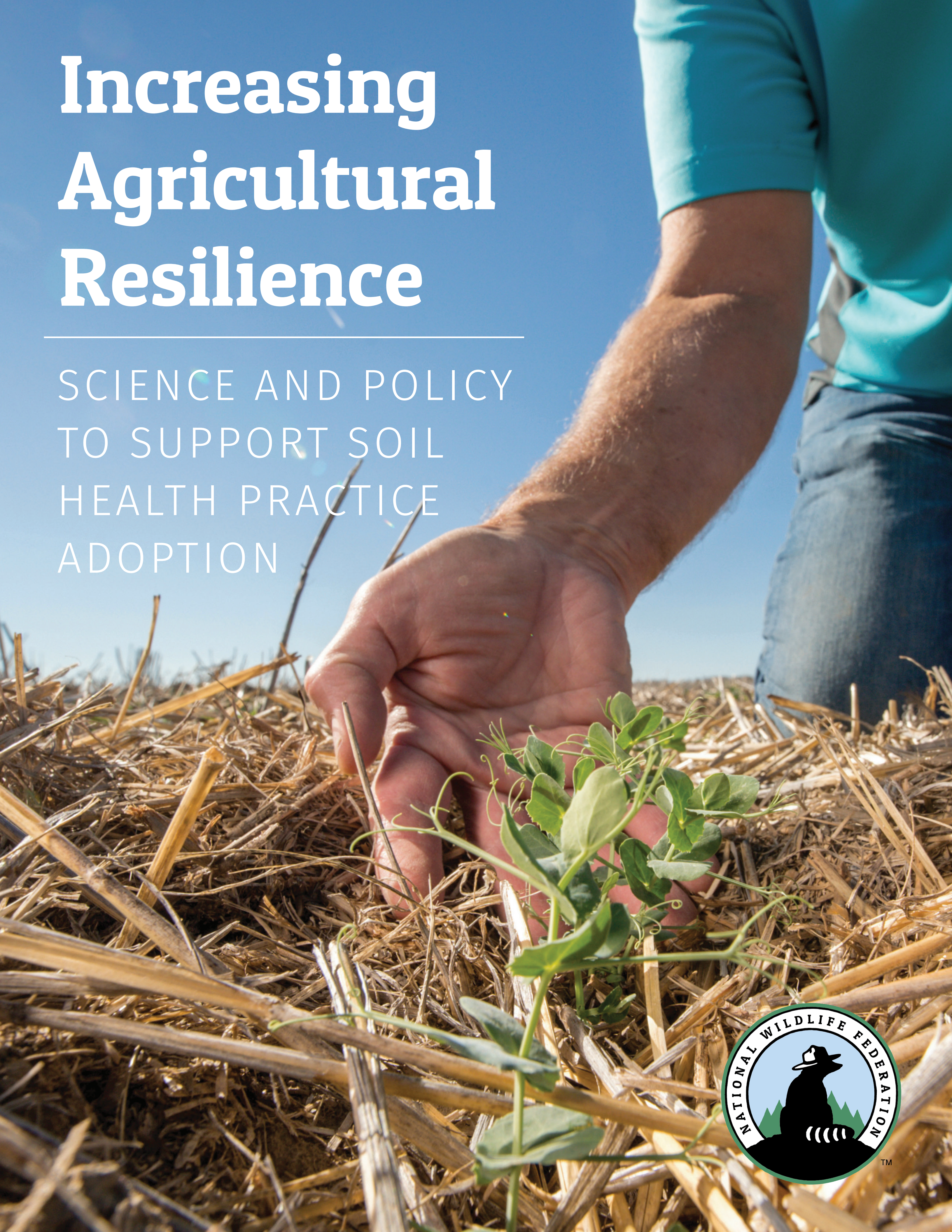
Increasing Agricultural Resilience

SCIENCE AND POLICY TO SUPPORT SOIL HEALTH PRACTICE ADOPTION



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Cover image: No-till clover cover crops emerge through crop residue. Photo: SARE Media Library

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A test plot of crimson clover at the USDA-NRCS Plant Material Center. Photo: SARE Media Library

Table of Contents

Researcher examines organic corn growing through cover crop residue. Photo: SARE Media Library

Executive Summary

Farming practices that restore and maintain healthy soils can increase the resilience of farming systems. Agricultural resilience is the ability of farms to manage and recover from disturbances.

Risk has always been a part of farming and ranching. While farmers and ranchers have long excelled at adapting to and managing the risks associated with production, climate change is increasing the frequency and severity of these risks. Farming practices that restore and maintain healthy soils can increase the resilience of farming systems. Agricultural resilience is the ability of farms to manage and recover from disturbances. Resilience requires diversification across farming practices, operations, and capital assets to defend against disturbances like droughts, floods, and rising input costs.

This report summarizes three actions to support farm resilience:

1. **Form an understanding of the current soil health management science**
2. **Reduce barriers to adoption of soil health practices**
3. **Enhance farmer supportive policies**

1. Building Farm Resilience through Soil Health. Healthy soils are living ecosystems with the continued capacity to support plants, animals, and humans.[6] Conservation practices such as cover crops and conservation tillage, build and protect soil health through four principles: 1) increasing diversity, 2) maintaining living roots throughout the year, 3) minimizing soil disturbance, and 4) maintaining soil cover throughout the year. These four principles enhance the farm's ability to cycle nutrients, fight disease, navigate a variable market, and recover from extreme weather events. Healthy soil helps farmers and ranchers build farm resilience by supporting the environment (natural assets), gaining peer networks (social assets) and conservation skills (human assets), and reducing reliance on expensive inputs (financial assets).

2. Barriers to adoption. Despite the substantial benefits that soil health approaches can provide, adoption of key practices by farmers in the U.S. has been climbing but remains low. There are a variety of barriers that can prevent a farmer from incorporating these practices;

- Technical challenges may include the need for new physical and human assets such as equipment and management skills.

- Economic barriers could be financial limitations that prohibit addressing technical challenges, limited markets for new crops, and delayed tangible economic benefits.

- Risk perceptions are a central paradox, farmers often perceive the cost and risk of changing practices to outweigh the potential cost and risk reduction soil health can provide.

- Narrow messaging and outreach methods do not always meet the needs of a diverse array of producers, particularly minority, women, and beginning farmers.

- Policy barriers can include misconceptions about crop insurance, insufficient funding, cumbersome application processes, and mistrust in government programs.

3. Increasing the Speed of Soil Health Adoption. Farm Bill conservation programs are the largest source of public funding to help farmers understand and adopt conservation agriculture systems, driving many day-to-day decisions on farms and ranches. Modest changes to these programs could substantially boost the adoption rate of soil health systems on America's farms and ranches, including:

- Prioritizing soil health in the design and delivery of USDA's suite of conservation programs, and increasing funding for those programs to meet growing demand.

- Improving USDA systems for collecting, storing, linking, analyzing, and sharing data on soil health practices and systems.

- Modernizing crop insurance to recognize the risk-reducing benefits of cover crops and other soil health practices, and making better use of USDA loan programs to fund transitions to soil health systems.

- Ensuring federal climate-smart agriculture investments promote widespread adoption of soil health systems.

Father and son farming duo assess soils from their field while their cattle graze on the cover crop. Grazing cover crops can help the return on investment of cover crops. Photo: Conservation Media Library

Cover crop mix of radish, annual ryegrass and clover interseeded into corn. Interseeding helps establish cover crops earlier in the season, and provides nutrient and weed management benefits to the cash crop. Photo: Conservation Media Library

Many agricultural regions have already experienced harm to their operations due to increasingly common extreme weather: extreme temperatures, drought, and excess precipitation.

Introduction: Resilience and Sustainability Challenges in US Agriculture

Farming is an inherently risky endeavor: temperature, precipitation, and soil conditions can all impact crop and livestock production, while farm incomes are impacted by market and policy conditions. All of these factors can change between or within a growing seasons. While these inherent risks have always been a part of agricultural production, global changes, especially climate change, are increasing these risks. Many agricultural regions have already experienced harm to their operations due to increasingly common extreme weather: extreme temperatures, drought, excess precipitation, and more severe storms. As the climate changes, pests and disease move into new regions, further complicating crop success. Systems—agronomic practices, markets, and policies—that prioritize risk management are more important than ever to maintain food production and agricultural livelihoods.

Farmers have long excelled at adapting to and managing production risks. Management decisions made by farmers can confer substantial risk management benefits to their farms. Diversifying production; investing in equipment, buildings, and infrastructure; and developing management and marketing skills are all methods historically used to mitigate risks. In recent decades, farmers in the U.S. have also increasingly relied on production insurance for risk management, supported by federal government subsidies. While this system has protected farm incomes during a period of increased production risk, focusing on a single risk management approach neglects a critical aspect of system health: ***resilience***.

A rapidly growing body of science is showing that adoption of practices that restore and maintain healthy soils can increase the resilience of farming systems on cropland and grazing lands. By better understanding the vulnerabilities of a system at the field, farm, and industry level, farmers, managers, and policymakers can make decisions that build resilience. This report summarizes the scientific basis for soil health practices that build agricultural resilience, outlines some of the existing challenges to adopting resilience-building practices, and provides recommendations for policies that better support agricultural resilience.

Adoption of practices that restore and maintain healthy soils can increase the resilience of farming systems on cropland and grazing lands.

Earthworms contribute to water and nutrient management by improving soil structure and soil organic matter, but their habitats are disturbed every time a field is tilled. Photo: Conservation Media Library

A green cover crop lines the Chesapeake Bay, protecting the water from runoff and the cash crop from floods. Photo: SARE Media Library

Agricultural Resilience

In an agricultural context, resilience primarily refers to the ability of a farm to respond to and recover from variable climate or market conditions while maintaining profitability and production.

Resilience refers to a system's ability to handle and recover from shocks. Resilience includes adaptability and recovery. A resilient system is both more resistant to disturbances and better able to recover and maintain the system's fundamental characteristics. These characteristics include the physical, economic, social, and cultural elements that define it. In an agricultural context, resilience primarily refers to the ability of a farm to ***respond*** to and ***recover*** from variable climate or market conditions while maintaining profitability and production. For example, resilient farms are able to ***respond*** to change by adjusting planting or harvest dates to accommodate weather patterns, and ***recover*** from damage by maintaining a diversified operation to spread financial risks across different income sources. Agricultural production is subject to a variety of risks and unexpected conditions, so resilience is a vital characteristic for ensuring the long-term viability of an operation.

Resilience is built by relying on resources across a variety of capital assets, including ***natural, financial, physical, social,*** and ***human*** assets (see Box 1). A system with high-quality assets across a variety of these categories has the capacity to absorb and adjust to variable conditions. These assets are tools that farmers can use to both resist and adapt to changes in precipitation, climate, market prices, and other unforeseen events. For example, human and social capital assets provide farmers the requisite skills and technical support to troubleshoot problems in crop or livestock production.[1]

Box 1: Capital Assets[1]

Capital assets are tangible property that a business uses to generate revenue. These assets confer substantial benefits to farm operations, but require investment, monitoring, and maintenance over time. It is important for system resilience to build high-quality assets across as wide a range of categories as possible.

Natural: These are the ecological factors that contribute to a farm's capacity to produce crops and livestock. These assets include the soils, water, climate, and biological resources on a farm. While many of these assets include inherent qualities endowed to a farm, management decisions can have significant influence on the overall quality and quantity of these resources.

Financial: Farms are businesses and require financial capital to build and sustain operations. Returns from harvests and sales can be reinvested in farm resources and allow farms to invest in other asset categories. Financial resources can also include payments from government programs and revenue protection provided by agricultural insurance.

Physical: These resources include all the built assets within a farm, including equipment, buildings, irrigation, and drainage systems. These assets require not only initial investments to build or install, but also ongoing maintenance and monitoring to ensure continued operation.

Iowa farmers diversify their capital by growing cereal rye for future cover crop seeds. Photo: Conservation Media Library

Social: Every farmer is part of a community, and farmers often rely on the support and assistance from neighbors and other community stakeholders. Many farmers receive technical advice from agricultural retailers, crop advisors, and government agencies to support their operations. A farmer's social and professional networks are a significant, and often under-appreciated, form of capital.

Human: Farms are operated by people with a range of personalities, skills, and capacities. A farm with access to sufficient labor and management abilities are likely to have greater resilience. These skills are built through formal education as well as informal learning and experimentation within the farm operation, which can grow over time.

[1] Adapted from Lengnick 2014

Every farmer is part of a community, and farmers often rely on the support and assistance from neighbors and other community stakeholders.

Farms have most recently relied on financial and physical assets to build resilience and adaptive capacity.[2] In crop production systems, this includes building financial capital through increased operation size to take advantage of economies of scale, investments in large-scale equipment to manage larger fields and narrow field operation windows, and physical infrastructure such as irrigation and drainage to respond to changing weather patterns. Similarly, livestock producers increasingly rely on government financial programs to buffer against market volatility and extreme weather conditions by investing in physical infrastructure including fencing, water, buildings, and waste management system.

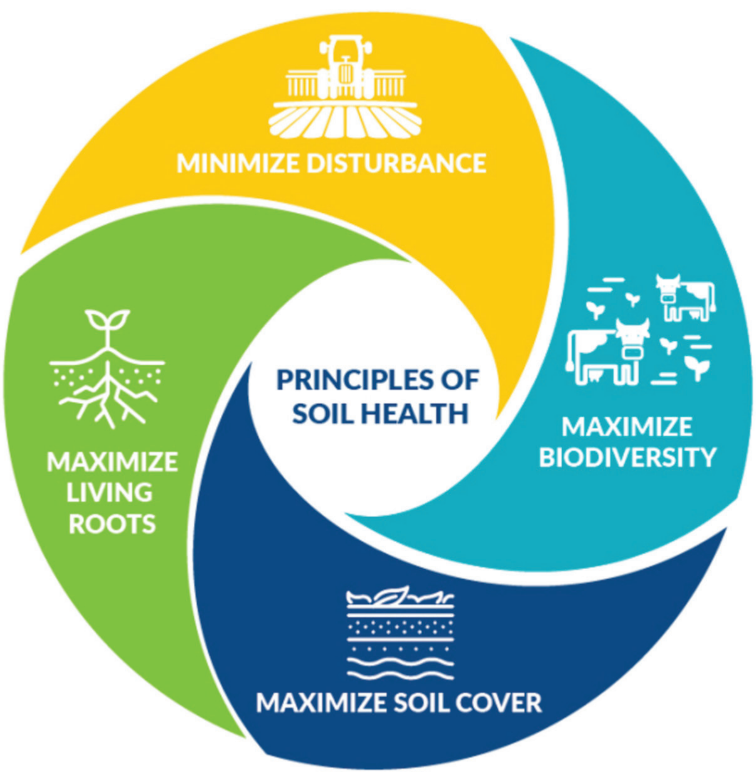
While financial and physical forms of capital are important for overall resilience, natural capital should also be considered. Building the natural capital of farms has significant potential to buffer against climate and ecosystem volatilities and give farmers more tools to adapt to changes in the future. Farmers know their operations best. With proper support from policies and infrastructure, they can make the changes that will provide the greatest resilience to their operation.

This hairy vetch plant with very visible root system and nodules (see arrow) increases nitrogen in the soil for the following cash crop. Photo: SARE Media Library.

Building Farm Resilience through Soil Health

While it has long been acknowledged that natural resource assets contribute to agricultural productivity, recent advances in scientific knowledge have revealed a more complete picture of how ecological systems underpin sustainable production. Natural assets, including soils, water resources, and climate, function together with human management to create an ever-evolving ecosystem. Management practices such as cover crops and reduced tillage work ***with*** natural ecological systems to create more resilient farms by increasing the capacity to respond and recover.

The advancement of systems thinking in scientific knowledge has led to increased focus on ***soil health*** and conservation agricultural practices that restore healthy soil. Conservation agriculture is based on four key principles: 1) increasing plant diversity, 2) maintaining living roots throughout the year, 3) minimizing soil disturbance, and 4) maintaining soil cover during as much of the year as possible.[3] Some experts also add a fifth principle: incorporating animals into crop production systems.[4] These principles treat natural assets as evolving systems rather than fixed properties of



Natural assets, including soils, water resources, and climate, function together with human management to create an ever-evolving ecosystem.

This farmer is maintaining living root coverage and minimizing disturbance by planting tillage radish. The large radishes create holes in the soil that help reduce soil compaction. Photo: SARE Media Library

A healthy soil is one with the "continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.

farm fields. This approach promotes soil qualities that enhance resource cycling (water, nutrients), minimize the need for synthetic inputs (fertilizers, pesticides), and buffer systems against volatile environmental conditions.[5]

Soils are complex ecosystems with physical, chemical, and biological components. A healthy soil is one with the "continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans".[6] ***Box 2*** lists the most important physical, biological, and chemical components to soil health, identified by the Cornell University Soil Health Laboratory, and how they impact farm resilience.[7]

The diversity of plant species in a given field, the level of soil disturbance, and soil cover can all have a significant impact on the composition and functioning of the soil. Conservation agriculture utilizes its four principles to create beneficial synergies between ecological systems and agricultural production. **Increased production diversity** with crop rotation, cover crops, and diverse cash crops better models a prairie or forest ecosystem by increasing plant diversity. These diverse ecologies spread risk across multiple income sources to better recover from crop failures. They also create habitats for a wide variety of fauna, and support ecological processes such as water filtration and carbon sequestration.

Diverse production systems also tend to **extend living root coverage through the year,** since some species will always be better adapted to extreme temperature and moisture conditions. Living root coverage supports soil health by increasing soil organic matter and stimulating the ***soil microbiome,*** or the community of bacteria and fungi living in the soil. Plants live in a complex and mutually beneficial relationship with the soil microbiome. Plants use their root systems to release ***exudates***, energy-rich chemicals that are an important food source for the microbiome. In turn, these organisms release nutrients from soil minerals, which can then be taken up by plants. This plant-microbe mutualism is key to supporting plant development and growth, as well as a major driver of soil nutrient cycling.[3, 8]

The soil microbiome and other soil fauna especially benefit from **minimized soil disturbances**. Disturbances can be in the form of tillage, fungicides and pesticides, chemical fertilizers, erosion, and flooding.

These events can reduce the diversity and abundance of soil organisms, lowers metabolic activity, and inhibits their functions.[9] It can take years for soil biology to recover from intense disturbances,[10] leading to reduced production and increased risk in the meantime. Disturbances create a ***negative feedback loop,*** where each amplifies the effects from the other. When disturbances occur, healthy soils will recover more quickly, while unhealthy soils will experience higher levels of erosion, flooding, and nutrient loss rendering them even more susceptible to damage from future disturbances.

Finally, **maintaining soil cover throughout the year** improves soil health. Soil cover works hand in hand with all three principles–planting a mix of cover crops to overwinter increases plant diversity and maintains living roots, while reducing soil disturbances. Soil cover can also repress weeds, provide habitat for the predators of crop pests, reduce pathogenic nematode levels, and reduce reliance on tillage. Soil cover helps maintain an even soil moisture, which reduces the risk of crop loss due to flooding and drought, and helps growers get into their field sooner after major rain events.

Farmers often achieve these soil health improvements through a variety of practices and management. Most commonly, farmers will implement reduced or no-till systems to minimize soil disturbance and maintain living roots, use extended crop rotations to increase plant diversity over time, and use cover crops between cash crops to increase diversity, maintain living roots throughout the year, and increase soil cover. Over time, building soil health through these practices reduces nutrient, pest and weed challenges, allowing farmers to reduce synthetic inputs such as fertilizers, pesticides, and herbicides. When growers utilize social and human assets to work ecologically with their field's natural assets, they rely less on financial assets to recover from disturbances. This financial resiliency that conservation agriculture can provide is invaluable for growers to manage the many risks involved with farming.

Cover crops and conservation tillage support healthy soil ecosystems, help reduce negative environmental impacts from farming operations, and confer greater operational resilience. Other systems-based approaches include maintaining natural habitat areas, such as prairie strips or forested buffers, near fields to provide pollinator and pest predator habitat; incorporating intercropping or relay cropping, in which production crops overlap to maximize soil cover and increase nutrient cycles; agroforestry or silviculture, in which animals or crops are produced under tree cover; and integration of indigenous agricultural and ecological knowledge, such as polyculture systems. These approaches can provide substantial resilience as well, and complement the effects of soil health conservation practices like cover cropping and reduced tillage.

Cereal rye planted between corn stubble maintains soil cover throughout the fall and early winter, protecting the field from soil erosion. Photo: Conservation Media Library

Box 2: Comprehensive Soil Health Assessment Soil Health Indicators

Cornell University Soil Health Lab selected the following indicators due to their sensitivity to management practices, measurement accuracy, and relevance to important soil functions.[2]

Physical Indicators

Predicted Available Water Capacity is the estimated amount of water stored in soil. Soils with high available water capacity increase the crops ability to survive drought stress.

Surface Hardness is the level of soil compaction, which can result from heavy machinery, aggressive tillage and heavy rain events. Farms with lower surface hardness have higher available water capacity, healthier microbiomes, and crops roots can more easily penetrate the soil, making these farms less susceptible to droughts and flooding.

Aggregate Stability is the ability of soils to maintain structure during rainfall. Soils with high aggregate stability tend to have lower surface hardness and higher available water capacity. Aggregate stability allows for water and air movement thus creating a desirable habitat for soil organisms, improving seed germination, and facilitating crop root development.

Biological Indicators

Organic Matter is the amount of plant-derived material in the soil, and heavily influences all other soil characteristics, as well as crop production potential. Replacing plant material lost through harvest by cover cropping and high organic inputs (such as compost and animal waste) must be a key management priority for building healthy soils.

Predicted Soil Protein is the fraction of organic matter that contains protein, these proteins are important sources of nitrogen (N) for soil mineralization. Higher predicted soil protein, which can be achieved through reducing tillage and increasing organic matter inputs, has greater potential N, reducing the need for heavy N fertilizer inputs.

Soil Respiration measures microbial activity. Higher microbial activity indicates that soil microorganisms are actively digesting carbon, cycling nutrients, decomposing residues into organic matter, and aggregating the soil – all key components of healthy and resilient soils. Microbial activity is disrupted by heavy tillage and biocides, but can be promoted by inputting carbon through cover crops and manure.

Chemical Indicators

Soil pH is a measurement of the acidity of the soil. When the soil pH is outside of a narrow range (6.2-6.8), nutrients such as phosphorus, iron, calcium, and potassium become unavailable to plants. Farms with the correct pH have better nutrient efficiency, reducing reliance on expense fertilizer inputs.

Extractable Phosphorus is the amount of plant-available phosphorus, an essential nutrient for cash crops. Phosphorus commonly binds to the soil making it difficult for plants to access, and polluting waterways through soil erosion (exacerbated by unhealthy physical soil traits). Cover cropping with phosphorus mining plants can release phosphorus bound to the soil in excess, reducing inorganic inputs and protecting waterways.

[2] Adapted from Schindelback et al. 2008

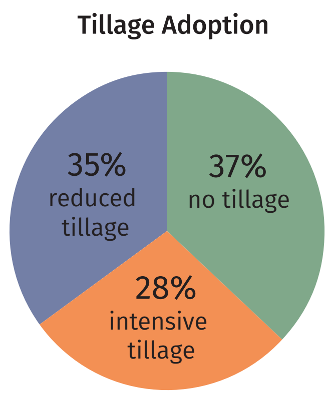
One-on-one outreach in action. Photo: NRCS Photo Gallery.

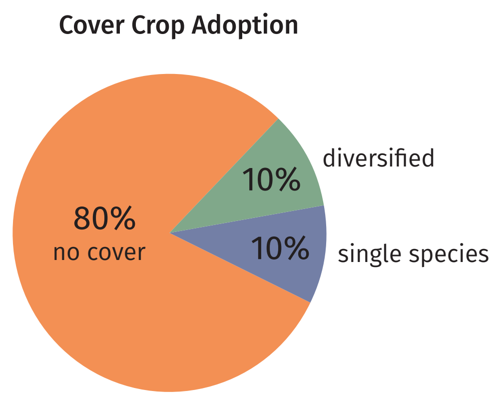
Barriers to Soil Health Adoption

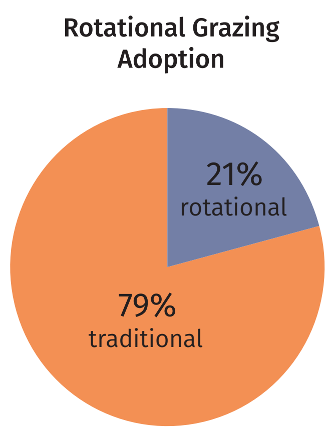
Despite the substantial benefits that soil health approaches can provide, adoption of key practices by farmers in the U.S. has been climbing but remains low.

According to the 2017 Census of Agriculture: no-till systems are used on roughly 37% of cropland,[11] 35% use reduced/conservation tillage, and 28% still use intensive tillage. Cover crops are used on less than 10% of crop acres annually and diversified crop rotations on less than 10% of crop acres. About 21% of producers with pasture use rotational grazing systems.

A variety of barriers can prevent a farmer from incorporating these important practices into their operation. Despite decades of research on the topic, no







Despite decades of research on the topic, no universal set of factors explain adoption or lack of adoption of soil health practices

universal set of factors explain adoption or lack of adoption of soil health practices;[12] rather, barriers are context-specific and can vary widely depending on the producer, the practice in question, and the producer's situation. With this context-dependence in mind, there are several factors that tend to be reported as most significant when producers are considering adopting soil health practices. Barriers are often due to limitations to certain capital assets, including technical challenges at the field scale due to financial and human asset challenges, a lack of equipment or infrastructure (physical assets), economic barriers (financial assets), or lack of adequate markets or social support. (financial and social assets).

This no till corn planter helps farmers plant large fields quickly directly into their cover crops in the spring. Though this maximizes soil cover and minimizes disturbance, the machine is costly and can involve a steep learning curve. Photo: SARE Media Library

Technical challenges: When compared with 'conventional' crop production systems that rely on regular soil tillage and a narrow set of commodity crops, conservation production systems require different physical and human assets such as equipment and management skills.[19] Practices such as cover crops or reduced tillage are often seen by producers as incompatible with their current management practices or disadvantageous in key ways. Farmers may need new physical assets like seed drills to implement soil health practices. Introducing new crops, either cash crops in a rotation or cover crops between main crops, requires new crop management skills that take producers time to learn. Soil health practices often require changes to management timing, including planting cover crops in the fall, killing or suppressing cover crops prior to cash crop planting, or delaying planting in reduced tillage systems.[13, 14]

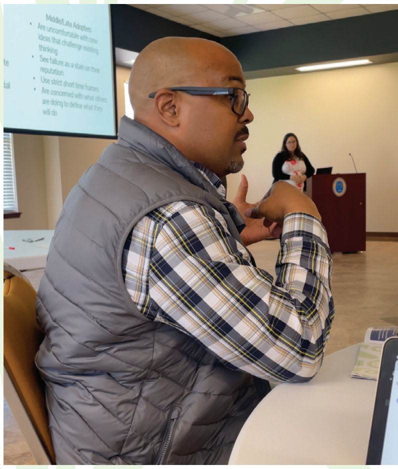
Economic barriers: Similarly, there are often economic barriers to implementing soil health practices. Building physical and human capital such as purchasing new equipment, acquiring cover crop seed, installing fencing and water for grazing systems, and hiring additional labor or advising services can all be substantial upfront costs. Acquiring technical and management skills to implement new systems can also incur time and financial costs for farmers. Soil health takes time to develop and farmers may not see tangible economic benefits for several years after implementing new practices. Increasing crop diversity requires having markets to sell into; in many areas, supply chains are focused on a narrow set of commodity crops and there may not be outlets for additional crops (such as small grains) that could provide farm-scale soil health benefits.[14] Limited financial assets due to unstable markets and inherent farming risks makes it difficult to invest in the upfront costs to incorporate soil health practices.

Risk perceptions: This aspect of decision making is a central paradox in soil health adoption. While soil health practices can confer substantial resilience and reduce production risks, farmers often perceive greater risk in changing practices. Many producers perceive risks associated with delayed field access for planting in reduced tillage or cover cropped systems.[15] Soil health practices can change water infiltration and cycling, which can be perceived as risky. There are also perceived risks in cover crops competing for nutrients or water from cash crops. Social and reputational risks associated with changing practices can prohibit adoption. Soil health practices substantially change the way fields look, particularly in the fall, winter, and spring when conventional fields are most typically tilled and fallow,[16] prompting judgement on the farmer from peers. Social norms are a strong, but often underappreciated, barrier to implementing new practices for many producers. Farmers with limited social assets, especially limited peers and advisors practicing conservation agriculture, may experience higher perceived risks because they are unable to borrow equipment or problem-solve challenges with a group.

Messaging and Outreach Challenges: Research on farmer conservation decision making has repeatedly revealed the wide range of farmer perspectives and mindsets when it comes to deciding whether to adopt new practices.[17] Information about the benefits and management of these practices however typically relies on a narrow set of communication strategies that do not always meet the needs of a diverse array of producers. Minority, women, and beginning farmers have all historically been underserved by the conservation delivery system. Black and Indigenous farmers in particular have faced systemic discrimination from government agencies and traditional conservation organizations and have been largely ignored in the past by alternative agriculture efforts, including organic and regenerative farming, even as these movements appropriate traditional agricultural approaches.[18] These communication limitations bar certain populations–often populations most interested in adopting soil health practices–from accessing the necessary social, human and financial assets to begin practicing conservation agriculture.

Adopting complex practices such as no till or cover crops is a step-wise process, not a binary proposition. For example, the cover crop practice contains a wide range of decisions that reflect differing complexity, sophistication, and longevity, including species choices, amount of acreage, and integration with other practices. Moreover, trying a practice does not guarantee its continued use. A recent survey of farmers identified that nearly a

Adopting complex practices such as no till or cover crops is a step-wise process, not a binary proposition.



National Wildlife Federation Outreach Specialists discuss how to tailor conservation messaging to your audience. Photo: NWF Agriculture Outreach Team quarter had used cover crops in the past but no longer used them or planned to in the future. Financial incentives alone, without consistent technical and social support can decrease the likelihood of sustained adoption of practices.[19]

Policy barriers: Most producers rely on crop or production insurance as a risk management strategy, yet many perceive soil health practices as incompatible or problematic for their insurance policies. Crop insurance does not typically disallow use of reduced tillage or cover crops, but may require certain management actions to ensure that use of these practices does not interfere with crop production. These administrative requirements have changed in recent years, decreasing this barrier to adoption, though farmer perceptions may be slower to change. These requirements can be complicated and difficult to interpret, leading some producers to avoid these practices out of concern for conflict with their insurance policies. Not all farmers who have adopted cover crops identified this as a challenge (Fleckenstein et al. 2020), and the 2018 Farm Bill included a provision to address the major issue between cover crop use and potential loss of crop insurance.

While there are federal, state, and local programs that support farmer adoption of soil health practices through cost share and technical assistance, these programs are often insufficiently funded to meet the potential demand. Program applications can be time consuming and cumbersome, not all producers may qualify for programs, and there is a documented lack of awareness of programs.[20] Additionally, not all producers want to use government programs to meet their management goals for ideological or personal reasons.[21] Past systemic discrimination in government program access for non-white producers, women farmers, and new and beginning farmers, create significant equity gaps that persist to this day and undermine trust in government agencies.[18] Government conservation programs are a powerful tool for supporting farmer adoption of soil health practices, but they are insufficient in their current form and scope to meet the societal need for transition to this approach in U.S. agriculture. New policies and programs are needed to speed this transition.

Tillage radish cover crop. Photo: SARE Media Library

No till soybeans emerging through corn stubble. Photo: SARE Media Library

Increasing the Speed of Soil Health Adoption

Supporting farmer use of conservation agriculture systems to build soil health and resilience should be a key goal of U.S. agricultural policy. Existing USDA programs and initiatives to promote soil health should be strengthened to support voluntary adoption by farmers. Modest policy changes can better align incentives for producers to help manage risk through on-farm practices. In this section, we detail some specific policy and program changes that would increase soil health practice adoption.

USDA Conservation Programs

USDA conservation programs are the largest single source of funding to help farmers and ranchers understand and adopt conservation practices and systems. This suite of programs funds a variety of practices and they vary considerably in how much of the funding is used for soil health practices. For example, an analysis of Environmental

Cover crops are used on less than 10% of crop acres annually and diversified crop rotations on less than 10% of crop acres.

Field signs promoting the use of cover crops creates a positive social pressure to prioritize soil health. Photo: NWF Agriculture Outreach Team

Quality Incentive Program payments between 2017 and 2020 showed that just 23% of payments went for soil health and other practices that mitigate climate change.[22] USDA can do much more to support diversified cropping and advanced grazing systems that build and sustain healthy soils and deliver resilience.

- The Conservation Stewardship Program and Environmental Quality Incentives Program turn away two-thirds or more of the farmers who apply for assistance, because of a shortage of funds. Additional funding for these programs, as was provided by the Inflation Reduction Act in 2022, could help more farmers/ranchers adopt soil health systems.

- Prioritizing soil health/conservation agriculture systems in the design and delivery of USDA conservation programs could increase farmer/rancher understanding of soil health principles and practices and provide financial assistance for systems and practices that deliver more resilient farms. Conservation Reserve Program soil health benefits could be increased by covering a portion of the cost to install fencing and water systems needed to allow intensively managed rotational grazing. That would allow rotational grazing as a mid-contract management tool and help to maintain the land as a grazing operation when the property exits the program, retaining the soil health benefits gained during the CRP contract.

- The Agricultural Conservation Easement Program funds the conservation and protection of wetlands, grasslands, and other farmland. Requiring a robust conservation plan on lands to be enrolled in the program could ensure the use of appropriate soil health systems.

The Regional Conservation Partnership Program leverages federal conservation program investments to address regional conservation needs through partner-driven initiatives, but administrative hurdles have slowed approval and delivery of program benefits. Providing a selection priority for proposals that focus on soil health and streamlining program delivery could speed on-farm implementation of soil health and other conservation practices.

Research and Data

Policy-makers, agencies and organizations need more information on strategies and programs that best deliver results, and the most effective strategies for providing education, outreach, and advice to different groups of farmers and ranchers. Farmers and ranchers need information on appropriate practices and options for their soils, climate, and farming systems. USDA can help deliver this information through improved data collection, measurement, and analysis systems.

- USDA systems for collecting, storing, linking, and analyzing should be streamlined and enhanced to meet these needs. USDA should also create a data warehouse where de-identified data collected by the various USDA agencies can be stored, analyzed for agency purposes, and made available to public and private sector researchers. This would improve program delivery, quantify risks and rewards of conservation and production practices, identify potential impacts on profitability, yields and resilience, and improve the delivery of soil health information.

- USDA programs that research farming systems that support healthy soils and resilient farms need adequate funding; at current levels they typically can fund only a small share of the needed research.

Crop Insurance, Commodity and Loan Programs

USDA's crop insurance, commodity, and farm loan programs provide financial incentives that are a significant driver of on-farm decisions. At times they can work

Examples of USDA Programs

Organic Agriculture Research and Extension Initiative

Organic Transitions Research, Sustainable Agriculture Research and Education

Long-Term Agroecosystem Research Network, Agriculture and Food Research Initiative

Environmental Quality Incentives Program Conservation Innovation Grants program

Specialty Crop Research Initiative

Farm manager works with soil conservation agent to plant corn into killed cover crops. Leftover cover crop biomass helps farmers get their tractors in the field on time by reducing spring flooding and water-logged soil. Photo: SARE Media Library

Farmers making the transition to soil health and conservation agriculture systems often see financial and other benefits the first year, and new conservation systems rarely lead to significant loss of yield.

against efforts to broaden the use of soil health practices and other conservation strategies, but modest changes could remove barriers to the adoption of soil health systems.

- ***Modernize crop insurance to recognize soil health practices that reduce risk and reduce insurance claim payout.*** Research shows that using cover crops and other soil health practices reduces the risk of an insured loss due to drought or excess precipitation . The federally subsidized crop insurance program should recognize these risk-reducing benefits by offering a premium discount for farmers who use cover crops and other risk-reducing soil health practices. This approach could also provide a long-term savings to taxpayers who fund more than 60% of the cost of federal crop insurance. As farmers diversify crop rotations to boost soil health they can find that federal crop insurance may not cover crops not commonly grown in their county. USDA can address the problem by improving options for insuring crops not grown widely in an area and by simplifying Whole-Farm Revenue Protection insurance that is tailored for farms with a diverse mix of commodities. Farmers making the transition to soil health/conservation agriculture systems often see financial and other benefits the first year, and new conservation systems rarely lead to significant loss of yield.[24] but, farmers may perceive the risk to be significant. USDA can help farmers manage the perceived risk by piloting a new crop insurance option that protects producers against short-term loss based on their actual production history. The product could provide an affordable option to help farmers address the perceived concerns about yield drag.

- ***Make better use of USDA farm loans to help farmers adopt soil health systems.*** USDA provides direct and guaranteed loans that help farmers acquire land, equipment, operating capital, or livestock at competitive loan rates. With expanded authority, USDA could offer more loans to help farmers and ranchers adopt soil health and conservation agriculture practices like cover crops, diverse crop rotations, advanced grazing management and organic farming methods.

New Markets

Ecosystem services markets provide an exchange of cash for activities that provide ecosystem benefits (e.g. reducing air or water pollution or storing carbon). They have been around at least since the early 1990's, when New York City began paying farmers in the Catskills to change their farming practices to help New York avoid the cost of an expensive new water treatment plant.[25] The 1997 United Nations Kyoto Protocol set out international rules for carbon markets.[26] Such markets work best when all parties involved are under some requirement to cap or reduce their contribution to the problem and when there are clear exchange rules based on solid science. There are some limitations to ecosystem services markets that inhibit large scale success. They often fail to reward the early adopters who have already made the investments needed to change their farming system. They can present challenges in verifying that the hoped-for ecosystem benefits are actually delivered, especially given the difficulty in accurately measuring changes in soil carbon storage and agriculture emissions and the transitory nature of soil carbon storage.

Despite these challenges, expanding and improving upon the Inflation Reduction Act (IRA) and Partnership for Climate-Smart Commodities program (PCSC) investments in climate-smart practices and research could expand opportunities to enhance agricultural resilience. Investments made through the IRA and PCSC can have a transformative effect on the agricultural landscape. The added funding through both initiatives will give farmers more options for obtaining technical and financial help to transition to soil health systems.

- USDA has the opportunity to support the adoption of conservation agriculture cropping and grazing practices on tens of millions of acres of farmland by focusing the $19.5 billion in Inflation Reduction Act funds for NRCS conservation programs on climate-smart soil health and conservation agriculture solutions.

- Partnership for Climate-Smart Commodity Program investments will improve knowledge, and on-the-ground adoption, of climate-smart practices. Reinforced with a "learning network" for farmers, ranchers, and businesses to share data and best practices and avoid common pitfalls, the initiative can help the US agricultural community improve resilience to climate change effects. Pairing financial capital inputs for resilient and diversified markets with strengthened social and professional networks builds farm resilience in a variety of areas—financial, physical, social, and human.

- Carbon markets should be built on solid science and structured so they deliver the emissions reduction and/or carbon storage anticipated, at least at a landscape scale. Measuring farm-scale changes in carbon

Prairie strips planted between rows of corn restores diversity and supports native plants. Photo: Conservation Media Library

Rye cover crop roots reduce soil erosion. Photo: SARE Media Library

Building diverse soil ecosystems bolsters the natural capital of farms, increases farm resilience, and reduces dependence on expensive synthetic inputs.

accurately is very difficult, so any models used to estimate impacts need to be well documented and subjected to regular ground-truthing.

- Carbon marketing systems benefit from having independent third-party verification to reduce the potential for financial conflicts of interest and ensure the integrity of the system. Farmers, ranchers, and carbon credit purchasers should benefit from having consistent, transparent rules that apply to all parties offering to buy or sell credits.

Taken together, these policy actions can help farmers and ranchers overcome barriers and speed the widespread adoption of soil health systems on America's farmland and grasslands. Soil health practices provide substantial resilience benefits to farms across a variety of domains. Building diverse soil ecosystems bolsters the natural capital of farms, gives farmers increased resistance to extreme weather events, and reduces farmer dependence on expensive synthetic inputs of fertilizers, herbicides, and pesticides. Farmers face some significant barriers to adopting these practices however, including the upfront cost and risks associated with implementing new management systems. Supporting farmer adoption and sustained use of soil health practices requires building social and human capital among farmers. There is a need for enhanced public policy to reduce these barriers and provide the right tools and resources for farmers. Empowering farmers to use management practices that build soil health is the best path to a resilient 21st century American agriculture.

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Soil health field day featuring air seeding cover crop into corn. Photo: SARE Media Library

Red clover at the USDA NRCS Plant Material Center. Photo: SARE Media Library

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