Photo by Edwin Remsberg & USDA-SARE

Encouraging Farmer Adoption of Regenerative Agriculture Practices in the United States

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Report Methodology

The goal of this paper is to examine the challenges and barriers for regenerative agriculture in the United States, and to focus on the role of the private and public sectors in supporting farmers with regenerative practices at the farm level. This paper provides a review of the science on how regenerative agriculture (also sometimes referred to as climate-smart agriculture or conservation agriculture) can help our food and agricultural systems become more resilient. To complement the scientific review, consultations were conducted with a variety of experts on best practices for engaging farmers on the benefits of adopting or expanding their use of conservation practices, and identifying which entities are the most trusted sources of information on this subject. A total of 12 interviews were conducted with representatives of state and national commodity organizations, academia, environmental/conservation non-governmental organizations (NGOs), and major companies currently supporting expansion of regenerative agriculture through regenerative agriculture sourcing programs (see Acknowledgements for the list of stakeholders interviewed). Congressional and federal agency staff who work on these subjects were contacted for interviews, but none agreed to participate. These interviews helped to inform the conclusions and recommendations found toward the end of the paper.

Introduction

Today, farmers and ranchers confront the need to maintain high levels of productivity while facing considerable challenges from external factors. Modern farming practices have enabled farmers to increase per acre production substantially over the last several decades, improving our capacity to meet global food security needs while keeping food prices relatively low. However, these practices can also contribute to the depletion of the quantity and quality of natural resources (such as soil and water). These practices could also contribute to climate change due to the sector's emissions of methane (CH_4), nitrous oxide (N_2O), and carbon dioxide (CO_2), the primary contributors to the agriculture sector's 11 percent share of total U.S. emissions as of 2021.[1] Climate change is impacting farmers through increased frequencies of major weather events, including changing rainfall patterns and temperatures.[2]

In the wake of these challenges, regenerative agriculture is emerging as an approach to farming that aims to increase farm resiliency by improving soil health, restoring natural resources, and increasing biodiversity through integrated farming practices.[3, 4, 5, 6] In the past few years, major food and agricultural corporations have been looking to encourage greater adoption of regenerative agriculture among farmers to address fundamental risks and challenges they face in their supply chains. Long-term risks of climate-induced disruptions include declining soil productivity, crop vulnerability to temperature increases, changes in rainfall patterns, extreme weather events such as droughts and severe flooding, and increased pest and disease pressures. The public health responses to the COVID-19 pandemic exposed risks of disruptions at multiple points of agricultural supply chains. These companies must also respond to consumers, investors, and regulators who increasingly call for more sustainable production systems. Major corporations like General Mills, Danone, Nestlé, Unilever, PepsiCo, and Walmart have all launched regenerative sourcing pilot programs to incentivize farmers from whom they source commodities to adopt practices like cover crops, reduced/no-till, planting pollinator habitats to enhance biodiversity on-farm, and integrating livestock with crop production to a greater extent (for a list of corporate commitments in regenerative agriculture, see Marston, 2022). By launching regenerative sourcing programs, these companies are setting goals to advance acreage farmed using regenerative agriculture practices across the

United States and globally. The area intended to be targeted under these programs cumulatively represents a major potential footprint of farmland around the world. Regenerative agriculture can play a key role in helping farmers develop more resilient production systems and mitigate the challenges they face, all while contributing to the goals of companies supporting these practices, including goals of achieving carbon neutrality and sustainable supply chains.

Regenerative Farming Principles and Practices

Regenerative agriculture is based on a core set of soil health principles that aim to build healthy soil, restore degraded land, and increase biodiversity through integrated farming practices. While practices may vary depending on commodity and geography, the core set of principles remain the same and include: keeping soil covered, minimizing soil disturbance, maintaining living roots, increasing biodiversity, integrating livestock into cropping rotation, and minimizing external inputs. Regenerative agriculture has an outcomes-based focus, with components that address economic, environmental, and social goals important to farmers and society alike.[7]

Depending on a producer's context—climatic, geographical, and social—reaching these various outcomes may involve using a combination of different regenerative farming practices. Some widely used practices that fit into this category include using cover crops, minimizing tillage, incorporating rotational grazing, and planting conservation buffers. The benefits and considerations of each of these practices will be further discussed, but it is also worth noting that the benefits of combining these practices can capture complementarities that cannot be realized otherwise.

Cover Crops

Use of cover crops is rapidly growing in the United States among row crop producers and other production types.[8] Cover crops provide a living cover—live plants—for farmland during the period when a cash crop is not growing and the soil surface would otherwise be bare. By maintaining living roots, cover crops build soil health by providing nutrients to essential soil microbes, alleviating soil compaction, and improving water retention. The presence of a living cover also provides weed control and helps moderate soil temperatures by shading the ground during spring, keeping soil temperatures down until the leaves from the succeeding cash crop (like soybeans or corn) grow tall enough to shade the rows.

A cereal rye cover crop provides a mulch layer in a soybean field. Photo by Rob Myers.

Farmers report a number of economic benefits from using cover crops: reduced challenges related to herbicide-resistant weeds, reduced costs of dealing with soil compaction (e.g., equipment and fuel costs, as well as time spent on the combine), and reduced inputs, as cover crops can add nutrients to the soil. Cover crops can also be used to feed grazing livestock, presenting opportunities to either incorporate livestock into a row crop operation or to provide forage for neighboring livestock producers for a fee.

While cover crop adoption is growing, there is substantial room to increase acres of cover crops across the United States. As of the 2017 Census of Agriculture, less than four percent of all US cropland had been planted to cover crops in that year, with a more recent study suggesting a higher adoption rate of this practice in the Midwest.[9] Reported barriers to adoption include lack of knowledge on how to manage cover crops and what seed varieties to use, in addition to concern for the increased time, labor, and cost of seed associated with introducing the practice.[10] Farmers may also be concerned that cover crops will incur a yield lag, thus reducing overall productivity. While some studies identify initial yield losses when using cover crops,[11] a number of studies and surveys suggest that consecutive use of cover crops in corn and soybean fields can increase yields over the course of several crop years (Table 1).

Minimize Tillage

Minimizing tillage involves reducing soil disturbance by decreasing the intensity and/or number of tillage passes across a given field (known as reduced tillage or conservation tillage) or eliminating tillage altogether

Table 1: Percent increase in corn and soybean yields after one, three and five years of consecutive cover crop use on a field, based on a regression analysis of data for crop years 2015 and 2016

	1 year	3 years	5 years
Corn	0.52%	1.76%	3.00%
Soybeans	2.12%	3.54%	4.96%

Figures shown are an average of yields from the 2015 and 2016 growing seasons, with yield data obtained from about 500 farmers each year through the SARE/CTIC National Cover Crop Survey.

Crimson clover blooming in mid-spring. Crimson clover is the most popular legume cover crop in the United States, and is best suited to the southern half of the country since it does not reliably overwinter in northern areas. Photo by Rob Myers.

(no-till). When soil is heavily tilled on a consistent basis, soil aggregates are degraded, soil organic matter declines, and soil macropores are destroyed. Reducing soil disturbance helps alleviate these issues by rebuilding soil structure and enabling root growth, which in turn reduces soil erosion and improves water retention.[12] Reducing tillage also means that more crop residue (leaves and plant stems) is left on the soil surface after harvest, which preserves soil moisture and shields the soil from excessive sunlight and wind.[13]

While transitioning to no-till or reduced tillage can involve investing in new equipment, minimizing tillage has both short- and long-term economic benefits for farmers. In the short-term, farmers save on costs of fuel, labor, and time spent tilling fields each year. By reducing issues of compaction and building soil health, farmers can improve the long-term viability of their land. According to the 2017 Census of Agriculture, the total no-till acres in the United States was reported as 104 million acres, approximately eight million more acres than was reported in the previous Census in 2012.[14] However, reduced/no-till are still not viewed by farmers as the standard practice on US farmland. Barriers to minimizing tillage include lack of producer experience with the practice, knowledge, and access to appropriate equipment. In the absence of tillage, ensuring adequate seed placement depends entirely on the planter and its settings.[15] Planters may need to be upgraded or adjusted to ensure successful seed placement and seed-to-soil contact. Importantly, the optimum benefits from minimizing tillage are typically realized after maintaining the practice for several consecutive years.[16]

Adaptive Multi-Paddock Grazing

Rotational grazing, where livestock are intentionally rotated through multiple fenced paddocks over relatively short periods, offers multiple benefits to producers, preservation of natural resources, and to the animals themselves. In adaptive multi-paddock rotational grazing, producers graze livestock from a single day to a few weeks, then provide paddocks a resting period which allows forage plants to recover, preventing overgrazing, which in turn reduces runoff, minimizes soil erosion, and improves water quality. The practice of rotating animals across numerous paddocks also enhances the even spread of manure, leading to improved productivity and vigor of forage species, as well as increased resilience to drought.[17]

There are different levels of rotational grazing, which may be classified as intensive rotational grazing, which uses an average grazing period of 14 days or less per paddock, and basic rotational grazing, which uses 15 days or more per paddock.[18] Studies conducted in different areas of the United States report that intensive rotational grazing produces high quality forage, enhances forage biomass, including root biomass and rhizodeposition—the release of organic compounds from plant roots into surrounding

Soybeans being planted directly into cover crop to minimize disturbance to the soil caused by tillage. Photo by Cory Ritter.

Adaptive multi-paddock grazing. Mac Kincaid (Missouri farmer) moves electric fencing to rotate his cows to another pasture. Photo by Aaron Phillips.

soil—which boosts soil organic carbon sequestration rates.[19] By increasing soil organic carbon sequestration rates by more than one ton per acre annually, this research suggests that intensive rotational grazing can result in a net negative greenhouse gas footprint in terms of the average per-animal enteric methane levels.

There is ample opportunity to increase rotational grazing practices in the United States. A recent USDA report found that in 2017, only 32 percent of US cattle operations use intensive rotational grazing.[18] A common perceived barrier to adopting this practice is the belief that it takes more time and labor to frequently move livestock between paddocks than using continuous grazing. However, efficiently designed rotational systems make moving livestock easy, taking as few as 15 minutes per day per livestock group.[18] This is minimal compared to the time it takes in confinement systems to grow or procure hay, provide feed and silage to livestock, and move manure. Practitioners also report that frequently moving livestock allows them an important benefit of being able to consistently take stock of herd health.

Another barrier is the assumption that substantial investment in fencing and water infrastructure are needed for intensive rotational grazing. However, most farmers using this system rely on temporary electric fencing and moveable water sources, which are less costly than permanent structures. Finally, producers need training and guidance to effectively manage intensive rotational grazing systems. A truly sustainable livestock system would require behavioral changes by both producers and consumers.

Conservation Buffers

Conservation buffers—sometimes referred to as herbaceous field borders or hedgerows—are strips of non-crop grasses, forbs, shrubs, and/or small trees planted along the edges of agricultural fields. Properly managed and properly sited conservation buffers help to reduce soil loss from wind and water erosion,[20, 21, 22] and act as filters between fields and waterways, reducing sedimentation and filtering chemical inputs and excess levels of nitrogen and phosphorous fertilizer above plant uptake from leaching out into streams and rivers.[23, 24, 25] Conservation buffers provide the ground with living and decomposing vegetation and root materials which can be taken up by soil microorganisms to produce soil organic carbon.[26] In addition, maintaining these borders adds biodiversity to farms and creates habitat for pollinator species and other types of wildlife.[27] Planting native and flowering plants provides nesting sites and floral resources for beneficial insects, like wild bees, and invites more pollinators from natural areas to fields.

Despite the benefits of conservation buffers, adoption rates are relatively low. Producers are often concerned that diverting portions of their field into such structures will reduce net income because land

is taken out of production or crop yields decline because of crop damage from increased animal feeding or crop damage from wild animals that use the field borders for habitat. Yield reduction can also result from shading of the crop by tree lines, increased weed pressure, or increased insect damage. Anticipated problems like increased pest pressure can be mitigated by selecting plants that attract beneficial insects that prey on insect pests, plants that bloom sequentially throughout the growing season, and avoiding plants known to increase pest abundance.[28]

Another practical challenge associated with field buffers is that they must be properly and often professionally installed with consideration to engineering factors, geographic features, and topographic attributes of the field. Additionally, decisions about plant species must be made strategically in order for field borders to be maximally effective for the local resource concern in question (e.g., wind erosion, nutrient loss mitigation, wildlife habitat). Engineering expertise for designing field buffers is available to farmers almost exclusively through federal agencies like USDA's Natural Resources Conservation Service (NRCS), but these agencies often require farmers to complete lengthy and time-consuming paperwork and wait months or even years for the full engineering assessment and design protocols to be completed.

Despite these challenges, studies find that installing conservation buffers can improve crop yields by reducing soil loss and minimizing wind erosion.[29, 30] There is also the potential to generate income-producing products from conservation buffers by planting valuable timber or specialty crops, like nut-producing trees.

Combining Practices

On their own, each of these practices contribute to several positive agricultural outcomes, and combining practices can reinforce these advantages. For example, using no-till in combination with cover crops improves soil quality, reduces sediment loss, and produces higher levels of soil organic carbon than using no-till alone.[31, 32, 33, 34] Transitioning from a tilled system to a no-till system can cause temporary soil compaction and reduce nutrient distribution at first, which in turn can affect cash crop yields in the first few years. Starting with cover crops and then adding no-till later can reduce or avoid these temporary effects, while some conservationists advocate adopting no-till first because cover cropping is a more management-intensive practice which has a steeper learning curve. Table 2 illustrates the payoffs of using cover crops to assist the conversion from conventional tillage to no-till over five years in operation growing corn or soybean.

Using livestock to graze cover crops through rotational grazing can add an income-generating activity to offset the costs involved with using cover crops. Grazing cover crops can also serve as a replacement

Cattle grazing cover crops. Photo by Brett Peshek, Green Cover Seed.

for hay, providing high-quality forage to livestock and saving on costs of raising, harvesting, baling, and storing hay throughout the year.[35] According to data collected through the National Cover Crop Survey from 2012 to 2016, grazing cover crops generated a potential per acre grazing income of $49.23 per acre yearly. Table 2 portrays the potential grazing income and adjusted net return over five years of using cover crops in either corn or soybean operations.

Barriers to Regenerative Agriculture

Despite the benefits described above from using regenerative farming practices, there are barriers that impede adoption. Top barriers are often interrelated and include: (1) financial concerns, (2) access to necessary materials, equipment, and infrastructure, (3) knowledge and education, (4) time, and (5) land tenure. Sociocultural factors further compound these barriers, as there are generational divides to incorporating changes and farmers are influenced by what is considered socially and culturally acceptable by their peers.[37]

Financial Concerns

Financial considerations can feel particularly burdensome when adopting new practices in the first year. For example, planting cover crops requires purchasing cover crop seed and requires added labor costs to manage them (see Table 3 for typical cover crop costs per acre). Rotational grazing often requires investing in temporary fencing and watering facilities. Planting conservation buffers means purchasing seed and seedlings of the desired species. These upfront costs can be major deterrents to farmers who have not yet experienced the benefits of regenerative agriculture.

Another financial concern is that regenerative farming practices will impact a farmer's bottom line. Conservation buffers may require that farmers take small amounts

Table 2: Per acre impact of using cover crops in combination with other practices over five years [36]

		Years of cover cropping		
		One	Three	Five
Using cover crops to assist conversion to no-till from conventional tillage[a]		$23.96	$23.96	$23.96
Corn	Adjusted net return	-$7.40	$25.38	$41.86
Soybeans	Adjusted net return	$0.41	$24.38	$34.14
Potential grazing income with cover cropping[b]		$49.23	$49.23	$49.23
Corn	Adjusted net return	$17.87	$50.65	$67.13
Soybeans	Adjusted net return	$25.68	$49.65	$59.41

[a] *No-till savings versus conventional: No fall chisel plow ($11.22 per acre) and savings on two field cultivator passes in the spring (2 x $6.37 per acre).*

[b] *Assumes that grazing a cover crop (cereal rye in this example) results in a reduction of 1,093 pounds of hay fed per acre of cover crops. This is based on 1,500 pounds per acre of dry matter generated by rye, then reduced effective use of the rye by 50 percent due to hoof action and selective grazing. Assumes average feedlot waste of 22 percent for hay fed (88 percent dry matter). The hay is valued at $80 per ton. Additional savings of approximately $5.50 per acre generated due to lower labor, fuel and machinery depreciation from reduced hay fed. Assumes grazer already has water access for their grazing area and an electric fencing system.*

of farmland out of cash crop production. The first few years using no-till and/or cover crops can result in decreased yields and increase expenses related to implementing new practices. These are understandable concerns, but current research shows that the long-term financial benefits of building soil health and soil organic carbon outweigh these initial deterrents. Still, farmers need access to financial resources to implement and maintain these practices, especially in overcoming the lack of tangible benefits in the first few years.

Access to Materials and Equipment

As noted previously, regenerative farming practices can require different materials, equipment, and infrastructure than farmers have been previously using. Farmers may not know where to access these resources or they may not be readily available in the first place. At present, cover crop seed varieties are limited and there is a need for more cover crop seed producers across the country to produce the quantity needed to support broader adoption of cover crops in the United States. In 2022, USDA provided funding to the Farmers for Soil Health initiative with the goal of doubling cover cropped acres to 30 million by 2030.[38] Many regenerative practices also require access to different equipment: no-till is most successful when using a planter designed specifically for no-till, and roller crimpers are often used to terminate cover crops. To be fully successful in adopting these new practices, farmers need ready access to this equipment and to know how to use it.

Knowledge and Education

To reap the benefits of regenerative practices, farmers must know how to effectively incorporate them into their overall farm management framework. In the past, there has been a dearth of easily obtainable educational and training materials to help farmers navigate adoption of these practices. Moreover, technical services providers—including private and public extension and outreach professionals and agricultural advisors—have not always had the capacity to support farmers' transition to regenerative systems. Today, there are more resources than ever to guide farmers' adoption of these practices through USDA, EPA, state departments of agriculture, and various NGO and private sector sources, which is an important step. But there is still a need for guidance relevant to specific contexts that farmers trust.

Time

A major barrier to adoption of regenerative farming practices is the perception that they require too much time to implement and reap the benefits. Regenerative farming practices are a multi-year investment which requires preparation for the impact the transition will have on income, along with a shift in mindset for long-term investments to reap long-term benefits. Furthermore, farmers need to be able and willing to refine aspects of practices to work best for their own unique farming operation in order to realize the full range of benefits over time. In many

Table 3. Typical Range of cover crop costs per acre

Item	Cost per acre
Cover crop seed	$10–$50
Seeding the cover crops	$5–$18
Termination	$0–$10
Subtotal range	$15–$78
Median cost from survey	$37

Note 1. Estimates based on farmers' responses to 2015-2016 CTIC Cover Crop Surveys.

cases, these practices take a few years to show their advantages. For example, when using cover crops, farmers may face a yield decrease and hit to their net profit in the few years, but their results typically improve after three to five years (see Table 1). On average, the Conservation Technology Information Center surveys suggest that it takes three years to break even. Often, farmers report a net higher cost from the new practice in years one and two, which starts to reverse in year three, followed by a positive return starting in year four (see Table 2). The initial setback can cause farmers to abandon the new practice before it has time to demonstrate its full set of benefits.

Land Tenure

Land tenure is another barrier to adopting regenerative farming practices. An estimated 39 percent of US farmland nationally is rented land. It is rational for tenant farmers to determine that the investments of time and resources needed to implement regenerative practices are not worthwhile if they do not hold a long-term tie to the land they are farming.[39] Willingness on the part of landowners to share in the cost of implementing the practice and/or give a multi-year lease to farmers could facilitate greater adoption of these practices on rented land. Land access is also a challenge for new and beginner farmers, who are reportedly often quite interested in using regenerative agriculture but struggle to find land to launch their operations.

Opportunities for Transitioning to Regenerative Agricultural Practices

A range of public and private programs are aimed at supporting farmers' adoption of regenerative agricultural practices. These programs may offer financial incentives or cost-share opportunities to reduce financial barriers to implementation and/or educational and technical assistance to build farmer capacities.

Public Funding

Public funding for conservation is available through a number of federal and state programs, including the Environmental Quality Incentives Program (EQIP) and the Conservation Stewardship Program (CSP),[40] implemented by NRCS. In these voluntary programs, farmers apply to receive financial and technical incentives in exchange for adoption of approved conservation practices. In these programs, interested farmers work with an agent at their county NRCS office to create conservation plans and apply for financial support to partially offset costs of putting their plans in place.

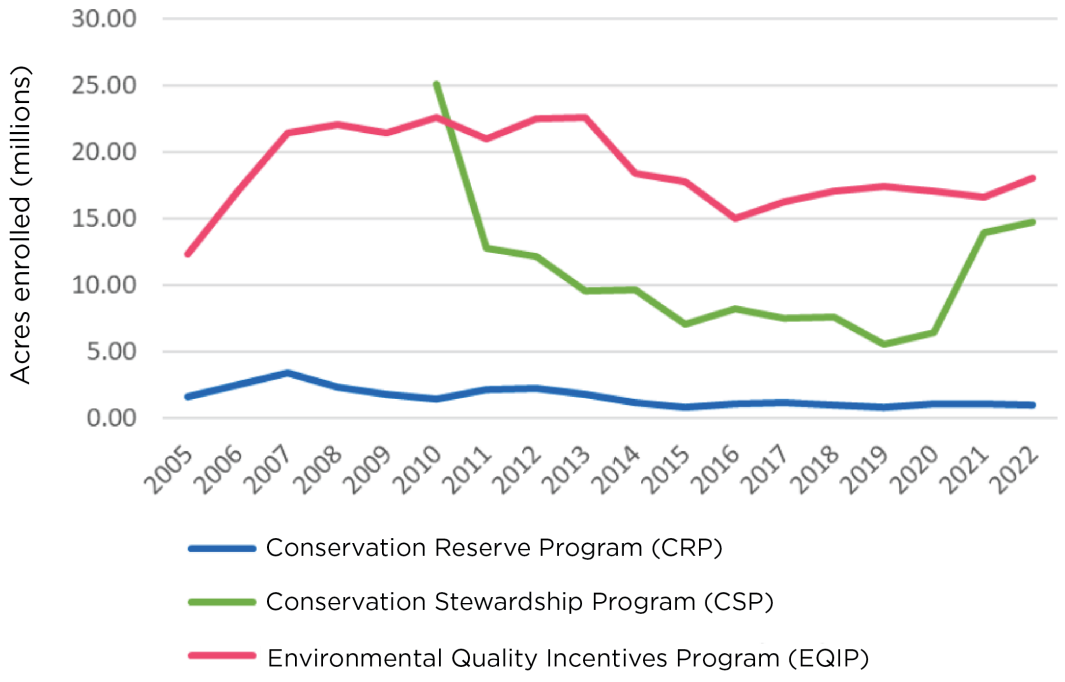
While these programs have been available for several decades, rates of participation have varied (Figure 1).

Awareness of these programs varies across farmer types and regions, thus impacting participation.[42] The perception that the application process and reporting on compliance are too burdensome can also deter farmers from applying for this support.[38, 43] Other factors associated with positive participation include one's environmental values, having previously participated in a conservation program, and having an existing relationship with a county agent.[44] Certain farm and farmer characteristics also impact participation, for example, larger farms are more likely to apply than smaller farms.[45, 46]

The Conservation Reserve Program (CRP) is a federal program administered by USDA's Farm Service Agency (FSA) designed to support the establishment of conservation buffers by offering an annual rental payment to farmers who remove environmentally sensitive land from production and plant native or perennial plant species to restore the land for contract periods of 10 to 15 years.[47] The current version of this program was originally authorized through the Food Security Act of 1985 and has had variable enrollment over the past 35 years, ranging from 35 million acres at its peak in 2007 down to 21 million acres in 2018.[48] High crop prices and low CRP rental rates compared to market rental rates are disincentives reported by farmers for enrollment and for maintaining CRP acres.[49, 50]

Soil and Water Conservation Districts (SWCDs) are local units of state governments based in nearly every county across the United States to provide local assistance on a range of natural resource challenges. SWCD programming offers technical assistance, training, information, and cost-share/incentive payment opportunities to

Figure 1: New acres enrolled in a cost-share program from 2005-2022[47]



Data from Natural Resources Conservation Service, "NRCS Conservation Programs."[41]

landowners, farmers, and ranchers in their county to help them reach their conservation goals. Each county SWCD is locally led and has specific program goals and natural resource concerns. They work with county-based NRCS staff, local State Department of Natural Resources, and the State Department of Agriculture to implement programs. There are nearly 3,000 SWCDs across the United States, some with slightly varied names (e.g., in California such entities are called the Resource Conservation Districts, in Nebraska they are called Natural Resource Districts).[51]

The Sustainable Agriculture Research and Education (SARE) is a federally funded decentralized competitive grants and education program that supports projects from farmers, ranchers, researchers, and educators to generate the knowledge and tools needed to research and promote sustainable agriculture.[52] This program operates across all US states, with regional councils that target region-specific resource objectives. SARE provides an essential service in funding farmer-driven research projects to improve understanding of sustainable agriculture. SARE also funds education projects to help farmers and farm trainers advance implementation of sustainable practices.

Carbon Market Programs

In a carbon market program, the project developer adopts one or more protocols developed by a carbon registry to generate carbon offsets. These protocols identify specific practices that either mitigate creation of greenhouse gases or sequester carbon and establish standards on how to measure, report, and verify them to meet requirements for generating marketable offsets. The project developer enrolls farmers or ranchers as participants to implement the protocols by following the standardized requirements. The fulfillment of these requirements is typically verified by independent third-party verifiers, who then issue offset credits. Finally, the project developer registers the carbon offsets with a carbon registry where they can be sold to buyers, which are often private companies or individuals, on carbon markets. Purchasing carbon credits helps private companies and individuals meet their climate commitments or sustainability goals.

Carbon markets may be implemented by governments or private entities and typically are categorized as either "compliance markets" or "voluntary markets." Compliance markets mandate certain entities to limit or reduce their greenhouse gas emissions. Voluntary markets are opt-in opportunities for businesses, organizations, and individuals to purchase carbon offsets. In recent years in the United States, a series of private companies have launched voluntary agricultural carbon markets.

There are many questions surrounding the viability of carbon market programs in the United States. To start, there remains uncertainty on the effectiveness of carbon markets to actually produce real net emissions reductions. There are ongoing concerns on the criteria that should be met to confirm carbon offsets, including the intrinsic quality of carbon offsets (referred to as "realness" within the carbon market environment) and how long the sequestered carbon must be maintained in the ground (referred to as "leakage" and "permanence").

Critics also argue that current credit prices are too low for producers to justify the costs of implementing new practices.[53] There are also concerns regarding which farmers and ranchers can most readily take advantage of carbon market opportunities, as small- and medium-sized producers report barriers to participate including not meeting minimum acreage requirements. In addition, carbon market programs tend to recruit participants who have not yet used these practices because they want to register "new" greenhouse gas reductions or carbon sequestration, thus leaving out early adopters who have been using the beneficial practices for many years from being able to capture this benefit for their efforts.[54]

Finally, there is a lot of confusion among farmers about these programs. Although mainstream media is reporting on the idea of carbon credit programs, most US farmers either do not know how to access them or are not comfortable with the terms of the contracts that are available and are uncertain about the stability of the entities offering the payments.

Regenerative Sourcing Programs

In recent years, several regenerative sourcing programs from private companies have emerged with goals to increase farm acres using regenerative practices.[55] These corporate initiatives aim to incentivize farmers they source commodities from to adopt practices like cover crops to help them meet their climate commitments. The parameters of these programs differ by company, but the companies may offer financial incentives, complimentary services or technical assistance, or output price premiums to farmers who adopt practices. Some programs also provide educational components and/or coaching to participants. Typically, companies work with a third-party organization, often from the environmental NGO community, who implement and/or monitor these programs in the field. In the last few years, some companies have chosen to rely on their employees at regionally located facilities, such as grain elevators or implement dealerships, to recruit farmers to participate in their program.

Farmers express interest in learning about these opportunities, but most of these programs are relatively new—mostly in pilot stages—and are thus not widely accessible at present in the United States. As is the case for carbon credit programs, the majority of farmers do not know how to access these opportunities.

Agriculture Lenders

When the agriculture sector faces risks, so does the agricultural finance community. In the past, agriculture lenders often perceived regenerative agriculture as risky and worried about its impact on farmers' profitability. More is now known about how regenerative agriculture can provide both short- and long-term benefits to farm productivity.

In January 2022, the Environmental Defense Fund (EDF) and Farmers Business Network partnered to pilot the "Regenerative Agriculture Finance Fund", a loan product aimed at rewarding farmers for regenerative farming practices that increase climate resilience and build soil health.[56] Enrolled farmers who meet the EDF-set nitrogen and environmental standards by the end of the year gain access to a 0.5 percent rebate on a one-year line of credit. This $25 million pilot program quickly enrolled 48 producers—with a growing waiting list—who are either already using regenerative practices or are transitioning to regenerative systems.[57] This pilot program represents one approach that agriculture lenders can take to support farmers' adoption of regenerative farming practices.

Recommendations

Avoid Carbon Tunnel Vision

As companies strive to reach their climate commitments, much of the focus has been on carbon sequestration. However, regenerative agriculture can provide myriad benefits: increasing biodiversity, water quality, air quality, addressing issues of resource scarcity, and more. Often, the ecosystem benefits are interconnected and relate to each other. A singular focus on carbon risks can undermine and undersell the long-term promise of regenerative agriculture for farmers as well as companies, investors, and communities.

Recommendation 1: Regenerative agriculture initiatives should be a component of comprehensive climate strategies that employ an integrated approach to catalyzing climate resilience.

Regenerative Practices on Public and Private Lands

With more public-private support than ever for regenerative farming, efforts should be taken to promote these practices as standard practice. This can be achieved through supporting adoption on both public and privately owned lands.

In the public sphere, regenerative agriculture can be used and modeled in our public lands, parks, and universities. The US Land Grant system's agricultural experiment stations were established under the Hatch Act of 1887 to conduct agricultural research to meet the needs of US citizens.

Recommendation 2: Additional funding should be provided for state-designated programs and the US Department of Agriculture's National Institute of Food and Agriculture (NIFA) in support of agricultural experiment station farms in conducting short- and long-term research and demonstrations on regenerative agriculture practices.

This will help to improve the resiliency of these lands, therefore extending their potential to continue as viable experiment stations, while simultaneously acting as demonstration sites to model how regenerative agriculture practices can benefit our public lands and parks. For example, conservation buffers can be planted along hiking or biking paths in state or national parks to create habitat for pollinators and wildlife that parkgoers will enjoy.

As previously described, several private companies have also begun supporting regenerative agriculture through regenerative sourcing programs. As targets are set to convince increasingly more farmers to adopt regenerative farming practices through these corporate-funded sourcing programs, the eventual public policy goal should be that all sourced products are grown using regenerative farming practices.

Recommendation 3: To encourage regenerative practices on private lands, corporations (such as Cargill, Danone, General Mills, McDonald's) should continue efforts to incorporate regenerative agriculture into their operations by sourcing products from farms practicing regenerative agriculture.

Improve Communication between Farmers and Other Entities

Despite an extensive array of initiatives and programs intended to support producers' adoption of regenerative farming practices, farmers report issues of access in addition to a lack of relevance to their contexts and needs. To support their adoption of regenerative agriculture, it is essential to recognize and understand the issues that farmers face and feel.

To make regenerative sourcing programs and public opportunities more accessible, consultation with diverse panels of farmers should be a central part of design and implementation teams. This iterative co-production approach is essential to improve the relevance, resonance, and ultimately, the success of these initiatives.

Effective communication means understanding and leveraging the communications channels favored by producers. Farmers look

to other farmers, farm groups, and the agricultural press for information to help inform their decision-making.[58] There are several farmers who have gained local and/national attention as leaders and innovators in regenerative agriculture, and these speakers use mediums such as farm events, conferences, and social media such as podcasts to share their experience with other farmers. Through speaking engagements and often through videos that are widely shared on platforms like YouTube, they can be quite influential with other farmers. These farmers' ability to share their message has been amplified by the expansion of farmer-to-farmer learning networks in recent decades. For example, Practical Farmers of Iowa, established in 1985, is a non-profit organization that uses farmer-led investigation and information sharing to help farmers practice an agriculture that benefits both the land and people.

Providing additional support to organizations that have a proven track record in organizing and sustaining farmer learning networks would be the single most effective investment that could be made to facilitate the crucial initial step in going down the regenerative agriculture path.

Recommendation 4: Public and private entities should support and partner with trusted farmer organizations in organizing and sustaining farmer learning networks, which would enable more farmers to learn enough about the benefits of these practices to convince them to ask more questions about it.

The agricultural press and farm groups are also trusted sources of information by farmers. However, in the past, some of these groups have been sources of misinformation, including perpetuating denial of climate change, and particularly the connection between climate change and human activity, which has influenced how many farmers think about climate change.[59] As trusted voices for farmers, it is critical to improve the climate literacy of these entities. Climate researchers and policymakers must better engage with these groups. Organizations such as the Trust in Food division of Farm Journal work with individual companies and trade associations to help improve their communications with farmers on the adoption of regenerative agriculture practices.

Workforce Development

In 2022, roughly $20 billion was provided to USDA to expand adoption of climate-smart agricultural practices under the Inflation Reduction Act (IRA). An additional $3.1 billion in funding from the Commodity Credit Corporation (CCC) was set aside by USDA to establish pilot projects exploring market-opportunities for products grown using regenerative practices under the new Partnership for Climate-Smart Commodities program. These investments represent a quantum leap in public support for investing in US farmers' voluntary adoption of regenerative farming practices.

USDA's current capacity to provide technical assistance to facilitate the farmer planning needed to implement climate-smart practices and conservation practices, both by NRCS staff and private sector conservation professionals formally certified as technical service providers (TSPs), are inadequate to meet the demand for such services implied by the additional $20 billion plus federal investment in climate-smart and conservation efforts.

Recommendation 5: To address the shortage of technical service providers in the short-term (one to three years), NRCS should streamline the processes of certifying private sector conservation experts as TSPs to allow more farmers access to service professionals and facilitating the adoption of regenerative agricultural practices.

In this context, NRCS should consider allowing experts to qualify as TSPs for a narrowly defined set of conservation activities that are in greatest demand by farmers seeking to receive funding under the Inflation Reduction Act provisions promoting the adoption of climate-smart agricultural practices, and also delegating certification authority for TSPs to state conservation agencies.

Recommendation 6: At the same time that USDA takes steps to expand the corps of eligible TSP's, the private sector should fund activities to develop capacities of professional agronomists and crop consultants—experts that many farmers rely on for advice—in implementing regenerative farming practices.

One useful model for this approach is the Trusted Adviser program established in the state of North Dakota by General Mills, which provides an educational program about conservation for certified crop advisers (CCAs) working in that state. It might be advantageous to engage with the American Society of Agronomy on this topic, which sets up programs at the state level to provide voluntary certification to crop advisers as CCAs. Even if this training does not rise to the level of qualifying an individual as a TSP, having a broader awareness of the value of these practices among the professionals who work with farmers can still be helpful.

Launching a regenerative agriculture movement that will persist over time will require it to have a sufficiently trained workforce to carry out regenerative practices.

Recommendation 7: Over the longer-term, land-grant universities should develop undergraduate curricula focused on regenerative agriculture for both crop and livestock production.

Ag in the Classroom programs should be encouraged to include greater emphasis on conservation in classroom materials. Private or public sector entities could then encourage students to pursue this educational path by providing scholarships or other forms of financial assistance. The goal is for land-grant extension specialists to offer the same quality of advice to farmers seeking to adopt regenerative agriculture practices as they do to farmers engaged in conventional farming practices. These institutions should also invest in programs specifically aimed at supporting first-generation, underrepresented, and minority students interested in agriculture. Such an investment will increase the number of students who have access to knowledge and training on regenerative agriculture. Long term, this endeavor will increase the diversity of trusted experts, support under-represented farmers and farming communities, and expand the diversity and number of farmer-to-farmer programs.

Implement Farmer-to-Farmer Peer Learning Opportunities

Several organizations are involved in establishing, funding, and/or operating organized farmer learning networks in many parts of the country. This approach gives farmers a number of different ways to access information about regenerative agriculture practices and the benefits they provide from experienced farmers who can share their stories about the journeys they took to attain success with these practices. A key function of these networks is to prepare farmers who are passionate about their conservation practices to take the next step and be willing to talk to their neighbors about their stories in an organized setting, such as in workshops, conferences, or field days. The objective is to train more farmer leaders to have the confidence to 'take the microphone' on such occasions.

Recommendation 8: In-person conversations and events, such as field days and farmer conferences, should be used as they are the most effective means of engaging farmers on the benefits of regenerative agriculture.

These are particularly effective because the source of information is other farmers who have achieved demonstrable success with their conservation ethos. These conversations can occur during the course of field days held on farms, at conferences focused on topics such as no-till or cover cropping held frequently during the year, or less formal workshops or group discussions frequently held on farms. Those conversations must engage those farmers not just on the environmental benefits that the practices are expected to generate, which largely accrue to the general public, but they also need to provide information on how the practices can reduce input costs and potentially increase their yields if maintained over time.

Farmer leadership endeavors should also look to bolster the voices and networks of underserved farmers and farming communities. Federal programs and private institutions should be intentional in establishing trust and forming partnerships with underrepresented groups—including new and beginning farmers, Black, Brown, and Indigenous farmers, women, and LGBTQ+ farmers—to understand their unique barriers and identify opportunities based on their felt-needs. Partnerships to expand these existing networks should provide spaces for underserved farmers and farming communities

to access larger audiences and strengthen farmer-to-farmer and farmer-community networks. Crucially, these partnerships will need to provide ample opportunities for these farmers to access financial, material, technical assistance resources, and spaces, such as field days and farm events, to engage with other farmers. An example is USDA's Indigenous Food Sovereignty Initiative, which is a partnership between the USDA and tribal-serving organizations that includes underrepresented farmers in decision-making spaces. The initiative aims to rework federal food and agricultural programs based on Indigenous perspectives and needs while supporting Indigenous communities' and reclaiming Indigenous foodways.

Provide Capital to Assist Farmers' Transition

Producers need adequate access to capital and credit to ensure that producers have the resources and time needed to successfully transition to regenerative agriculture. Agricultural lenders can play an important role supporting farmers' transition to regenerative agriculture, which in turn reduces the vulnerability of the lenders' financial assets. USDA's Conservation Loan program, established in the 2002 farm bill, provides loan guarantees to farmers for installing conservation practices and systems. Such loans are made by commercial lenders but repayment is guaranteed by USDA should the borrower default. Between 2008 and 2019, this loan program provided less than $20 million in guaranteed loans.

Recommendation 9: To provide loan guarantees that would encourage adoption of regenerative practices on US farms and ranches, Congress should take steps to streamline the operation of USDA's Conservation Loan program, publicize its availability to farmers, and increase funding levels for it through the annual appropriations process.

There is need for more agriculture lenders to think creatively on how to incentivize farmers through current and novel programs to support their adoption of regenerative farming practices. Agriculture lenders need to understand that regenerative agriculture is a multi-year investment, similar to providing ownership loans for equipment purchases.

Recommendation 10: The private sector should invest in preferential industries to provide capital and loan options to farmers using regenerative practices that have lower interest rates and are packaged as multi-year loans (3-5 years) to allow farmers to fully transition to regenerative systems.

Through regenerative sourcing programs, there is a role for large corporations to provide the necessary financing to producers they source from to ensure they have the resources they need to put these practices in place.

Recommendation 11: Agricultural lenders should also follow suit to expand loan options for farmers using regenerative practices.

In addition, programs should intentionally seek to reduce barriers to socially disadvantaged producers who have historically faced discrimination from accessing loans and participating in USDA programs.[60, 61] These partnerships would bolster trust, support farmer-to-famer networks, and expand regenerative agriculture to under-represented farming communities.

Elevate Infrastructure for Regenerative Agriculture

To launch a regenerative agriculture movement that persists and expands over time, it will need to be supported with adequate access to needed inputs, equipment, and infrastructure that are often distinct from those used in conventional agriculture. For example, inputs such as cover crop seed are notably lacking in both quantity and quality.

Scaling up regenerative agriculture will require more resources—including inputs, equipment, and infrastructure—to put these practices in place. If cover crop adoption is expected to grow substantially, a critical first step is to have regionally adapted, quality seed with traits that meet a variety of producer objectives, such as biomass and forage quality, winter-hardiness, weed suppression, and increased root growth. These varieties will need to be available in

sufficient supply and affordable to a wide variety of producers.

Recommendation 12: Incentives should be provided from both public and private sources to expand and stabilize the supply chain for cover crop seeds, such as cereal and legume seeds.

As conservation buffers are most beneficial when incorporating diverse species and native plants, better support is similarly needed for seed producers that produce contextually relevant and native plant seeds used in this practice.

Recommendation 13: The federal crop insurance program should be revamped to remove penalties for farmers wishing to harvest, clean, and sell their cover crop seeds.

Regenerative farming practices also depend on specific equipment, such as no-till drills, which needs to be available to farmers through direct purchase or rental arrangement. There is also likely to be increased demand for equipment and parts needed to install high-efficiency irrigation systems, especially in the western states within the Colorado River system, which has been facing a chronic shortfall in water flow compared to irrigation demand in recent years.

Recommendation 14: A study should be commissioned examining the impact of expanded conservation under increased funding levels and how it will affect demand for inputs and equipment specific to regenerative agriculture, such as no-till drills and high-efficiency irrigation systems.

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