studies have shown improved energy and protein yield compared to monocultures of the same crops (Pleasant 2016). There is also nutritional complementarity; corn is a source of carbohydrate that is lacking in protein, particularly the amino acids lysine and tryptophan, and these are specifically found in beans (Ngapo et al. 2021). However, three sisters intercropping is not just an agricultural strategy or technology but a cultural complex complete with stories, ceremonies and customs (Ngapo et al. 2021). In the first academic description of the three sisters (Parker 1910), the Iroquois People reported planting the three crops as a polyculture because it required less time and labor than planting the crops individually, and because they believed the plants were "guarded by three inseparable spirits and would not thrive apart" (Pleasant 2016).

Rotational grazing

The integration of livestock and cropping systems has been included as both a defining practice and principle of regenerative agriculture, viewed as fundamental to soil restoration (Newton et al. 2020; Schreefel et al. 2020; Fenster et al. 2021). Grazing ungulates and grasslands have co-evolved over a period of 55-45 million years (Stebbins 1987) and provide mutually beneficial services such as promoting the growth of vegetation, dispersal of seeds, and nutrient and water cycling (Notenbaert et al. 2012). For example, farmers in the Andes report that cattle feces carry seeds that contribute to maintaining the populations of grasses and other plants (Lezama-Núñez et al. 2018). Transhumance, the seasonal movement of livestock between complementary ecological belts, is a recurrent feature of Indigenous management systems (Dong et al. 2009; Notenbaert et al. 2012). In northern Nepal the Tamang people move Chauri (a yak-cattle cross) gradually from alpine pastures in summer to forestry areas in the downstream valley in winter (Dong et al. 2009). Different herds are grazed at different sites according to their adaptability; yak spend the winter at higher altitudes in subalpine pastures or forest, and the cattle (mostly Zebu) are herded with the yak in the summer for mating, but graze in the village scrubland or cultivated zone in the winter. Villagers observe rituals to protect the yak over winter (Gurung

and McVeigh 2002), use horns and skulls in religious ceremonies, and celebrate yak festivals with traditional music and dances (Joshi et al. 2020). This demonstrates the key cultural and social significance (the nonmaterial value) of yak herding to these communities. Furthermore, within transitional pastures animals are rotationally grazed and moved between plots every 10 – 15 days (Dong et al. 2009). The Tamang herders report that they observe the remaining grass cover to inform the frequency of rotational movement between plots, which protects pastures from being overgrazed and increases forage production. Local farmers also stressed that internal and external parasite problems are reduced by following these methods.

This complex and sophisticated indigenous grazing system is strikingly resemblant of rotational and management-intensive grazing (MIG) concepts associated with regenerative agriculture today. In regenerative grazing, rest-rotation cycles are maintained where short periods of dense grazing are followed by long forage rest periods that support vegetative growth and recovery (Spratt et al. 2021). In MIG the length of time that animals graze a particular plot is based on observing the intensity of forage utilization (usually around 50% depending on circumstances) and opportunity for regrowth (usually a minimum of 8 inches regrowth and a closed canopy) (Gerrish 2004; Shawver et al. 2020). Recent studies have demonstrated that this can improve soil quality through reducing bulk density, and increasing water retention, soil carbon storage, forage growth, and abundance of beneficial soil invertebrates including earthworms and beetles (Otálora et al. 2021; Teutscherová et al. 2021). However, key authors who have shaped approaches to rotational grazing consider holistic decision-making as a prerequisite (Gordon et al. 2021). For example, holistic planned grazing includes livestock rotation, but is based on holistic management (Savory and Butterfield 1999; Gosnell et al. 2020). Allan Savory developed holistic management in the 1960s as a values-based approach, in response to his perception that poor decision making driven by reductionist thinking was at the root of most human-made environmental problems (Gosnell et al. 2020).

Holistic planned grazing differs from rotational grazing where management decisions are based on goals involving either forage, animals, or finances, because it considers social, environmental, and economic factors simultaneously, and views all living things in the context of an interrelated dynamic community (Savory Global 2015). As a founding figure in regenerative agriculture, Savory states that “I was not by any means the first to make the connection between the hooves

of animals and the health of the land", noting that Scottish shepherds referred to the 'golden hooves' of sheep many centuries ago, and that Navajo Indigenous Americans warned government officials of a link between the hooves of the sheep and the health of the soil (Savory and Butterfield 1999). Savory states that modern farmers and ranchers have damaged parts of Africa and the Americas more in 300 years than "nomads and their flocks" did in more than 5000 years. He concludes that "we have no traditional land ethic or collective sense of conscience and responsibility, either to our fellow humans or to other life, and our governments reflect this". Savory's experiences, born to white British colonials in Zimbabwe, reflect the colonial mentality of human/nature binaries which have dominated socio-ecological relationships through Western discourse (Seymour and Connelly 2022). In fact, the Indigenous Shona people of Zimbabwe did show the collective sense of conscience and responsibility that Savory identified as lacking. The growing of traditional crops is central to enhancing social relations among the Shona people, whose proverbs emphasize the value of cooperation (*rume rimwe harikombi churu* ("one man does not surround an anthill")) and reciprocity (*kandiro kanoenda kunobva kamwe* ("a small plate of food goes where another comes from")) to bring people together though the production of food (Tavuyanago et al. 2010). The introduction of European crops (mainly maize) through colonial regimes disrupted social relations of 'oneness' or 'togetherness' among the Shona, as mechanization encouraged separatist work (Tavuyanago et al. 2010). Savory's values-based holistic management reflects Indigenous worldviews that focus on values, cultural beliefs, and norms of reciprocity, and could therefore be viewed as his reaction to the Western colonial discourse or reductionist thinking that legitimized exploitation of people and the planet.

Agroforestry and silvopasture

The intentional integration of trees and shrubs into crop and animal farming systems as a regenerative practice takes many forms - intercropping rows of trees between alleys of crops, forest farming with understory crops, trees planted as riparian buffers adjacent to waterways, silvopasture for livestock production, simple windbreaks (Elevitch et al. 2018). Agroforestry is a relatively new term, coined in the 1970s, and its practices have multiple ecological, social, and economic benefits providing diverse, resilient, multi-layer food systems. In possibly the earliest

documented mention of agroforestry in Central America, Cook (1901) observed that "the custom of planting leguminous trees with coffee is general" and Indigenous planters "have been practicing unconsciously a system of soil fertilizing". As we have seen in previous sections, Indigenous farmers are in fact well aware of the benefits of their techniques. Cook goes on to discuss the contradicting ideas of scientific investigators at the time, who viewed the practice of growing coffee under the shade of trees "illogical and insufficient…irrational and unjustifiable on the basis of any existing theories". Nevertheless, he concludes that the "wisdom of existing systems of [Indigenous] culture… hold possibilities as unsuspected as they are unrealized" (Cook 1901). Research in Ethiopia's Bonga natural coffee forest has shown that coffee rhizospheres under leguminous trees harbor a higher number of arbuscular mycorrhizal fungi spores, which stimulate coffee growth and soil nutrient content (Muleta et al. 2007). Shade trees have also been found to suppress major coffee pests, regulate temperatures, and increase the size and quality of beans.

In Northern California the Karuk and Yorok Indigenous Peoples manage agroforestry systems by lighting understory fires in early autumn in forests dominated by Tanoak and Douglas Fir, to remove weevil- and moth-infested acorns prior to the full harvest. This also clears dense underbrush making subsequent acorn, huckleberry, hazelnut, and mushroom harvest more successful (Rossier and Lake 2014). Amerindians refer to these fires as 'cultural burns' because they improve the qualities of resources central to both subsistence and ceremonial practices (Marks-Block et al. 2019). For example, hazel shoots from recently burned ground are considered by the Yorok and Karuk women to be the best for basket weaving. The baby basket is of great cultural significance, offering a vision to the infant of its lifelong relationship to the land, water, fire, spirituality, responsibility, and stewardship (Aldern and Goode 2014). However, Indigenous agroforestry fire practices and ecological knowledge have been disrupted for over a century through Federal and State fire policies which made Indigenous burning largely illegal (Lake 2021). This has contributed to the deterioration of forests and watersheds and created conditions for catastrophic wildfires in California through the build-up of vegetative fuel (Tripp 2012). The Karuk Tribe and Department of Natural Resources are now working to restore cultural fire management practices and protect natural ecosystems in these areas (Karuk Tribe 2020).

Soil amendment and cover crops

Green manure/cover cropping (GMCC) involves using plants as ground cover and canopy in crop or animal production systems, to reduce soil erosion, and improve fertility, moisture, water infiltration, weed and pest control, and human and/or animal nutrition (Eilittä et al. 2004). The earliest recorded use is from 500 BC China: "for manuring the field, lu tou [mung bean] is best, and siao tou [black mung bean] and sesame rank second. They are broadcast in the 5th or 6th month and plowed under in the 7th or 8th month…Their fertilizing value is as good as silkworm excrement and well-rotted manure" (Paine and Harrison 1993). Indigenous green manuring and mulching systems are widespread, such as the slash-and-mulch pre-colonial systems in Central America. *Frijol tapado* (covered beans) is traditionally used to sustainably produce beans (and to a lesser extent maize and rice) on hillsides in Costa Rica (Eilittä et al. 2004). Bean seeds are broadcast at high rates into carefully selected vegetation, which is then slashed with a machete to cover the seeds in a thick mulch. The beans grow through the mulch and are left untouched until harvest. This system has been developed by local farmers over centuries and protects soils on steep hill slopes in high rainfall areas, maintains soil fertility without chemical inputs, reduces labor and conserves locally adapted native bean varieties (Araya and González 1994). Additionally, *frijol tapado* has a central role in local value systems, which place importance on strong cultural traditions of food security, self-sufficiency, and family labor (Meléndez 2004). The benefits associated with these value systems are likely to have contributed to the persistence of *frijol tapado* despite the slightly decreased yields resulting from lower germination through the thick mulch. One local farmer responded "while I'm alive, I'm going to tapar beans" with regard to the possibility of no longer practicing *frijol tapado* (Meléndez 2004).

Research has shown that Indigenous slash-mulch systems have lower production costs, higher profitability, and support increased local labor compared to technology-oriented systems involving machinery, improved seed, and increased chemical inputs (Flores 1994). In the nineteenth and early twentieth century, ley farming (rotating forages with annual crops) was common in England, and cover cropping was introduced and adopted by settlers in the USA (Paine and Harrison 1993; Eilittä et al. 2004). The utilization of these techniques quickly declined after the second world war due to the high availability and low price of inorganic

fertilizers. However, by the 1980s and 90s, in response to increasing and critical land degradation, cover cropping was increasingly researched for its soil-improving characteristics and impact on crop yield (Eilittä et al. 2004). In recent years, the use of cover crops has gained attention amongst farmers and scientists in Western agriculture, with considerable funding available for research in this area (Groff 2015).

Biochar and Amazonian black soils

Carbon entering soils as charcoal is a significant sink for atmospheric carbon dioxide, and the application of biochar has received considerable interest as a regenerative strategy. The technique of using charcoal as a soil improvement is thought to have originated in the Amazon, where highly fertile dark soils (*terra preta*) with elevated nutrients and organic matter have been found that date to between 500 – 4800 years ago. Archaeological studies have demonstrated these fertile soils extending over areas of 3 to 5 hectares with an anthropic horizon that varies from 70 cm to 1.2 m in depth (Morcote-Rios et al. 2013). One feature of *terra preta* that has attracted increasing attention is its significantly higher content of soil organic carbon (147 – 506 Mg C ha^{-1} m^{1}) compared to adjacent soils (72 – 149 Mg C ha^{-1} m^{1}) (Sombroek et al. 2003; Bezerra et al. 2019). The high amounts of carbon in *terra preta* soils are likely the result of both on-site carbon management, through burning of forests and crop residues, and bringing in off-site charred materials for example from fireplaces (Neves et al. 2003). Its formation involved several other Amerindian soil improvement practices, including using human and animal wastes, crop resides, leaves, compost, cleared weeds, seaweed, ant nest refuse, and water (Levis et al. 2018). High densities of ceramic fragments and botanical remains are also associated with *terra preta* sites, including phytoliths, charcoal, and seeds (Morcote-Rios et al. 2013). The identification of ceramic traditions and cultivated plants indicate cultural practices associated with these areas. Western academia's discovery of these soils has helped to overcome the illusion of the Amazon as untouched by human intervention (Bezerra et al. 2019; Fletcher et al. 2021) and highlight pre-colonial human-nonhuman relationships which have maintained rich and complex landscapes over long time periods.

The unique high fertility, carbon storage capacity, and anthropic origin of *terra preta* soils have inspired hope that their re-creation could increase soil fertility, sequester carbon, and reduce

emissions on a global scale (Bezerra et al. 2019). Scientific research into *terra preta* soils began in the 1980s, and the concept of reproducing them (*terra preta nova*) emerged at a workshop in Brazil in 2002 (Bezerra et al. 2019). In 2006, research and technological developments surrounding the application of biochar replaced the concept of *terra preta nova*, and the Western scientific articulation distanced the Indigenous Amazonian cultural and historical context. Biochar is produced through heating biomass (e.g. vegetation, agro-industrial, manure residues) to temperatures between 200-900 ℃ under low oxygen (Sánchez-Reinoso et al. 2020). Research and development is strongly focused on its potential for carbon storage and climate change mitigation, as a highly marketable way to increase soil fertility and create revenue through carbon trading (Bezerra et al. 2019). While biochar attracts global policy, private markets, and industrial actors, the concept of *terra preta* is embedded in Indigenous rights, cultural practices, rural livelihoods, local communities, and close relationships between human and nonhuman nature. Bezerra et al. (2019) argue that the divergence of these concepts represents the different conceptualizations of human-nature relationships between Western and Indigenous ontologies. As opposed to a 'silver-bullet' commodity such as biochar, it is likely that *terra preta* soils emerged from Indigenous People's lived relationships with their surroundings and giving-receiving with natural resources. The dominant Western articulation is another example of the subsummation and colonization of Indigenous and local wisdom and practice.

Summary

Indigenous farming practices developed over millennia through close relationships and interactions between local ecologies, epistemologies, climates, and cultures largely reflect the practices associated with the Western regenerative agriculture movement today. They represent sophisticated techniques for soil management, weed suppression, plant protection, and food security which are inextricably embedded in nonmaterial and relational values, and are non-reliant on the 'package of technologies' associated with the Green Revolution (Boyer 2012). It is evident that regenerative agriculture therefore applies old solutions in the form of local and traditional knowledge to the contemporary problems of the Anthropocene. Dominant capitalistic narratives often conflict with local, place-based, and relational views of the environment which characterize pre-colonial agricultural systems (Pascua et al. 2017). It is important to recognize

that Indigenous people who have challenged Western agricultural policies in an effort to halt environmentally destructive colonial practices have been ignored, silenced, and in some cases, even criminalized (Robyn 2002). The application of these techniques in the regenerative agriculture movement today may be indicative of a general desire amongst farmers for freedom from manufactured inputs and the extractive system they represent.

Epistemic regeneration

Regenerative agriculture can be viewed as a transition narrative (Escobar 2015) for the period when humans attempt to move from being a destructive force on the planet to a mutually enhancing one. Through regenerative agriculture, nature is no longer seen as an obstacle, as it is in intensive conventional operations, but as a co-worker in the quest to produce the benefits the natural environment brings to humans (Krzywoszynska 2020). For example, in the definition proposed by Shreefel et al. (2020), "soil conservation" is used to "contribute to multiple provisioning, regulating and supporting ecosystem services". This is about facilitating the soil (through conservation) to provide ecosystem services: "working with the soil", instead of just "working the soil" Krzywoszynska (2020). Here however, nature remains a means to an end for productivity, and the value of regeneration lies in the production of economic resources for the benefit of humans. This continued framing within the Western extractive narrative surrenders regenerative agriculture to old conceptual and analytical frameworks (Santos 2014) and is not indicative of the social and ecological transformation required in response to planetary emergency.

For farmers operating within this system their livelihoods depend on continued growth, productivity, and profitability. Yet, much evidence points to these farmers having a co-existent sense of stewardship and connectedness to the land that is often overwhelmed by financial concerns (Comito et al. 2013; White et al. 2022). The cost of making changes to agricultural management strategies can be significant, and payment for ecosystem services (PES) programs have been proposed to provide financial support, incentivize environmentally beneficial outcomes, and reduce the burden of risk for farmers transitioning towards regenerative practices (Gresham et al. 2021). Inevitably, these PES programs are also based on concepts of nature as

capital, such as soil valued by the degree to which it can be operationalized as a carbon sink in relation to capital markets (Salazar et al. 2020). Despite this risk, alternative models are possible and not all PES programs replace the intrinsic stewardship ethic and land connectedness of farmers with monetary valuation of nature (Chan et al. 2017). Rather than payment for service, an agroecological approach to sustaining farmer livelihoods and their capacity to make transformational changes manifests as compensation for stewardship. This centers value on stewardship as care in action and reinforces relatedness of farmers to their landscape and broader agroecosystem.

From an Indigenous perspective, nature is not valued with respect to the material or economic resources it provides, but rather its components (biotic, abiotic, human, nonhuman) are regarded as coinhabiting the same life space in a more equal and less exploitative way (Zent and Zent 2022). For example, no known Amerindian languages have a term even approximate to the idea of nature (Zent 2015), but rather observe a single sphere of life. Zent (2015) synthesizes this vision of the biosphere as 1) lack of a lexeme to translate 'nature', 2) absence of comparable notions of (separate) culture or society, 3) personhood or shared consciousness of the nonhuman, 4) state of permanent transformation of beings, and 5) non-existence of a notion of pristine environments. Central to this is the concept of reciprocity and mutual care between human and nonhuman nature, where ecosystem services are gifts from the earth, and there is a responsibility not just to take but to give back in return (Kimmerer 2013). This is viewed as key to survival because the biophysical world is governed by cycles of giving and receiving (Kimmerer 2013). Furthermore, as exemplified by the Venezuelan Amazon Indigenous *Jotï* philosophy of *jkyo jkwainï* ("to love and care for, and hence protect, one's environment"), the ethic of appreciating and respecting nonhuman life is a deeply ingrained strategy for survival (Zent and Zent 2022).

It is crucial here to confront the reaction that this language evokes for those operating within Western and scientistic value systems, where concepts such as respect and love may be, at best, dismissed as lacking a framework for implementation. However, this dismissive or negative reaction is itself a symptom of the silencing, exclusion, marginalization, and continued colonization of Indigenous worldviews (Clement et al. 2021; Graeber and Wengrow 2021). The fact that over 476 million Indigenous people in at least 90 countries operate and live by these values (Zent and Zent 2022), for whom ecophilosophies of loving-caring are an absolute reality

and not some abstract ideal, should be legitimacy enough. These reciprocal, mutually respectful, loving, and bi-directional socioenvironmental value systems are ubiquitous in diverse cultures across the globe and represent a strategy based in ancient wisdom for constructing and preserving, as opposed to dominating and eliminating, life on earth. The regeneration of Western epistemologies through the application of such values could precipitate a revolutionary break from the developmentalist-extractivist economic model (Santos 2014).

It is important to acknowledge that evaluating the behavior of Indigenous people according to Western concepts of conservation and environmentalism is problematic because it imposes Western epistemological ideals, standards, and terms, and risks stereotyping and obscuring Indigenous culture (Nadasdy 2005). In this way, (re)claiming a pre-colonial past would be an extension of colonialism and appropriation through declaring ownership of an identity which is not one's own. The novelty of regenerative agriculture must therefore not be in pointing to the past, but in aiming at the future through an unprecedented foregrounding of non-Western conceptualizations of humanities place in the biosphere. For regenerative agriculture to act as an epistemic bridge between Western and Indigenous land stewardship, care must be taken to acknowledge and carry forward the foundational ethics and motivations of Indigenous land care.

Agroecology, which has many parallels to regenerative agriculture (Titonell et al. 2022), promotes the co-creation of knowledge as a core principle for socially just transitions. This fosters a participatory and interactive sharing of knowledge from different perspectives, often between farmers with local or Indigenous knowledge and 'experts' with scientific or Western knowledge (Utter et al. 2021). Toledo (2016) argues that agroecology, at its core, revolutionizes the Western and scientific relationship with knowledge through co-creation, and takes methodological and epistemological leaps to new ways of creating knowledge while fundamentally valuing traditional and ancestral wisdom. Embracing the "epistemology of the South", many agroecologists in South America have put intent and work towards deconstructing the colonial paradigms inherited from Europe. Failing to carry forward the Indigenous roots of regenerative practices and the worldview that created them, therefore risks losing an important counterbalance to productivist oriented agriculture. However, scholarship on the co-creation of knowledge in agroecology finds that it is rife with challenges, and the absence of Indigenous worldviews in current definitions of regenerative agriculture reflects many of these.

Without care and intent, the unspoken negotiation of power relationships in knowledge co-creation often favors the perspectives of Western or scientific expertise (Pohl et al. 2010). Additionally, the process of collaboration often brings forward new understandings that elevate the overlap of local or Indigenous expertise with science-based expertise, and this can leave behind the things that cannot be combined, and that are not compatible (Blaser and De la Cadena 2017). Blaser and De la Cadena (2017) promote *uncommoning* as an anti-colonial approach to integrating diverse knowledge sources – this means intentionally identifying and elevating the things that are incommensurable, and that cannot be agreed upon, rather than leaving them behind. It is for this reason that we conclude this review with a definition of regenerative agriculture that intentionally foregrounds Indigenous value systems – we do not shy away from including language distinctly associated with relational values and Indigenous ecophilosophies – and present them alongside the Western scientific perspective.

Conclusion: moving towards an anti-colonial definition for regenerative agriculture

In this article, we provide evidence that while regenerative agriculture is often framed as a novel solution to anthropogenic environmental and socioeconomic crises, the associated practices can be traced back to Indigenous cultures and pre-colonial knowledge systems around the world. It is widely understood that racial and social justice must be central to conservation (Martin et al. 2016; Schell et al. 2020). In examining what this means for regenerative agriculture, we make three conclusions: 1) the solutions being proposed to correct the environmental damage resulting from post-colonial agriculture have their roots in Indigenous and local knowledge systems; 2) the Western hegemonic framing of these solutions neglects relational values and is a continuation of injustice by failing to represent Indigenous and local knowledge; 3) confinement to a Western conceptual framework is an inadequate response to the climate, biodiversity, and socio-economic emergencies of the Anthropocene, which stem from deeper systemic issues and require radical cultural shifts.

Thus, in crafting a definition of regenerative agriculture we must remove the blinkers of epistemic primacy and prioritize the rights and agency of Indigenous and local people. A truly equitable definition seeks to regenerate degraded environments, unjust economies, dispossessed peoples, and silenced and obscured epistemologies. We also acknowledge that this must be a

dynamic definition, leaving space for our understanding to develop and evolve over time. Drawing on the most comprehensive published analyses (LaCanne and Lundgren 2018; Newton et al. 2020; Schreefel et al. 2020; Fenster et al. 2021) and the authors lived experiences of Indigenous ecophilosophies (Zent and Zent 2022) we propose an anti-colonial definition for regenerative agriculture:

> *A way of farming comprised of entangled values and practices, and founded in Indigenous principles of loving-caring for the Earth. This approach to farming values 1) reciprocity, 2) respect, 3) collective (human and non-human) wellbeing, 4) knowledge co-creation, 5) (re)localization, and it is often practiced through some combination of 1) minimizing soil disturbance, 2) maintaining vegetative soil cover, 3) maximizing diversity, 4) integrating livestock, and 5) minimizing synthetic agrichemicals.*

This structure is a result of honoring the diverse knowledge systems associated with regenerative agriculture, and the integration of wisdom through which values and practices are co-constitutive. It foregrounds non-Western conceptualizations of human-nonhuman relationships and values. Not all social/ecological contexts are the same, and while the Indigenous perspective is intended to be foundational to any definition of regenerative agriculture, the practices included are examples and not intended to be prescriptive. It is the inter-relation between values and practices that are central to sustaining outcomes. We believe this urgently needed, and previously missing, approach confronts current epistemic injustice, and represents the sociocultural shift required for regenerative agriculture to achieve its transformative potential.

Declarations

The authors have no competing interests to declare that are relevant to the content of this article.

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Figures

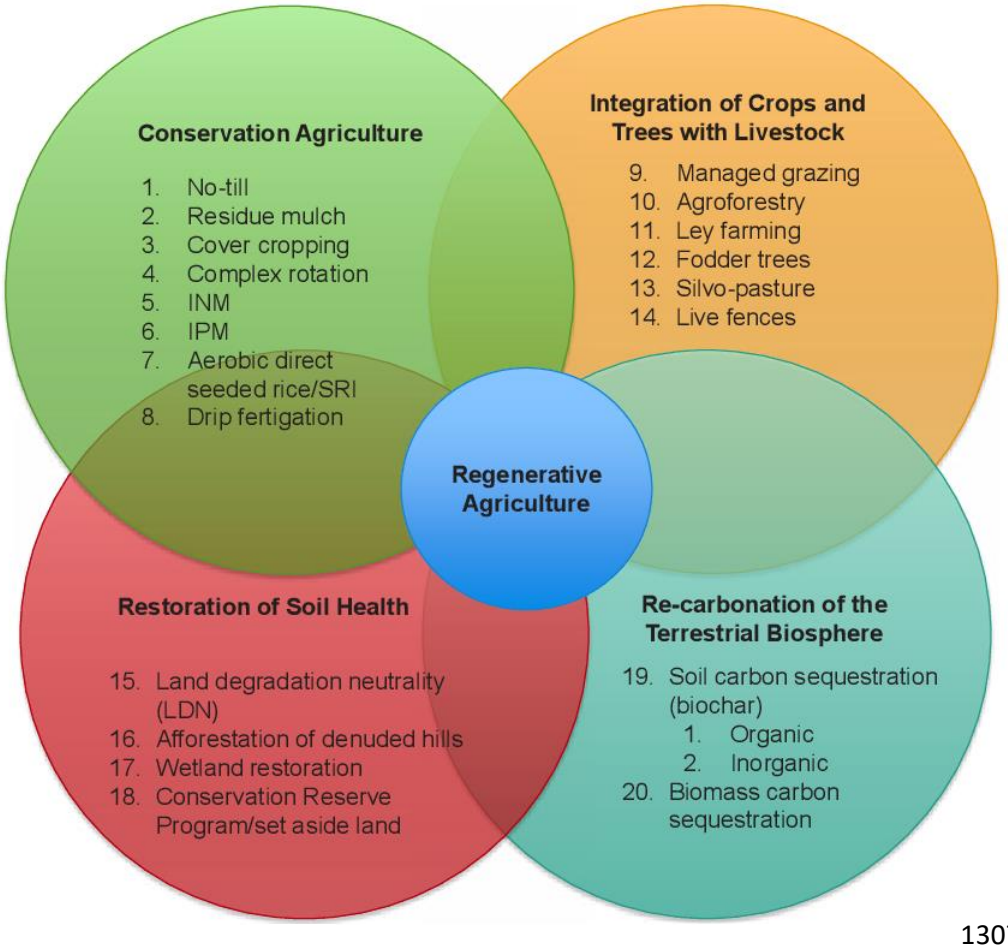

Fig. 2 An example of a conceptual diagram of regenerative agriculture from an academic paper. Note the overwhelming emphasis on biophysical dimensions (Source: Lal 2020).

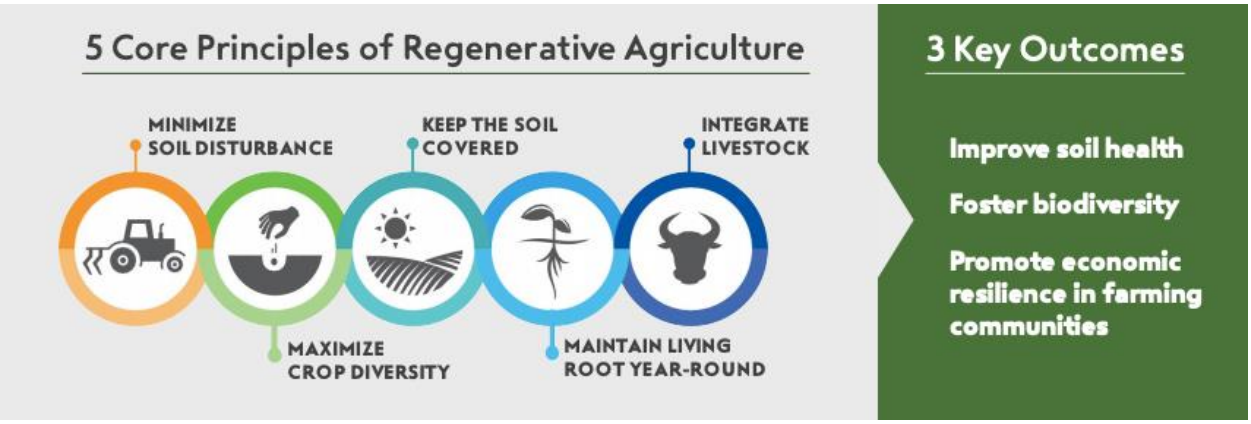

Fig. 2 An example of a conceptual diagram depicting both principles- and outcomes-based understandings of regenerative agriculture. Note the presence of biophysical and socio-economic dimensions of agricultural systems and the absence of nonmaterial dimensions, including values, cultural beliefs, spirituality, and norms of reciprocity. (Source: General Mills 2019)

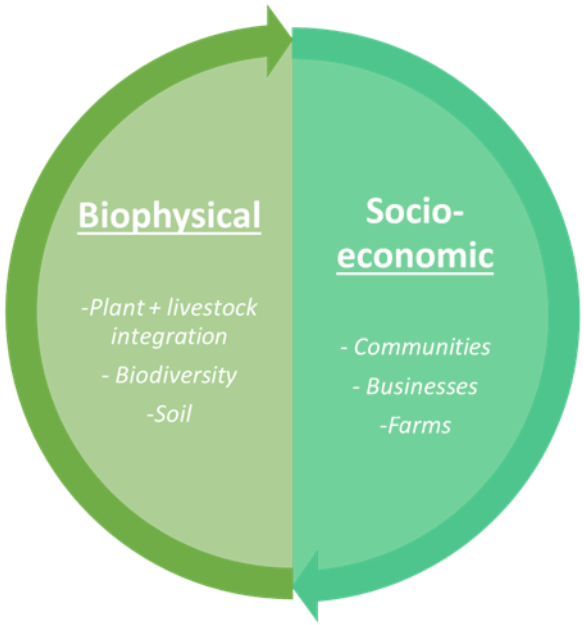

Fig. 3 Conceptualization of regenerative agriculture through a Western scientific lens. Emphasis is on biophysical regeneration with considerations for socio-economic regeneration, while little

to no attention is given to the regeneration of the nonmaterial dimensions (including spirituality, values, reciprocal norms, and cultural beliefs).

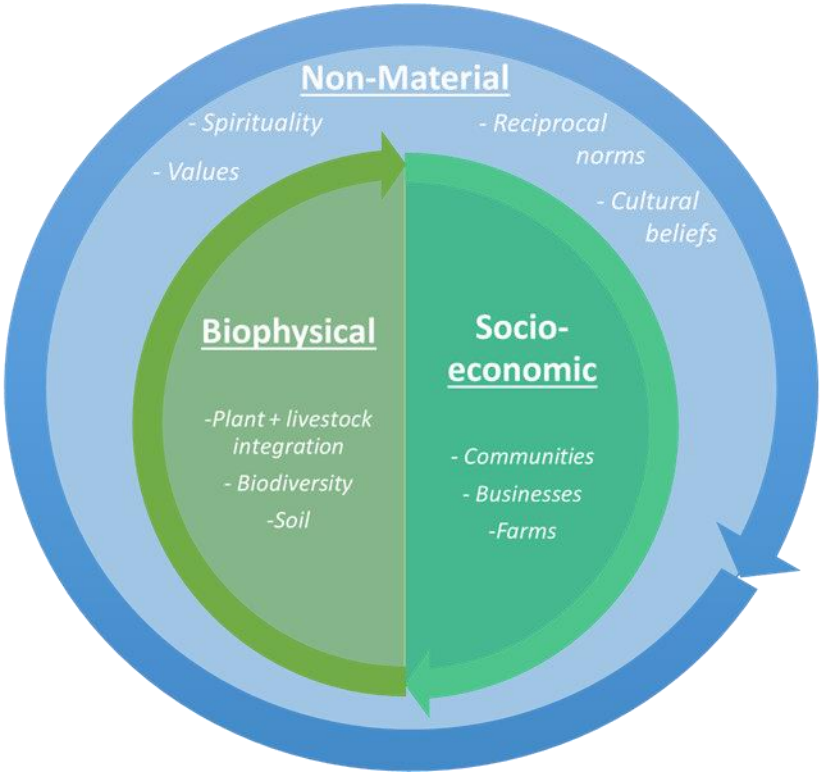

Fig. 4 Conceptualization of regenerative agriculture based on understandings of Indigenous and local knowledge systems. Both biophysical and socio-economic dimensions are relational in terms of material regeneration, but these systems are also embedded in and inextricable from a broader cultural context which entails nonmaterial dimensions, such as spirituality, values, cultural beliefs, and reciprocal norms.