REGENERATIVE AGRICULTURE AND PRODUCER DECISION-MAKING: A LITERATURE REVIEW

FINAL VERSION

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October 1, 2021

Funded by the National Science Foundation "Smart and Connected Communities" Award (2019)

Project title: Connecting communities through smart tools and sensors to deliver enhanced ecosystem services and economic returns from regenerative farmland management

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INTRODUCTION

Regenerative agriculture (RA) is an approach to agricultural production that uses a suite of practices, goals, and values related to social and environmental well-being. According to Giller et al. (2021), the term 'regenerative agriculture' was put into use in the 1970s and gained recognition in the 1980s as the Rodale Institute (1983) adopted the term to describe their agricultural philosophy of renewal, innovation, and well-being in social and environmental agroecosystems (Francis and Harwood 1985). The RA approach, under this terminology, received rather little interest in the academic literature between 1986 and 2016; since 2020, it has gained extensive popularity in both the academic literature and among global conservation organizations (Giller et al. 2021) as a means of climate change mitigation.

In the literature review that follows, I examine the existing academic literature on the social dimensions of RA. The goal of the review is to aggregate and summarize current understanding of how farmers make conservation practice decisions on their farms, with particular attention to (a) how these decisions relate to RA (or related practices) and (b) how conservation decisions relate to regional or community-level conservation efforts (e.g. communities of place, communities of practice).

In the first section, I summarize and analyze existing definitions of and terms used to describe RA (there are many). Most of the papers that analyze the definitions of RA do so from an ecological or agronomic approach; accordingly, the social dimensions of what RA is or is not are not as thoroughly conceptualized as the biophysical dimensions at this time. In the second section, I provide a summary of the personal characteristics, motivations, and barriers faced by producers involved in RA. The goal of this section is to provide a quick reference to information on RA producers. There are few peer-reviewed studies that provide an in-depth look at RA producers (including comparisons to producers in conventional agriculture); most social science understandings of farmer characteristics, their decision-making, and farming communities pertain to conservation practice adoption within the context of conventional agriculture.

In the third section, I summarize existing theories of agricultural conservation practice adoption and analyze how these theories may or may not pertain to RA. The theoretical approaches summarized in this section consider the decision-making processes of producers at the *individual, or farm-scale* and are as follows:

- diffusion of innovations
- theory of planned behavior/reasoned action approach
- transformative models of change
- social-ecological systems approach

- policy, market, and organizational influences on farm-level conservation decisions

A prominent question that underpins recent interest in regenerative agriculture is how to scale-up RA practices from that of single, often small operations to practices that involve multiple producers in geographic proximity to one another—in other words, how to increase the use of the RA approach within a region or place. Decision-making is not solely based on individual considerations, but is also influenced by the social aspects that stem from personal or professional relationships, norms, culture, and broader forces in society. To scale RA is to encounter these broader social forces. In the fourth section that follows, I summarize literature on agricultural conservation that considers the social forces that shape, or could potentially shape, conservation decisions. Here, I focus on the following four areas that have, or may, influence farmer adoption:

- gender and identity
- communities of practice and communities of place
- cooperative resource management
- social movements

To focus the literature review, I did not include certain topics. The review does not address the ongoing discussion on the magnitude and type of climate mitigation ecological outcomes associated with RA (e.g., Ranganathan et al. 2020). By comparison, there is far less discussion in the literature about the social outcomes of RA, which are generally positive and support both on-farm social-environmental well-being and resilience (Gosnell, Grim, and Goldstein (2020); however, these outcomes are not as thoroughly assessed as ecological or soil carbon outcomes. Second, I did not summarize the literature on barriers to entry in agriculture. There is some linkage, evidenced in the gray literature, between the barriers to entry (technical assistance, access to land, access to financial capital) and the barriers to adopting RA (O'Connor 2020); however, those interconnections are not well examined in the peer-reviewed literature. I also did not review the academic literature on agricultural policy or carbon markets related to RA. Spratt et al. (2020) provide an analysis of current U.S. Farm Bill programs and how they may be modified to support RA. Jackson Hammond et al. (2021) analyzes four models of soil carbon credit programs that would incentivize soil carbon sequestration; however, their analysis focuses on the programs and not the producers attitudes towards or engagement with them.

Lastly, there is a gray literature on RA that is, by and large, not included herein. I made the decision to limit the review to peer-reviewed literature for two reasons. First, the literature review is intended to support a full NSF proposal and scholarly literature would be a better fit for the NSF audience. Second, the gray literature on RA is extensive and includes reports from government, nonprofit, corporate, indigenous, and scientific, and other organizations. I am

confident that there are valuable insights within the gray literature and recommend a targeted approach to understanding these insights if supplemental documentation is deemed necessary.

There is extensive interest in RA as an alternative to the dominant, conventional form of industrial agriculture. To understand the social dimensions of RA adoption, I first summarize answers to the question, *what is RA?*

WHAT IS REGENERATIVE AGRICULTURE?

Definitions of RA share a common thread of principles or practices related to ecosystem integrity and social well-being. RA falls under many titles or names, including sustainable agriculture (Rhodes 2017), agroecology, natural agriculture, regenerative farming, climate-smart agriculture (Giller et al. 2021), with related practices found in holistic management (which pertains to ranching and grazing systems, and to some extent, permaculture and organic agriculture (Rhodes 2012).

In a recent review of RA (primarily in the scholarly literature, but also including practitioner websites), Newton et al. (2020) found that there are multiple definitions of RA and that these definitions fell into three categories: the **processes and practices** of RA, the intended **outcomes** of RA practices, or **combinations** of the two. The processes and practices of RA involve conservation-minded actions that primarily pertain to soil health (Lal 2020, Roesch-McNally, Arbuckle, and Tyndall 2018). While the particular practices that are considered regenerative vary widely across definitions, there is strong agreement among researchers and practitioners that the RA involves the reduction or elimination of tillage the reduction of inputs (e.g., fertilizers, herbicides), the integration of livestock, and the use of cover crops (Giller et al. 2020, Newton et al. 2020). Parallel to discussions about conservation practices in conventional agriculture, Lal (2020) notes that RA practices must be tailored to meet "the biophysical factors and the human dimensions" of an operation (123A).

Other approaches to defining RA emphasize the outcomes—intended or actual. These outcomes identified in the literature often include restoration of topsoil quality, increased soil organic carbon, increased water storage, and more soil biodiversity (e.g., microbial, mycorrhizal fungi, and insects) (Newton et al. 2020). Some, but not many, outcome-based definitions include off-farm results such as watershed health, carbon sequestration, enhanced ecosystem services (Rhodes 2017). Another outcome that is less tangible and not as popular in the biophysical RA literature is the transition to a more sustainable agricultural system—one that does not depend on the Haber-Bosch process for fertilizer or fossil fuels (Rhodes 2017, 2012). Lastly, climate change mitigation via carbon sequestration is increasingly an outcome of interest (Evans et al. 2015, Newton et al. 2020). In reference to the carbon sequestration potential within RA, Merfield (2019) claims that, "RA farmers are actively engaged in solving these massive global

challenges" (15), and that their role in mitigating climate change is a welcome departure from climate denialism prevalent in many conventional agricultural circles and organizations.

Most of the definitions summarized in Newton's process-outcome typology above are based on biophysical analyses of RA. A broader look that includes the social sciences indicates that RA definitions include another component: RA **as a philosophy, ideology, or culture** based on interconnections within the natural world and those between the farmers and the ecosystem (Rodale 1983). Many authors describe RA or related approaches (e.g. holistic management (HM) in grazing and ranching) as a mindset, an outlook, or a "fundamental paradigm shift" in the approach to agriculture (Gosnell, Grim, and Goldstein 2020, White 2020). Some characterize RA in and of itself as an ideology (Richards and Lawrence 2009). Others see RA as a social movement (discussed further below), for some with Indigenous roots (Petro and Haslett-Marroquin 2020), or as a direct rejection of agricultural practices established under settler-colonialism that devastated the soil in order to meet the capitalist imperative for production (Burns 2020, Rhodes 2012). For some, RA is as much a set of beliefs as it is a suite of practices or social-environmental outcomes.

CALLS FOR SOCIAL SCIENCE ON RA

Much of the literature included in this review responded to calls for further research on 1) the social outcomes of RA or 2) the decision to transition to RA practices. Gosnell, Charnley, and Stanley (2020) note that academic research on the social science of RA is thin and separate from the biophysical research on environmental outcomes of RA practices. The leading work on social processes and outcomes surrounding RA is Dr. Hannah Gosnell (Oregon State University) and her colleagues who conduct research on holistic management (a framework of decision-making and goal setting that emphasizes quality of life and protection of resource bases in ranching systems [Gosnell, Charnley, and Stanley 2020]). This growing body of work considers the interconnections between social and agroecological systems, often considering feedbacks and system resilience.

Other calls for social science research are rooted in questions of farmer adoption (i.e., farm transitions to RA practices)—*who has, or will, adopt regenerative practices?* There is limited research that addresses this question (see "Who practices RA? A brief summary" below), and some fear that there is a rush to incentivize RA practices without an understanding of the social dimensions. As said by Merfield (2019, p16): "If farming and farmers are to change how they practice agriculture to address the multitude of environmental and social issues humanity faces, taking a purely technical approach is highly likely to fail, the social side has to be addressed too." What constitutes the 'social side' is somewhat up for debate, as multiple scales and frames can be used to understand RA transitions and social-agroecosystem connections. In

other words, the adoption of RA practices may be studied as a decision made at the farm scale or studied as a social movement (Burns 2020).

In the next section, I provide a brief summary of the current literature on who uses RA practices. I then return to the question of scale to summarize literature on agricultural conservation practice decision-making at the individual or farm scales and the ways that broader social forces can shape conservation decision-making.

WHO PRACTICES RA? A BRIEF SUMMARY

Many people and organizations are interested in responses to the question, *who practices, or is likely to practice, RA?* The section below summarizes the current responses to this question in three categories: 1) the characteristics of RA adopters, 2) the motivations for engaging in RA, and 3) the barriers to implementing RA practices.

CHARACTERISTICS OF RA PRACTITIONERS AND THEIR FARMS

RA farmers are far from 'one-size-fits-all,' but there is little research that has quantitatively analyzed the characteristics of farms and farmers using RA techniques. RA farmers tend to be younger producers or newer to their land, suggesting that their ties to the farm are not as longstanding as other producers (Abson, Sherren, and Fischer 2019, Gosnell, Grim, and Goldstein 2020). There is some preliminary work that suggests women are more involved in RA operations than on conventional farms (Carlisle 2016). In Australia, ranches practicing holistic management were more often managed by married couples than on conventional ranches; the authors speculate that marriage may supplement social support for RA practice that may be filled by a community of social relations for more typical operations Abson et al. (2019). Thus far, studies on political orientation, formal education, or region (in the U.S.) were not uncovered in the literature.

Attitudes may play an important role in the decision to adopt RA practices (see "Diffusion of innovations theory" below). Environmental concern is influential for other conservation practice adoption (Prokopy et al. 2008; Ryan, Erickson, and De Young 2003). The literature on select soil health practices does not demonstrate a clear effect of environmental attitudes on soil health practices (e.g. cover cropping, no till); however, few studies have measured producers' environmental attitudes in relation to soil health (Carlisle 2016b).

In terms of farm size, producers on smaller farms were more motivated to use regenerative soil health practices, but larger farmers were found to have greater financial ability

to implement these techniques (e.g. purchase necessary equipment), suggesting that scale-related barriers could be removed for smaller farmers via cooperatives or greater policy supports (Carlisle 2016). In a case study in California, RA farms were small or medium-sized (compared to the typical size of farms in the region) (Elias and Marsh 2020).

MOTIVATIONS FOR RA TRANSITIONS

A few studies considered producers' motivations for transitioning to RA or holistic management practices. These motivations generally fell into three categories: producer well-being, natural resource protection, and economic production. Producers who implemented RA practices were inspired to do so for their improved quality of life (Gosnell, Robinson-Maness, and Charnley 2011) and the perceived improvements to quality of life for future farming generations (Kennedy and Brunson 2007). The quality of life dimensions most frequently mentioned was that for more personal time and less work stress under RA or holistic management frameworks. While the initial years of transition into HM took time investments, producers reported substantial time savings as something that they sought and gained with the new farming approach (Gosnell, Grim, and Goldstein 2020).

The protection or renewal of on-farm natural resources was paramount to farmers who had transitioned to holistic management systems. Kennedy and Brunson (2007) found that ranchers in Colorado were very motivated to improve the 'land base' of their ranches, as evidenced by improved forage production, range health, and improved water quality. In Mexico, a group of ranchers formed a holistic management ranching club out of their perception of severe on-farm land degradation (Alfaro-Arguello et al. 2010). Farms already using RA practices found that regenerative agriculture helped to mitigate climate risks (e.g., drought) and market fluctuations (Elias and Marsh 2019). In the studies that addressed farmer and rancher motivations, there was no mention of off-ranch or off-farm environmental outcomes (e.g. improved water quality downstream) as reasons for RA transitions.

Economic profit appears to be a weaker motivation for RA producers than for conventional farmers (Richards and Lawrence 2009), as economic profit is important but only one component of the rationale for RA practices (Gosnell, Gill, and Voyer 2019). Profit-based motivations were often secondary to other interests in holistic management such as natural resource protection or livestock production (Kennedy and Brunson 2007, Roche et al. 2015). Farmers in California and Indiana who were practicing RA prioritized social and community sustainability, as they designed their businesses to supported year-round employees and were involved in community development (Elias and Marsh 2019, Iles, Ma, and Nixon 2021).

Climate change mitigation is not a prominent motivation for farmers' transition to holistic management or regenerative practices, as many producers do not associate climate change

mitigation with these techniques (Gosnell, Charnley, and Stanley 2020). Australian ranchers more readily identified their operations as regenerative agriculture or holistic management rather than "carbon farmers" or other climate-related terms (Gosnell et al. 2019). Furthermore, producers viewed carbon markets as "obscure," believed that carbon prices were too low, and were concerned about a lack of process transparency (Gosnell, et al. 2011, 23).

BARRIERS TO ADOPTION

The literature on regenerative practice adoption includes three types of barriers: a lack of knowledge about RA practices, less social support, and a paradigm shift that many undergo to implement RA.

Limited knowledge of soil health practices (specifically in this review cover cropping, no-till or conservation tillage, and crop rotations) is a major barrier to their implementation (Carlisle 2016). Producers with some first-had experience were more likely to adopt these practices (Carolan 2006a), and those reporting less knowledge about cover cropping practices were less likely to implement them (Arbuckle and Ferrell 2012). To implement RA techniques, producers need to learn more than just the regenerative practices, they need to learn about their agroecosystem (the organisms and their functions within the system), how to make observations about their farm ecosystem, *and* how to respond to what they see (Gosnell, Charnley, and Stanley 2020). There are opportunities to address knowledge barriers including peer-to-peer learning networks and support for existing communities of practice such as classes, trainings, demonstration projects, and hands-on learning opportunities (Elias and Marsh 2019). Gosnell, Charnley, and Stanley (2020) emphasize that community learning networks are key to successful transitions.

There are social barriers to RA implementation, one of which is less local support for RA within communities of place (Blesh and Wolf 2014). In Australia where conventional ranching practices dominate the landscape, producers using holistic management techniques have less access to knowledge about farming practices through their immediate social relationships (e.g., neighbors, friends) (Abson et al. 2019). The source of information on holistic management is critical for potential, or eventual, adoption, as found by Kennedy and Brunson (2007) who note that, "…the initiation of an idea for change comes from information sources important to them" (39). Another social barrier to RA transition was described as 'social pressure': in some instances, people practicing RA receive pushback against the decision to transition to RA from nearby farmers or family members (Gosnell et al. 2019).

Many studies note that there is a fundamental paradigm shift that is an integral part of transitioning to RA, one that sees the farm as an ecosystem that prioritizes soil health over short-term production goals and emphasizes producers' well-being (Stinner, Stinner, and Martsolf

1997). For many producers, some producers are not able to realign their outlooks to match regenerative or holistic frameworks, as reported by holistic management trainers (Mann and Sherren 2018).

INFLUENTIAL CHARACTERISTICS FOR OTHER CONSERVATION PRACTICES

Agricultural conservation practice adoption has been well studied, and well-reviewed. These reviews typically quantified findings on the influential characteristics of the farmers (e.g. formal education) and farm (e.g. farm size, tenure) where conservation practice uptake occurs. There are no characteristics that uniformly encouraged (or discouraged) the adoption of conservation practices (Prokopy et al. 2008, Prokopy et al. 2019). That said, Baumgart-Getz et al. (2012) and Prokopy et al. (2019) report a suite of characteristics that encourage the adoption of agricultural conservation practices either in a majority of the studies that they reviewed or that encouraged adoption more often than by random chance. These characteristics are as follows:

- *Positive attitudes*: towards the environment, towards the specific practice or program
- *Personal characteristics*: more formal education, younger age
- *Past behaviors*: already adopted a conservation practice, actively seeking information
- *Land and farm*: larger farms, farms with environmentally-vulnerable land

IMPLICATIONS AND RECOMMENDATIONS. Based on the summary of characteristics, motivations, and barriers above, the following are implications and recommendations for future research:

1. Research on RA practices and those who have implemented them is still in the early stages. Systematic analysis of these farmers and comparisons to conventional farmers would offer a major contribution to the social science literature.
2. It is crucial to investigate the knowledge gaps and barriers to more knowledge about RA within the general farming population. Barriers to seeking more knowledge may include perceptions of practice fit, contrasting identities, or a lack of connection to the RA community of practice (all of these ideas are discussed further, below).
3. The RA approach seems to call for a deeper, more fundamental change within psychological, social, and practical approaches to farming that cannot be achieved with the adoption of one particular conservation practice. This poses many challenges for

scaling-up RA practices if their use is to remain consistent with current RA culture and ethics.

The theories and approaches discussed below address conservation practice decision-making and may offer some potential pathways to better understand RA adoption and implementation.

HOW DO PRODUCERS MAKE DECISIONS SURROUNDING AGRICULTURAL AND SOIL MANAGEMENT?

There is an extensive body of research that considers farmer decision-making, particularly decisions regarding conservation practices or the use of new agricultural technologies. In this section, I organize this literature around four theoretical approaches to understanding farmer decisions, all of which emphasize the cognitive dimensions of individual-scale decision-making. The first two, *diffusion of innovations theory* and *theory of planned behavior*/*reasoned action approach*, are longstanding approaches that have been thoroughly examined in qualitative and quantitative studies. The second two, *transformative theories of change* and *social-ecological systems thinking*, are relatively new to the arena of farmer decisions.

For each of the four approaches, I provide a background and their key components, with evidence from conservation agriculture for support. I then analyze research on RA or related practices that has taken that theoretical approach. Lastly, I draw connections between the theoretical approach and key findings on conservation practice decision-making to decisions to implement and maintain RA practices.

DIFFUSION OF INNOVATIONS THEORY

The diffusion of innovations (Rogers 1995, 2003), also referred to as adoption-diffusion theory, is a framework for understanding how technological innovations are taken on and disseminated within a particular population. The theory was developed in rural sociology and has since expanded to many other fields of thought including engineering, innovation studies, and management. The key dimensions of adoption-diffusion theory are (a) stages of adoption, including the characteristics of adopters at each stage, (b) the characteristics of the innovation, and (c) the diffusion process.

A cornerstone of adoption-diffusion theory is the uptake of a particular innovation over time, including the relative points of time at which individuals chose to take on an innovation. The theory highlights **five stages of innovation and the characteristics of people** who adopt a practice or technology at that stage. As summarized by Padel (2001), the Innovators are the very

first to either develop an innovation or (more likely) to adopt one. Innovators are a small subset of the population and have a high tolerance for risk and uncertainty. Often, Innovators tend to be more cosmopolitan while Early Adopters, or those who adopt innovations in the second stage. Both Innovators and Early Adopters are opinion leaders in their communities of place, and have strong network connections within and outside of their geographic locations. Innovators and Early Adopters are well educated and have robust peer networks. Early Majority adopters, who take on innovations in the third phase, may adopt practices just before the practice becomes widespread, while Late Majority adopters may use the practice but be skeptical of it. Laggards, who do not adopt or do so relatively late in time, are proportionally few in number and tend to be outliers in the community.

Another important component of diffusion-of-innovations thinking are the **types of innovations** and the **characteristics of the innovation under consideration**. Rogers (1995) identified **two types of innovations**: hardware, such as machinery (e.g. a seed drill) and software, such as knowledge about practices (e.g. grazing rotations). These broad categories of innovations present different needs and challenges for adoption and integration with farming practices. In terms of agricultural conservation, equipment needs (a hardware innovation) are a barrier to certain soil health practices, particularly cover crops (Carlisle 2016). However, 'alternative' agriculture such as organic farming and RA require new knowledge of practices (Padel 2001) and a systems approach to understand inputs, outputs, and feedbacks for successful regeneration of farm soils (Mann and Sherren 2018).

Both hardware and software **innovations have certain characteristics** that may facilitate or discourage their adoption. Rogers (2003) identified five characteristics that shape adoption decisions, and Reimer et al. (2012) found that, for conservation practices, producers' perceptions of the practice were more influential in their adoption decision than the personal characteristics of the producers. General attitudes, such as environmental orientations, are important (Prokopy et al. (2008), but not as influential on adoption decisions as attitudes that specifically pertained to the particular practice (Prokopy et al. 2019).

The first characteristic of an innovation—and one that is often the most influential characteristic—is *relative advantage*, or the degree to which a practice is perceived as being better than the idea it may supersede. Often, relative advantage is considered in terms of economic advantage (i.e., cost savings), though other advantages such as environmental outcomes, social prestige, time savings, and a quick return on the advantage are also influential (Padel 2001; Rogers 2003, 1995). Environmental advantage is important for some adopters (Nowak 1983), and many may adopt practices that improve environmental quality but detract from immediate profit (Remier et al. 2012, Roesch-McNalley et al. 2018). Carlisle (2016) found that if the practice can solve an existing problem or improve soil health, then farmers are more interested in the practice and likely to adopt it.

Compatibility, the second innovation characteristic, is multidimensional: it is the degree of consistency with current systems—both on individual farms and in terms of the type(s) of farming in the locality (Remier et al. 2012). Compatibility also includes the perceived need for the new practice or innovation (Rogers 2003). Remier et al. (2012) found that grain producers adopted no-till practices when they believed that no-till practices were compatible with their farm system and generated profit.

An innovation's *complexity*, or difficulty of use, also shapes rates of adoption. The more difficult a sustainable agricultural practice may be, the more slowly it will be taken up by conventional producers (Gamon, Harrold, and Creswell 1994). One way to demystify an innovation or practice is to test this practice on a portion of an operation (Remier et al. 2012). This degree to which a practice can be tested on a limited basis is the practice's *trialability*, which reduces the risk of adoption (Gamon et al. 1994).

Lastly, the *observability* of a practice, or the extent to which the practice—and its outcomes—can be seen by others, is another important characteristic. The more observable a practice and its outcomes, the faster adoption occurs (Guerin and Guerin 1994). To this characteristic, in-person demonstration sites are often encouraged to enhance producers' knowledge about and uptake of conservation practices (Gamon et al. 1994).

The process of diffusion is another cornerstone in the adoption-diffusion theoretical approach. **Diffusion** is the process of dissemination throughout a certain population or group (Rogers 1995). Diffusion of agricultural conservation practices and technologies at first focused on the transfer of technological advancements from research institutions to the Early Adopters—(i.e., local change leaders) via extension agents. This model of top-down diffusion is often referred to as the 'technology-transfer approach' (Padel 2001). An alternative model of dissemination calls on scientists to work *with* producers who have already demonstrated advancements or innovations in practices (and outcomes) to better understand their innovations and to share these with the broader farming community (Teague 2018). Such bottom-up approaches were common in the dissemination of organic agriculture techniques (Pearl 2001).

There are many critiques of the adoption-diffusion theory. The adoption-diffusion paradigm was formulated with conventional agriculture as the prevailing practice, and therefore this approach did not include notions of resistance or pushback against dominant powers or institutions (Padel 2001). Theories of adoption also do not consider how conservation practices are sustained over time (after the initial adoption phase), or why practices are de-adopted (D. B. Jackson-Smith et al. 2010). Others have taken issue with theories of diffusion, noting that the technology-transfer approach limited the sorely limited the sources of innovation to that of scientists and that there was extensive emphasis on engaging Early Adopters in outreach, thus there was an over-emphasis on their information needs with far less understanding of Late Adopters (Russell et al. 1989). Coughenour (2003) noted that there are many actors involved in a single producer's conservation practice decision, and that the social relationships within a

community highly influence the rate and directions of diffusion. In Coughenour's (2003) analysis of no-till cropping, this innovation was diffused throughout the region by way of multiple, interacting actors which included both adopters (the farmers) and technical assistants from industry and academic sectors. Through these social relations, knowledge of no-till agriculture was explored, tried, and evaluated—processes through which, "the farmer's identity [was] reconstructed in the process" (301).

IMPLICATIONS AND RECOMMENDATIONS. The Diffusion of Innovations theory is very applicable to the current RA context and adoption imperative, but may have limitations. The following implications and recommendations can be gleaned from considering RA in the diffusion of innovations framework:

1. Future research should examine the many unknowns surrounding **farmer attitudes about specific practices** and their relative advantage, compatibility, trialability, and complexity on potential RA operations. What may be compatible with agricultural systems and communities of practice (see below) in the Northeastern U.S. could be very incompatible with the systems and communities in another region of the U.S.

2. **There is little research that compares RA producers with conventional producers**, and accordingly there is little understanding of what might differentiate current RA producers (i.e., the Early Adopters) with the Late Adopters of RA practices. Past work suggests that these comparisons will not be limited to personal characteristics, but will also include (a) attitudes about the RA innovations and (b) consistency with ongoing operation objectives.

3. Adoption-diffusion theory does a poor job at considering the broader social forces that encourage adoption, particularly those that may shape farmer identity. Furthermore, the decision to transition to RA includes emotions and feelings that are difficult to capture in a framework that emphasizes rationality (Gosnell et al. 2019). With many considering RA as part of the 'alternative' food movement, **future research should gently probe existing RA producers for attitudes and identities related to deviance, nonconformity, and system disruption**.

4. **Current RA producers, educators, and outreach practitioners should co-design research on RA**. Their involvement is consistent with the bottom-up knowledge base on RA, and would include the RA diffusion network that already exists. See the Social Movements section, below for further discussion.

THEORY OF PLANNED BEHAVIOR (TPB) / REASONED ACTION APPROACH (RAA)

The theory of planned behavior (TPB) is a well-studied model of individual decision-making (Ajzen 1991) with recent extensions and a new name as the 'reasoned action approach' (RAA) (for the sake of clarity, I will refer to these as a single model by the name of the most recent version (RAA) (Fishbein and Ajzen 2009). Under the RAA, individual actions are driven by behavioral intention, here the intention to adopt a practice. Behavioral intention is a function of 1) attitudes towards the specific behavior (also found in Adoption-Diffusion theory, summarized above), 2) norms, which can be broken into subjective norms (the expectation to or not to perform a certain behavior), descriptive norms (perceptions of how common a behavior or practice is), and personal norms (individual standards for conduct) and 3) perceived behavioral control, or the extent that people believe they can perform a behavior and that they have control over their performance (Fishbein and Ajzen 2009). Background factors, including personal characteristics (e.g. education, social networks) that play a more central role to Diffusion of Innovations thinking, are more marginal to RAA, but nonetheless play some role in decision-making.

Conservation practice adoption has been studied and reviewed extensively using the RAA model (Baumgart-Getz et al. 2012, Knowler and Bradshaw (2007); however, I could not locate a study on RA that used the TPB/RAA perspective. Connecting RAA to conservation practice adoption, specific attitudes about the practice are highly influential in the decision to adopt (Prokopy et al. 2019). Normative dimensions of adoption decisions are also important, but are not consistently operationalized and quantified in the literature, making the effects of norms difficult to assess. Niemic et al. (2020) found that subjective norms correlate with conservation practice decisions (i.e., when farmers perceive that they are expected by others to adopt a practice, they do), but the influence of subjective norms/expectations lessens when descriptive and personal norms are co-considered. It is possible that social expectations play a greater role in adoption decisions when the practices are highly visible, such as riparian buffers (Armstrong and Stedman 2012b) or residential irrigation (Chaudhary et al. 2017).

Perceived efficacy, or the perception of how effective the decision-maker and/or the practice will be at achieving intended outcomes, is a close cousin of perceived behavioral control (Fishbein and Ajzen 2009). Efficacy was not a dimension of conservation practice decision-making that was featured in many of the review articles cited herein; however, researchers increasingly point to efficacy as an important components of conservation practice decision-making (Armstrong and Stedman 2020), both in terms of perceived self-efficacy (Perry and Davenport 2020) and efficacy beyond their property lines: landowners feel like the practices are less effective if their neighboring landowners are not engaging in that behavior as well (Armstrong and Stedman 2012a).

IMPLICATIONS AND RECOMMENDATIONS**.** The RAA could be very useful for understanding RA adoption decisions, particularly surrounding social norms and perceived efficacy (both self-efficacy to implement the practices and the efficacy of those practices in mitigating climate change and achieving biodiversity outcomes).

1. The relationship between **social norms** (subjective, descriptive, and personal) **and the adoption of conservation practices are not well understood for both conventional and RA farmers**. Furthermore, the social norms are always changing and may be undergoing a particularly pronounced shift as new types of producers enter farming communities of practice and places, as responses to climate change grow more pronounced, and as social engagement increasingly unfolds over digital means. This is an area ripe for inquiry and one that **also interfaces with questions of social justice, diversity, and inclusion.**

2. **Perceptions of self-efficacy and the efficacy of RA practices are also crucial concepts to consider** in the study of RA implementation. Assessing these concepts will help to highlight key knowledge gaps and offer initial insights on how to educate producers on the efficacy of RA practices. Understanding producer's perceptions of effective (and ineffective) RA practices will also help to surface farmer knowledge.

TRANSFORMATIVE MODELS OF CHANGE

The decision to take on a singular conservation practice like a riparian buffer or soil testing may not be transformative, or present a fundamental change in an agricultural operation. RA practices, and even some singular soil health practices (e.g. no-till), present very different realities and demands for producers. Carlisle (2016) argues that there is little evidence that incremental on-farm conservation practice adoption brings about whole-farm changes for more sustainable practices (yet see and Prokopy et al. 2019, Singer, Nusser, and Alf (2007), and Wilson, Howard, and Burnett (2014) that show initial adoption may lead to additional adoption in the future). Decision models that approach conservation practice adoption **as a transformation** are important to consider for soil health practices, as these theories may highlight particular motivations or forces that influence conservation decisions at the farm or individual scales (Carlisle 2016b). Some literature on select soil health practices suggests that farmers adopted these practices after a catalytic event in their world views or lived experiences occurred (Carlisle 2016a).

Studies that consider transformation as the primary impetus for RA and holistic management adoption emphasize that these practices were adopted at a time of crisis (Gosnell, Grim, and Goldstein 2020, Gosnell et al. 2019). These crises included sever soil degradation or drought (Gadzirayi, Mutandwa, and Mupangwa 2007) or economic crisis (Gosnell et al. 2011,

Kennedy and Brunson 2007) in which producers were on the brink of collapse and were left with few choices other than turning to HM practices, or psychological and health crises experienced in the farm family (Gosnell, Grim, and Goldstein 2020). These crisis-forming events allowed farmers to "open the gate," and become receptive to alternative forms of agricultural production (Gosnell et al. 2019, 7). However, studies from this approach emphasized that the alternative form of production was not necessarily obvious—there remained a knowledge gap between conventional and RA practices (Mann and Sherren 2018). Reflecting on past mistakes helped producers manage their change in production forms, especially through the difficult hurdle of disengaging from conventional inputs (e.g. fertilizers) (Gosnell et al. 2019). Once in the new state practicing RA, producers reported that they had a new way of seeing their agroecosystems, including insects and grasses that they were previously unaware of (Gosnell et al. 2019).

IMPLICATIONS AND RECOMMENDATIONS. This area of study is underdeveloped in comparison to the adoption-diffusion and RAA models, but it is consistent with empirical evidence that demonstrates the existence and the need for a fundamental paradigm shift when adopting RA. The transformative dimension is also relevant in this era of climate disasters and chronic environmental problems. Implications and recommendations for future RA work from this perspective are as follows:

1. **Do not let a crisis go to waste**. In moments with seemingly few alternatives, producers will seek information on what to do next—it is critical that RA is one of those potential options. This means that outreach and education teams need to anticipate and target potential regions or types of operations where crises may unfold, and be ready with honed messaging strategies and financial, technical, and social support.

2. **Do more to understand the crises**. Not all disasters are the same, and it is reasonable to hypothesize that different types of crises will encourage different types of producers to take on RA at different times. Much, much more research should be done to understand the relationships between tipping points and agricultural transformation, and how organizations, researchers, and policy support may both leverage and encourage RA at times of disorientation.

3. **Recognize that the whole farmer is in crisis**. Studies of RA are increasingly addressing mental health and producer well-being (e.g. Gosnell 2021). It is critical for RA experts and advisors to support producers as much as the intended RA practices. Such social support is currently being offered in communities of practice (see below), but those communities are effective for *existing* rather than *potential* adopters.

SOCIAL-ECOLOGICAL SYSTEMS APPROACH

The social-ecological systems (SES) approach (based on Liu et al. 2007)) to understanding conservation practice decision-making at the individual scale emphasizes the integration of the natural environment—including the biophysical conditions on the farm or how natural phenomena are changing over time—with social and psychological factors that shape soil health and RA practices (Roesch-McNally et al. 2018). This growing body of work recognizes that most social and ecological components, motivations for adoption, and outcomes of the practices are studied in separate scientific analyses (Gosnell, Grim, and Goldstein 2020) that lack integration. While scientific debates on the ecological outcomes of RA "continues to rage" (Gosnell, Grim, and Goldstein 2020, 862), the potential benefits of HM on individual and social well-being, including social relationships networks, adaptive capacity, and resilience, are well documented. Briske et al. (2013) note suspected that the ecological outcomes of HM are under debate because they have not been studied under the SES approach through which the complexity of social-ecological benefits could be illuminated. Some argue that studying these complex systems could be achieved via producer engagement and participatory HM studies (Sherren and Kent 2019) and one that acknowledges producers' knowledge about agricultural practices and their outcomes (Gosnell, Grim, and Goldstein 2020). Others emphasize that, to truly be regenerative, RA programs, efforts, policies must consider social equity and address historical injustices and undervalued labor embedded in agricultural systems (Spratt et al. 2021).

IMPLICATIONS AND RECOMMENDATIONS. The SES approach has much potential for illuminating important relationships in RA systems, both on-farm and beyond the property line; however, this approach to farmer decision-making is relatively underdeveloped compared to the social-psychological approaches highlighted above. Two recommendations fall from this line of thinking:

1. **Some people will be very motivated by the environmental dimensions of RA practices, and others will not**. Based on Gosnell's works in Australia and the US, some people will be attracted to RA for the emphasis on ecosystems and ecological knowledge, and others will find the (often steep) learning curves a barrier to implementing RA.

2. **SES includes the "S"**. It is imperative that conservation programs, including RA outreach efforts, engage untraditional audiences and include people beyond the stereotypical white, male farmer. Furthermore, regenerating ecosystems through agriculture must also involve inclusive agriculture that acknowledges and rectifies past social injustices (Spratt et al. 2021).

POLICY, MARKET, AND ORGANIZATIONAL INFLUENCES ON FARM-LEVEL CONSERVATION DECISIONS

There is growing interest in how policy, market, and organizations are shaping farmer incentives to implement RA. A few of studies connected these meta-incentives with individual, farm-level decisions. In terms of federal policy, most facets of agricultural conservation policy (e.g. subsidies, research, and outreach) can be redesigned to incentivize regenerative ag practices or remove barriers to adoption by willing farmers (Spratt et al. 2021). Crop insurance for continuous cropping systems (which are common in RA operations) may not be insured in specific counties and thus farmers have higher financial risk implementing crop rotations that maximize soil health (Rosenzweig, Carolan, and Schipanski 2020). Similarly, access to federal conservation programs that may encourage RA practices (e.g. EQIP) are often determined at the county-level and interested producers may not have access to these important subsidies or technical assistance (Blesh and Wolf 2014). In an assessment of a soil health program sponsored by NRCS, the effect of cash payments on adoption rates was too hard to tease apart from technical assistance components of the program (Carlisle 2016).

Corporations are also building initiatives to support RA (Eckberg and Rosenzweig 2020). One form of market involvement in RA are payments for carbon storage and RA practice use. A decade ago, ranchers in the Intermountain West of the U.S. reported that these payments were too low to encourage practice implementation (Gosnell et al. 2011).

IMPLICATIONS AND RECOMMENDATIONS. Many questions remain on the influence of broader forces and individual decisions surrounding RA; however, there is not a lack of interest in designing and implementing programs that could incentivize carbon farming (and the like) among conventional producers. Questions of producer willingness, de-adoption, and program design remain unanswered.

WHAT ARE THE BROADER SOCIAL FORCES THAT INFLUENCE FARMER CONSERVATION DECISION-MAKING, BEHAVIORS, AND NEEDS?

No farm is an island. Decisions made by individual producers are influenced by their broader social and environmental settings. In this section, I summarize the literature on four areas that consider how individual producers are situated within or respond to broader social forces regarding agricultural conservation: gender and identity, communities (of practice and of place), cooperative resource management, and social movements.

GENDER AND IDENTITY

At first glance, gender and identity seem like personal characteristics that could shape farmer decision-making. They are personal, but these constructs are also very social and have implications for social relationships that unfold surrounding conservation practices.

Gender is an understudied dimension of conservation practice use (Carlisle 2016). Female landholders reported that they did not know enough about conservation practices (Druschke and Secchi 2014) and that they were often reluctant to talk to their tenants regarding conservation practice implementation (Wells and Eells 2011). Governmental conservation programs have not met the values, needs, or interests of women landowners (Petrzelka, Sorensen, and Filipiak 2018). Masculine identity also plays in to conservation practice use, as Peter, Bell, and Jarnagin (2000) found that certain versions of masculinity were more receptive to feedback and do not command as much control, and were therefore more open to practice adoption.

In that vein, the ‘good farmer’ identity (Burton 2004) encapsulates notions of stewardship and responsibility, in part, as keeping ‘tidy,’ weed-free fields that are often monocultures (Burton 2012). The aesthetics reflect industrial agriculture and very much contrast the practices found in RA, such as cover cropping in which a field is never ‘clean’ or bare (Carolan 2006b). Such norms, and expectations associated with them, are parts of local society and the social fields in which farmers interact on a regular basis (Carolan 2006b). Roesch-McNally et al. (2018) speculate that soil stewardship may be linked to farmer identity in that farmers who identify themselves as being stewards, ‘good’ farmers, or who are most vulnerable from extreme weather events. Rosenzweig et al. (2020) argue that farmers actively maintain their ‘good farming’ identities through comparisons to and evaluations of other producers and their actions.

IMPLICATIONS AND RECOMMENDATIONS. The ways that people conceptualize and define themselves form in response to their social surroundings and have important implications for the production decisions that they make. Much work remains on the interplay between identity and RA, but based on the literature considering social norms and RA as a rejection of conventional agriculture, it is likely that producer identity will influence in RA

implementation in both positive and negative directions. Recommendations based on the literature are as follows:

1. **Gender and gender-based identities are under-researched** in terms of agricultural conservation, with most studies not going further than comparisons between heteronormative gender binaries or considerations of how one gender may have different needs or goals than the other (Chiappe and Flora 1998). RA provides an opportunity to study more complex gender identities in agriculture and to include questions of power and access, not just of individual operators, but also in RA and conventional agriculture on the whole.

2. Stewardship identities and soil stewardship (Roesch-McNally et al. 2018) specifically could be a powerful line of messaging if these notions of stewardship effectively align with social norms of 'good farming.' Such alignment will probably require acceptance of RA in the broader communities in which producers socialize and construct normative meanings.

COMMUNITIES OF PRACTICE, COMMUNITIES OF PLACE

A clear and consistent theme in the literature on RA is that social relationships matter, both in the decision to engage in RA and the maintenance and growth of RA operations over time. There is much academic discussion that surrounds the term "community" and what a community may or may not constitute. I use the definition of *community* here as a space where there are interactions and exchanges between parties (individuals, farmers, organizations) in a way that builds or maintains a relationship or works towards a shared goal (Wilkinson 1991). 'Social network' and 'community' differ in important ways. 'Community' suggests reciprocity and affective dimensions including concern, care, shared history and language (among other facets of social life), whereas 'social network' is more simply a pattern of relations linking two or more parties (Marin and Wellman 2011).

There are two lines of thought and research on community: one focused on communities of practice, the other on communities of place. Both, summarized below, play important roles in RA decisions and transitions.

COMMUNITIES OF PRACTICE. A community of practice is a group of people who share common actions and problems related to these actions, and who collaborate to develop new knowledge (Wenger 1998, 2000). Their cooperation with one another is based upon joint enterprise (they are active in similar industries or professions), mutual agreement (they experience shared understandings via participation in a common network), and shared repertoire (similar portfolios, backgrounds). Communities of practice represent distinct social units within which social capital is generated via interactions; this social capital adds further value to the community of practice and fosters belonging (Duguid 2012). Participation within the community

is shaped by the nature of interactions, trust, shared values, the organizational structure, and knowledge transfer (Pretty and Ward 2001).

Agriculture includes a well-recognized community of practice with many sub-communities included within (Cross and Ampt 2017). Agricultural communities of practice include farmers, extension experts, industry representatives, and other knowledge experts. Many studies consider the knowledge exchanges among farmers as important components of practice dissemination (e.g. from the adoption-diffusion theory). In a review of research on organic farming, Padel (2001) found that the early adopters of organic practices compared to later adopters were more educated and were part of extensive farming networks, including other organic producers who were not geographically co-located.

It is also essential to consider who farmers are 'networked' with in addition to other farmers. Warner (2008) found that technology transfer from extension experts to agricultural producers is only one dimension of information dissemination in the agricultural community of practice and that extension agents also learn from producers, thus, an exchange occurs within their community of practice. Local fertilizer, chemical, and crop advisers are important players in dissemination networks (Bartels et al. 2013; Eanes et al. 2019; Korsching and Hoban 1990). However, farmers with sustainable practices have more trust in others with sustainable operations than those with conventional operations (Carolan 2006a).

Communities of practice are a critical component of the transition to RA. Most studies of RA emphasize that the communities of practice are essential for learning, social support, and information on how to transition a farm to RA (Blesh and Wolf 2014, Gosnell 2021, Gosnell, Grim, and Goldstein 2020, Stinner 1997). Many of these networks interacted with one another online. These networks support holistic management practitioners with a shared knowledge and language, and fostered a culture supportive of holistic uptake (Kennedy and Brunson 2007; McLachlan and Yestrau 2008). Some online forums are managed by prominent organizations including the Savory Institute, Quivira Coalition, and Holistic Management International Rodale Institute (Gosnell, Charnley, and Stanley 2020) or Regeneration International (Burns 2020).

Other studies found that RA farmers had a **blended community of practice**, with some interactions occurring online and others in person. One holistic management club gave ranchers in Canada more tools (and therefore a greater capacity) to address 'mad cow syndrome' (McLachlan and Yestrau 2009)—these were primarily communities of practice that extended well beyond their geographic locations, but were able to meet in person once a month. Blesh and Wolf (2014) found that agroecological producers in the Northeastern US had more access to visiting other alternative agriculture farms than their counterparts in Iowa, where agroecology was practiced at a lower density. As a result, the Iowa farmers turned to online resources more readily than the Northeastern producers.

COMMUNITIES OF PLACE. Agriculture happens in place, and the people who practice agriculture are similarly tied to those places. A **community of place** is the locality, including the social and natural relationships that producers encounter in daily life. Most research on communities of place and agriculture focus on community well-being and agricultural community change (Beaulieu and Mulkey 1986; Lobao and Meyer 2003). Of course, the relationships between grazing operations and communities of place have received more attention in the literature, particularly from a common pool resource (Ostrom 1990) perspective, yet only a few recent works are addressing communities of place regarding RA. With attention to holistic management practices, numerous studies point to the importance of neighboring farmers in providing informal support for practices such as continuous cropping systems (Rosenzweig et al. 2019), demonstration of particular practices, and social learning (Gosnell et al. 2019). Local education events that emphasize place-based solutions to practical problems, building confidence, and addressing social pressures were found to amplify and reinforce producers' decisions to use holistic management practices (Gosnell et al. 2019). Warner (Warner 2007, 2008) found that extensive partnerships surrounding RA were developed in California, including extension educators and NGO groups, to research, practice, and promote agroecology. There, extension did not take a top-down approach but rather educators exchanged information with producers.

Engagement within communities of place does not necessarily support adoption. Some adopters experienced pushback or even ridicule from other farmers and extension associates for adopting RA or holistic management practices (Cross and Ampt 2017, Gosnell et al. 2019, Richards and Lawrence 2009). Others reported feeling pressure from agrochemical representatives (Gosnell et al. 2019) and older family members with ties to the operation (Richards and Lawrence 2009). Those experiencing such social pressures within place-based relations found that these pressures subsided when their RA practices brought about tangible results, and when they sought support from other RA practitioners—either online or regionally (Cross and Ampt 2017).

IMPLICATIONS AND RECOMMENDATIONS**.** Based on understandings of community of practice and of place, and on the preliminary work on RA from these perspectives, the following are thoughts on directions forward:

1. **Questions of social support, knowledge transfer, and community identity are central to understanding RA implementation**. Future work with RA practitioners would identify existing off-farm connections and illuminate how and why farmers engage with RA communities of practice and of place, understanding that there are probably different motivations and outcomes for both of these communities.

2. While the preliminary work on communities of place suggests that RA farmers may experience discouragement in their local social circles, **there is much more that should be explored about those interactions**. Are RA producers connected to other producers in the area? Are they members of the same organizations (agricultural and otherwise) as conventional producers? What forms of interaction occur between RA producers and conventional producers? Answering these questions may highlight pathways through which (a) social exchanges unfold and (b) RA producers become, or could become local opinion leaders and therefore models of RA techniques.

3. Given that online communities of practice have been identified as the primary form of knowledge and support for RA practitioners, this avenue should be furthered considered as a space through which shifts in the local or regional food system could occur. See Weissman and Potteiger (2020) as a preliminary example.

COOPERATIVE RESOURCE MANAGEMENT

Cooperative resource management typically involves coordination of management or decision-making among individuals or across property boundaries. In the social sciences, collective management has been studied under a number of paradigms, the most prominent of which is common pool resources management (Ostrom 1990). The types of natural resources, communities, and management actions that are analyzed under the common pool resource approach are vast in number and scope. In this section, I focus on three resource areas—forest landowner cooperatives, agricultural cooperatives, and ecological restoration coordination (Jellinek et al. 2019)—and the ways in which collective management has unfolded within each. Overall, the study of coordinated resource management suggests that cooperation is often initiated as to maximize individual (often landowner) benefits (e.g. access to markets), but that public goods (e.g. environmental outcomes) may emerge (Ostrom 1990). Other questions that are addressed in this literature consider the types of benefits that are produced within a cooperative (perceived and actual), the resources needed to support cooperative arrangements (Wolf and Hufnagl-Eichiner 2007) and who benefits from these arrangements (Jacquet and Stedman 2011).

FOREST LANDOWNER COOPERATIVES

Forest management on privately owned forests is a rich area of study, with considerable attention paid to transboundary forest landowner cooperation. Forest landowner coordination is very common outside of the U.S. and includes over 3.6 million private landowners in developed nations (Kittredge 2005). There are many ecological, social, and economic benefits that may be gained from transboundary forest landowner cooperation; though I do not summarize these benefits (many of which share objectives of social-ecological health with RA).

What do forest landowner cooperatives look like? Kittredge (2005) reviewed forest landowner cooperatives in 19 developed nations and found that these cooperatives generally have one or more three objectives: information cooperation with shared educational opportunities, technical advice, or representation in policymaking; equipment cooperation, which may involve shared harvesting machinery (and often little coordination on forest management or operations); and financial cooperation, where landowners coordinate marketing of wood products for competitive pricing. Kittredge (2005) also found that there was substantial governmental involvement in the creation, development, and support for cooperatives. Some forms of state involvement include direct payments or indirect subsidies (e.g., payments for cooperative overhead), or payments to join cooperatives (as in France and Netherlands). Kittredge (2005) argues that there should be a management cooperative, on in which management goals build on information, equipment, and financial coordination, and that they consider an integrated suite of private and public benefits and that assure forest plans and management are effective.

Why do cooperatives form? Most forest landowner cooperatives came about in response to a perceived threat or a catalyst that prompted landowner interest (Kittredge 2005). The most common threats were threats to properties and the health of their forests (Fischer, Klooster, and Cirhigiri 2019). Other reasons for cooperative formation include organizational support from land trusts, watershed associations, and some state governments in the U.S. Lastly, forest landowner cooperatives also formed in response to local interests, with landowners who were very involved at the very initial stages of cooperative development (Kittredge 2005).

Why do forest landowners join cooperatives? This question has been the main focus of the social science literature on forest landowner cooperatives. Landowners value landscape-scale ecological outcomes (Belin et al. 2005; Rickenbach et al. 2011) and the social benefits of cooperation (Fischer et al. 2019). Overall, forest landowners are willing to consider cross-boundary approaches (Rickenbach, Guries, and Schmoldt 2006) and they understand the need to address some management and environmental issue at a cross-boundary scale (Ferranto et al. 2013), but they more often do not see the private benefits for participating in the cooperative (Rickenbach et al. 2006). Those with primarily financial investment interests in their forests are the least interested in participating in cooperative arrangements, while those who operate working forests tended to have both amenity and financial objectives and were interested in cooperation (Ferranto et al. 2013). Those who participated in forest landowner cooperatives emphasized that trust was essential and that trust was enhanced through a sense of shared values and purpose (Rickenbach and Reed 2002). On the other hand, economic incentives, such as property tax reductions were unlikely to increase participation in coordinated management programs (Klosowski et al. 2001).

What do forest landowner cooperatives need? Forest cooperatives heavily depend on resources from external organizations for development and support, as Wolf and Hufnagel-Eichiner (2007) concluded that institutional support is necessary for their survival and goal

attainment. In a review of western forest cooperatives Kittridge (2005) found that forest landowner groups experience chronic underinvestment and are regularly in need of human, social, and financial resources. The review also noted a major lack of forestry management coordination across property boundaries—cooperatives had objectives that supported management and decision-making on the part of individual landowners.

AGRICULTURAL COOPERATIVES. An agricultural cooperative is an autonomous association of individuals that voluntarily coordinate with one another to meet shared economic, social, and cultural needs and aspirations through a jointly owned and democratically controlled enterprise (International Cooperative Alliance 2021). In developed nations, agricultural cooperatives are very common and play prominent roles in food supply chains (Luo et al. 2020). For example, 75% of milk marketed in the U.S. in 2017 was done so through vertically-integrated dairy cooperatives (Wadsworth 2019). Farm co-ops have much experience working alongside powerful stakeholders in the food system; as such, they may have professional acumen and power (Luo et al. 2020).

What do agricultural cooperatives look like? Agricultural cooperatives take many forms, sizes, and governance structures. Cooperative members are co-owners with voting privileges and may take active roles in management (Bijman and Wijers 2019). Typically, each member receives one vote; however, there are many different governance structures that agricultural co-operatives may employ, some of which include farmer ownership and control, investor ownership and control, open membership, or administrators with boards of directors (Chaddad and Cook 2004).

How have they been studied? Social science research has considered the characteristics of high-performing agricultural cooperatives. Many studies point to the positive effect of **trust** on cooperative outcomes by helping to facilitate member commitment and to build effective partnerships (Luo et al. 2020). Another theme of in the studies of agricultural cooperatives is that of some interpersonal disagreement. Cooperation is an emotional process, and the day-to-day operations of farm cooperatives involve engagement that may produce disagreements, but ultimately support the organization's social capital, innovation, and governance operations (Wynne-Jones 2017). Mooney (2004) argues that the process of cooperation is transformative for farmers in that, through social interactions, farmers adhere to decisions or actions that differ from their predetermined judgements or norms. In other words, participants of cooperatives have been known to change their minds or evolve on topics. Interactions among cooperative members produce social capital, which is an important ingredient of farm cooperatives: Saz-Gil, Bretos, Diaz-Foncea (2021) found that there is a virtuous cycle of social capital in that that communities with strong social capital more readily build agricultural cooperatives, and that agricultural cooperatives in turn build more social capital within their coverage region.

There are two **common pitfalls** for agricultural co-operatives: weak regional economies that undermine agricultural productivity (Candemir, Duvaleix, and Latruffe 2021) and member

heterogeneity in terms of producer objectives (Bontems and Fulton 2009), farm characteristics (Plakias and Goodhue 2015), or sociodemographic characteristics of members (Elliott, Elliott, and Sluis 2018). When co-operatives are not able to find shared objectives across these differences, it is difficult to develop or adhere to common objectives (Candemir et al. 2021).

Recent studies point to agricultural cooperatives as an important direction for climate change **adaptation and increasing food system resilience**. With a cooperative, farms have less dependence on external resources, therefore reducing susceptibility to supply chain shocks (Saz-Gil et al. 2021). In Canada, bottom-up farmer collaborations increased farmers' capacity to adapt to new climate conditions; the authors of that study accordingly encourage more support of existing collaborations to enhance adaptive capacity (Soubry, Sherren, and Thornton 2020).

There may be important lessons from agricultural coordination to learn from the European Union. There, there many environmental aspects of agricultural land management are managed under **agri-environmental schemes (AES**), which are agreements between governments and individual landowners to plan and implement conservation practices (Prager 2015). The plans themselves are typically for individual farm operations, but they are informed by landscape-scale management approaches including habitat conservation, pollution management, and public access (Prager 2015). Different nations within the EU have different requirements for their AES, leading to some variation across the continent (Prager 2015). Some AES involve diverse actors including non-governmental organizations, other farmers, non-farming landowners, and local governments, but membership in these groups for non-farmers may be limited (Franks and Mc Gloin 2007). The Dutch are very collaborative in their farming arrangements and have a robust program of farmer-led "environmental co-operatives" that originated out of farmers' fears that the government was promoting technocratic and regionally ineffective conservation methods (Franks and McGloin 2007).

The form of AES collaborations is highly variable. Mills et al. (2012) provide a thorough meta-analysis and in-depth case study of farmer coordination under the AES system in England. Their work found that there is a range of top-down involvement in cooperative planning for environmental outcomes—the state involvement varied from individual payments for coordination to formal, facilitated coordination among landowners and interested stakeholders on the other. There is no single, most successful form of agri-environmental coordination (Mills et al. 2012). In Netherlands, the benefits of participating in the collaborative include access to low interest loans for farm improvements, a flow of information on conservation practices, and benefits to the rural economy via ecotourism of the conserved areas and farm experience accommodations (Franks and McGloin 2007).

IMPLICATIONS AND RECOMMENDATIONS. Based on research in the U.S. and drawing on the European model of AES, the following are **recommendations for RA stemming from work on agricultural and agri-environmental cooperatives:**

1. **Money does not always motivate**. Many landowners who are interested in cooperation will do so without financial incentives, while others who view their land as a financial investment may not be willing to collaborate in the first place.

2. **Farmers should be involved in all aspects of the agri-environmental cooperative**. Farmers should provide input on the farm conservation plans and to develop conservation objectives (Prager 2015), as well as monitor the outcomes of co-operative activities, which can build legitimacy and motivate future participation (Boulton, Lockett, and Seymour 2013).

3. **Operations should be thoughtfully planned**. Regular and frequent communication within the co-operative is important for achievement (Mettepenningen et al. 2012) and multi-landowner projects are more successful when a third-party facilitator is involved (Boulton et al. 2013).

4. **Don't reinvent the community**. It is important to support groups that are already collaborating and to allow for farmer-led collaborations to emerge organically (Boulton et al. 2013). Local presence is essential from the ground up including interest in cooperative formation and leadership.

RESTORATION COOPERATIVES. An emerging area of transboundary, private landowner cooperation is happening for the **restoration of agricultural lands** (Jellinek et al. 2019), primarily in Australia. There, restoration means the revegetation of land that was moved out of agricultural production with the intention of restoring natural vegetation and ecosystem properties (Jellinek et al. 2013). Restoration cooperatives typically involve set-aside programs in which land is removed from production, though some efforts include grazing management and pasture improvement programs as well (e.g., Crosthwaite et al. 2008). The leading researchers on this restoration model is Jellinek, who has taken primarily an ecological lens to this arrangement—accordingly, *little social science work has analyzed the form, functions, or social outcomes of these efforts*. Jellinek et al. (2019) noted that landowners may voluntarily join collective restoration efforts, and those which have done so often have taken prior restoration actions on their lands before participating in a cooperative. Additionally, they found that landowners need assistance to ensure management and maintenance continues.

IMPLICATIONS AND RECOMMENDATIONS. This is a young but growing body of work. It is useful in thinking about RA in that this work demonstrates that there are agricultural landowners who are willing to coordinate to achieve ecological outcomes—the question is

whether or not these landowners see the connection between what is done on their land and ecological outcomes that may result from RA practices occurring at larger scales.

SOCIAL MOVEMENTS

The social movements approach to understanding RA could be very important given that RA is regularly described as a grassroots or farmer-led movement (see Eckberg and Rosenzweig 2020, Burns 2020, and many others). There is a vast literature on social movements, which are defined as enduring collective actions with change-oriented goals that often occur outside of established institutions (Snow et al. 2018). Here, I include a small and specific sliver of the social movements literature on technological innovations in agriculture.

Knowledge is a source of tension in agriculture (Kloppenburg 1991). On one hand there is place-based, experiential knowledge that involves learning the land and understanding how situations take form in a particular location and time, and the formal or scientific knowledge about agriculture that is generated within land grant universities, corporate labs, and other farming institutions (Kröbel et al. 2021). The 'technology transfer approach' that was, and perhaps still is, the model of agricultural extension programs and the diffusion of innovations among farmers typically engaged scientific knowledge from institutions and did not examine or dissemination local and alternative knowledges. The tension between bottom-up and top-down knowledge is one that is primarily felt by farmers as they weigh new knowledge, and this tension can lead to resistance against implementing conservation practices (Jackson-Smith et al. 2018). Knowledge of RA presents a source of agricultural knowledge not seen in the U.S. since prior to the Green Revolution and land grant institutions—knowledge that originated on the ground and that grew within communities of practice.

Another facet of RA as a social movement is that RA and other models of agricultural production are (and have been for decades) framed as 'an alternative'—to industrial agriculture, to fossil fuels dependence, to soil degradation, etc. (National Research Council 1989). The depiction of RA as alternative is probably warranted, as RA practices are nowhere near common in agricultural production (at least not yet). Beus and Dunlap (1990) describe the differences between conventional and alternative agriculture as a "paradigmatic gulf" between the two forms of agricultural production (590) and highlight how alternative, sustainable agriculture at the time of their writing was threatening agribusinesses. Buttel and Gillespie (1988) (as read in Beus and Dunlap 1990) analyzed how land grant universities modified their work in response to growing interest in low-impact, sustainable agriculture of the 1980s, finding that some forms of sustainable agriculture were appropriated and others were disregarded or diluted for a new, broader audience. As an idea transitions from an alternative to the mainstream, the ideas will be tested, transformed, and reconstructed, particularly for ideas that are as value-laden as that of sustainable and RA practices (Buttel et al. 1986).

IMPLICATIONS AND RECOMMENDATIONS. Many scholars describe RA as a movement that is bottom-up, grassroots, farmer-led, or some combination of these terms (Burns 2020, Eckberg and Rosenzweig 2020, Gosnell 2021, Gosnell et al. 2019); however, there is very little work that analyzes the RA social movement at the global scale or that demonstrates why RA qualifies as a movement altogether. Some studies have taken broader approaches to analyze networks of actors—producers, organizations, policy—in agroecosystems (Blesh and Wolf 2014), but the movement as a unit of analysis is rare, with far more attention paid to the individual producer and the motivations that drive RA-related decisions. That said, there are a growing number of **recommendations on how to approach RA as a social movement** and how to align research on and advocacy for RA with the character of the movement. These recommendations are as follows:

1. **Co-produce knowledge and outreach**. Conduct research on RA using very participatory and inclusive designs (Gosnell, Grimm, and Goldstein 2020; Nerbonne and Lentz 2003; Sherren and Darnhofer 2018). This research would include farmers in the development of research questions, the design of field trials, and the dissemination of the knowledge gained (see Jackson-Smith et al. 2018 for an example).

2. **Respect the movement's origins**. Cross and Ampt (2017) warn that increased involvement from state resources (for education, research, etc.) could erode the culture that is present among RA practitioners and boundary organizations. Any shift in scale could dilute or discard this cultures (including knowledge and social relationships), which seems to be an important element of RA practices.

3. **Tensions will likely develop**. Gosnell et al. (2019) found that as farmers are eliminating chemical inputs consistent with RA practices, they see themselves as a threat to the agricultural chemical industry and receive interpersonal pushback from industry representatives. It is very possible that these tensions could also scale to conflict between the industry and an expanded RA movement.

CONCLUSIONS

For academic researchers, RA has been, until recently, a niche concept that was primarily popular with audiences focused on sustainable food production. The tides are turning and there is clearly a growing interest in RA (and related farming techniques) among conservation practitioners, researchers, and social scientists. There are many gaps in the literature on individual producer decisions to implement RA practices, and even larger unknowns about the barriers to transitioning to RA as a common form of agricultural production.

There are many ways of understanding farmer decision-making; the approaches highlighted in this review are by no means the only models to understand how farmers make decisions or how these decisions are influenced by broader social forces. These theories have limitations. However, the approaches summarized herin offer important perspectives that may inform future work on RA. In many respects, RA can be considered a new approach to agricultural production that will be adopted and diffused over time, and for some producers in some places it will unfold according to the processes that are outlined in the theories above.

There are other aspects of RA that do not fit the tried and true processes for implementing agricultural conservation practices. RA is purported to be a movement, not a suite of practices. Many of the studies cited above speak extensively of the personal 'transformation' that occurs during RA adoption and implementation. Often, these transformations come on the heels of a crisis—environmental, health, economic. Some producers may be ready for such transformation, and others will be far from it. As RA practices move from form of niche agriculture to common practice, the question that awaits is how to engage producers that do not identify with the ethics, attitudes, and methods that underpin RA practices. This is more than overcoming a knowledge gap (a formidable and extant challenge in and of itself). If training producers on RA remains true to the grassroots version of RA, then educators and outreach professionals will also train farmers on social-ecological relationships that they may not care to understand. Furthermore, this effort would require technical experts to reorient their work and teaching such that it is consistent with soil ecosystem and environmental objectives. This will take time, patience, and a lot of dedication.

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