MANAGING FOR SOIL HEALTH: SECURING THE CONSERVATION AND ECONOMIC BENEFITS OF HEALTHY SOILS

HEARING

BEFORE THE

SUBCOMMITTEE ON CONSERVATION AND FORESTRY

OF THE

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MANAGING FOR SOIL HEALTH: SECURING THE CONSERVATION AND ECONOMIC BENEFITS OF HEALTHY SOILS

TUESDAY, JUNE 25, 2019

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON CONSERVATION AND FORESTRY,
COMMITTEE ON AGRICULTURE,
Washington, D.C.

The Subcommittee met, pursuant to call, at 10:05 a.m., in Room 1300, Longworth House Office Building, Hon. Abigail Davis Spanberger [Chair of the Subcommittee] presiding.

Members present: Representatives Spanberger, O'Halleran, Pingree, Axne, Peterson (*ex officio*), LaMalfa, and Allen.

Staff present: Prescott Martin III, Félix Muñiz, Jr., Anne Simmons, Alison Titus, Josh Maxwell, Ricki Schroeder, Patricia Straughn, Dana Sandman, and Jennifer Yezak.

OPENING STATEMENT OF HON. ABIGAIL DAVIS SPANBERGER, A REPRESENTATIVE IN CONGRESS FROM VIRGINIA

The CHAIR. This hearing on managing for soil health: securing the conservation and economic benefits of healthy soils, will come to order.

Good morning. I would like to welcome everyone to this hearing of the Conservation and Forestry Subcommittee, entitled *Managing for Soil Health: Securing the Conservation and Economic Benefits of Healthy Soils,* a topic critically important to American agriculture and communities across the nation.

I would also like to thank Ranking Member Doug LaMalfa for his engagement on this issue, and each Member of the Subcommittee for taking part in the hearing today.

Soil health is a critical topic for this Subcommittee to address because it underpins so many of our other conservation efforts.

Soil health practices such as cover crop, crop rotations and no-till or reduced-tillage have the potential to provide financial benefits to farmers by reducing input costs, increasing yield, and ensuring the productivity of cropland over the long-term.

These same soil health practices can also provide environmental benefits that the rest of us enjoy. Healthy soil filters water, reduces runoff, and sequesters carbon.

Healthy soil also reduces risk. In recent years droughts and floods have cost our economy billions of dollars. Because healthy soil is better able to hold water, it can better withstand droughts and reduce runoff in floods.

Because healthy soil benefits not only farmers but the public at large, USDA provides financial support to farmers to implement soil health practices through programs such as the Environmental Quality Incentives Programs and the Conservation Stewardship Program, the Regional Conservation Partnership Program, and the Conservation Reserve Program.

Producers in my home State of Virginia are recognizing the value of and adopting these practices. Between 2012 and 2017, across Virginia we saw more than a 35 percent increase in cropland acres planted with cover crops. We have more than a million acres of cropland in Virginia where no-till practices are used.

Managing for soil health offers an exciting value proposition to farmers and society. It is my hope that with this hearing today we can discuss the value of soil stewardship, share best practices, and learn about any barriers to adoption of soil management systems.

[The prepared statement of Ms. Spanberger follows:]

PREPARED STATEMENT OF HON. ABIGAIL DAVIS SPANBERGER, A REPRESENTATIVE IN CONGRESS FROM VIRGINIA

Good morning, I would like to welcome everyone to this hearing of the Conservation and Forestry Subcommittee on *Managing for Soil Health: Securing the Conservation and Economic Benefits of Healthy Soils,* a topic critically important to American agriculture and communities across the nation. I would also like to thank Ranking Member Doug LaMalfa for his engagement on this issue, and each Member of the Subcommittee for taking part in this hearing today.

Soil health is a critical topic for this Subcommittee to address because it underpins so many of our other conservation efforts.

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Managing for soil health offers an exciting value proposition to farmers and society. It is my hope with this hearing today, we can discuss the value of soil stewardship, share best practices, and learn about any barriers to adoption of soil management systems.

The CHAIR. Finally, I would like to recognize the Ranking Member, the distinguished gentleman from California, Congressman Doug LaMalfa, for 5 minutes.

OPENING STATEMENT OF HON. DOUG LAMALFA, A REPRESENTATIVE IN CONGRESS FROM CALIFORNIA

Mr. LAMALFA. Thank you, Chair Spanberger, for holding today's hearing and for your help on this issue. It is a very critical issue to agriculture and to help hold our communities together.

As we saw with those dramatic pictures you have all seen back in the 1930s, the Dust Bowl, Congress recognized back then the importance of promoting soil health, soil stabilization across the country, and indeed it started with establishment of the Soil Conservation Service, otherwise known as the ASCS Office in our communities, which got changed to something else years later. But that is really the impetus for a lot of what USDA became about was that tremendous problem.

The need for this agency was indeed in response to a persistent problem of soil erosion across the country during those Dust Bowl eras but beyond.

The Natural Resources Conservation Service, as it is known today, plays an important role in preserving soil health across the country by providing producers with voluntary assistance in monitoring and assessing soil conditions on their land.

As our predecessors did for us in the past, we hope the future generations do what can be done to understand and recognize the importance of healthy soil. To that end, I am particularly proud of this Committee's work on conservation programs in a newly-enacted farm bill. During that process we came forward in a bipartisan fashion to reauthorize and strengthen our title II programs.

The issue of soil health has continuously been highlighted by producers and stakeholders during the 2018 Farm Bill deliberations, and I believe that is reflected in many of the improvements to the conservation program authorities who heard directly from farmers who expressed the need for more tools to promote the adoption of cover cropping.

This request was the leading influence in the creation of the CIP under EQIP, the CIP Program, allowing for simplified contract for the producers to adopt and maintain new conservation practices.

I am proud that so many farmers and foresters in California have taken voluntary steps to promote soil health. We have one of those early adopters here today who will be speaking to us about this conversation, so I will introduce her a little bit later.

Madam Chair, I will yield back.

[The prepared statement of Mr. LaMalfa follows:]

PREPARED STATEMENT OF HON. DOUG LAMALFA, A REPRESENTATIVE IN CONGRESS FROM CALIFORNIA

Good morning.

Thank you to Chair Spanberger for holding today's Subcommittee hearing on soil health. This is a critically important issue to American agriculture and strong farming communities.

Congress has long recognized the importance of promoting soil health across the country, starting with the establishment of the Soil Conservation Service as a permanent part of USDA in 1935.

The need for this agency was in response to a persistent problem of soil erosion across the country, particularly in the Dust Bowl region. The Natural Resources Conservation Service, as it is known today, plays an important role in preserving soil health across the country by providing producers with voluntary assistance in monitoring and assessing soil conditions on their land.

As our predecessors did for us in the past, we owe it to future generations to do what we can to understand and recognize the importance of healthy soil.

To that end, I am particularly proud of this Committee's work on conservation programs in the newly enacted farm bill. We came together in a bipartisan fashion to reauthorize and strengthen our title II programs.

The issue of soil health was continuously highlighted by producers and stakeholders during 2018 Farm Bill deliberations and I believe that is reflected in many of the improvements to the conservation program authorities.

We heard directly from farmers who expressed the need for more tools to promote the adoption of cover cropping. This request was the leading influence in the creation of Conservation Innovation Payments under EQIP, allowing for a simplified contract for producers to adopt and maintain new conservation practices.

Additionally, the final conference agreement adopted soil health as a priority for the Conservation Stewardship Program. And soil health will be a major component of the newly created On-farm Conservation Innovation Trials.

I am proud that so many of the farmers and foresters in California have taken voluntary steps to promote soil health. We have one of those early adopters here today to talk about the conservation efforts that she and her family have implemented on their family farm.

Ms. Shannon Douglass operates a specialty crop and beef cattle operation with her husband and son in Glenn County, CA. Ms. Douglass also operates CalAgJobs, a company that matches folks into jobs in the agriculture industry. She is here today representing the California Farm Bureau Federation, and serves as First Vice President.

Ms. Douglass, thank you for making time to be here today.

Whether it's protecting our water supply, keeping nutrients in place for the next crop year, or maintaining a supply of forage for livestock, there is no shortage of reasons as to why we must continue to foster innovation when it comes to promoting soil health.

We have a great set of witnesses testifying today, and I want to thank them for traveling here to share their expertise with the Subcommittee.

The CHAIR. The Chair would request that other Members submit their opening statements for the record so the witnesses may begin their testimony and ensure there is ample time for questions.

I would like to welcome our witnesses today. Thank you very much for being here.

Today we will hear from Dr. Shefali Mehta, Executive Director of the Soil Health Partnership Program, a part of the National Corn Growers Association. Dr. Mehta received her Ph.D. in Agriculture and Applied Economics, and a Masters Degree in Statistics from the University of Minnesota. Welcome and thank you for joining us.

Our second witness is Mr. Nathan Anderson, Secretary of the Board of Directors for Practical Farmers of Iowa. Along with his wife, Sarah, Mr. Anderson operates Bobolink Prairie Farms, a multigenerational family farm near Aurelia, Iowa. Nathan owns and rents a portion of his farm where he produces corn, soybeans, hay, and cattle.

And for our third witness, I would like to yield to the Chairman of the Committee for the introduction.

OPENING STATEMENT OF HON. COLLIN C. PETERSON, A REPRESENTATIVE IN CONGRESS FROM MINNESOTA

Mr. PETERSON. Thank you, Madam Chair, and I want to welcome one of my constituents, Ian Cunningham, who is a fifth-generation farmer outside of Pipestone, Minnesota. It is a beautiful part of the country. If you ever get up there, you want to go to see the Pipestone National Monument, right, Ian? It is quite a thing. They make peace pipes out of the stuff that they get there.

Anyway, Ian is a NACD soil health champion. He is an early adapter of soil health practices like cover crops and no-till, strip-till. He is in a leadership position at the local and state level on conservation districts, and is now the Secretary/Treasurer of the National Association of Conservation Districts. But more impor-

tantly, when I get off the track, he straightens me out on these conservation issues. I can't get too far out of line or he will let me know.

Anyway, we appreciate you being here, Ian.

Thank you.

The CHAIR. Welcome, Mr. Cunningham, and thank you for your work keeping the Chairman in line.

Our fourth witness is Ms. Shannon Douglass, the First Vice President of the California Farm Bureau Federation. She is also a first-generation farmer. She and her husband own Douglass Ranch where they raise beef cattle, sunflowers, pumpkin, corn, and forage crops.

Welcome.

And I would like to yield to Ranking Member LaMalfa for a continued introduction.

Mr. LAMALFA. Oh, thank you for that. I just don't have anything to add other than her pedigree is very impressive on that and we thank her for her travel here today. I represent a portion of Glenn County I share with Mr. Garamendi, so indeed it is great to have your time and travel here and your testimony, so thank you for what you do and for what your family has legacy-wise over there in Glen County, across the river from me.

Thanks for appearing today.

The CHAIR. Thank you, Mr. LaMalfa. And thank you for being here, Ms. Douglass.

Our final witness is Mr. Chad Ellis, the Board Chair of the National Grazing Lands Coalition. Mr. Ellis is also the Industry Relations and Stewardship Manager at the Noble Research Institute and has extensive experience in rangeland management.

We will now proceed to hearing from our witnesses. Each of you will have 5 minutes. When 1 minute is left, the light in front of you will turn yellow, signaling that your time is close to expiring.

Dr. Mehta, please begin whenever you are ready.

STATEMENT OF SHEFALI V. MEHTA, PH.D., EXECUTIVE DIRECTOR, SOIL HEALTH PARTNERSHIP PROGRAM, NATIONAL CORN GROWERS ASSOCIATION, WASHINGTON, D.C.

Dr. MEHTA. Chair Spanberger, Ranking Member LaMalfa, and Members of the Subcommittee, thank you for the opportunity to appear here today to share the story of the farmers we serve and the investments in soil health.

We applaud the Subcommittee's commitment to learning about the benefits of soil health practices and the efforts that farmers are making to blaze a trail in conservation.

I am Dr. Shefali Mehta, the Executive Director of the Soil Health Partnership, a program of the National Corn Growers Association, or NCGA. I have had the experience to work with and travel around the country and the world working with many producers and can personally attest to the value that farmers put on land stewardship and the impact that soil health has on long-term agricultural productivity.

The Soil Health Partnership, or SHP as it is known, was begun in 2014 when The Nature Conservancy and Monsanto and the En-

vironmental Defense Fund came together to develop a farm-led network that allowed us to measure the impacts of soil health practices on working farms.

True to their vision of being farm-led and making sure the decisions stayed there, SHP partnered with the National Corn Growers Association which represents 40,000 dues-paying corn farmers nationwide and more than 300,000 growers who pay into the corn check-off system which then goes into their states.

SHP continues to be administered as a flagship sustainability program for NCGA, so SHP partners with over 220 farmers who are fairly diverse across 15 states. We were recently joined by the National Wheat Foundation and currently work with over 120 partner organizations, including commodity associations, governments, nonprofits, and private companies.

Farmers work with their team of experienced field managers to measure the impact of practice changes on their lands. As a result, we have created a unique, in-depth data set to help support farmers' decisions and to understand the impact on soil, yield, input use, and the farmers' bottom line.

We are also assessing and understanding the near-term risks that can come with the adoption and also the long-term reduction and risk that comes from these practices and the increase in resiliency on land.

The farmers who work with us are exceptional land managers on their journey to improve the economic and environmental sustainability of their operations. Many are looking to reduce or eliminate tillage, try cover cropping, or experiment with advanced nutrient management.

This year we began incorporating farmers who are grazing on cover crops with their livestock, manure use, and diverse crop rotations. Our goal is to meet the needs of our farmers and to continue to add more tools to their toolkit to ensure that they have more economic diversification.

However, these practices are in no way a silver bullet. They must be understood in concert with the specific geographies where they are adopted and the goals and needs of the individual farm operation.

Our data illustrate that these practices can result in very different outcomes, even when implemented on the same farm operation but in different fields. Our work aims to better understand the impacts so farmers can use these tools to greater efficacy. We know that managing for soil health has concrete impacts. We are still working though to quantify the full benefits and costs.

Our initial analyses indicate that SHP farmers have soil health indicators that increase over time. For example, we have seen soil organic matter increase by ⅓ to ½ percent over 3 to 5 years. This may not sound like much of an increase, but soil organic matter takes quite a bit of time to change and evolve. This is a key indicator of soil health and linked to several benefits including reduced runoff and soil erosion, increased resiliency to extreme weather events, and increased carbon sequestration which in turn helps mitigate climate change.

Our SHP farmers highlight other benefits as well, such as making it easier to work in wet fields earlier in the spring. Those with

reduced-tillage have experienced cost-savings such as decreased machinery use, field use, labor needs, and more efficient use of farmers' time.

Soil health is about the long game. It gives the farmers the ability to reduce risks and increase resiliency, and our data indicates farmers invest in these practices because they believe in these long-term benefits as well.

Although there are clear benefits for managing soil, we must not lose sight of the fact that transitioning to these practices is costly and risky for farmers. It takes time to adopt and identify the combination of practices that will work on the land and in the context of their production system.

And keep in mind the benefits of soil health do take many years to come. The results we had in our data set were anomalous and actually have raised a lot of questions about what you can do, but on the whole it takes time.

Collaborations are key to successful outcomes in this arena. I would say no one group can do it alone, and so strong outcome-based collaborations like ours have seen greater awareness and adoption of soil health practices.

By supporting farmers making these investments, we increase the overall well-being of farmers and society overall, so thank you for your time and your continued support for soil health and farmers.

I look forward to your questions.

[The prepared statement of Dr. Mehta follows:]

PREPARED STATEMENT OF SHEFALI V. MEHTA, PH.D., EXECUTIVE DIRECTOR, SOIL HEALTH PARTNERSHIP PROGRAM, NATIONAL CORN GROWERS ASSOCIATION, WASHINGTON, D.C.

Chairwoman Spanberger, Ranking Member LaMalfa, and Members of the Subcommittee:

Thank you for the opportunity to appear here today to share the story of the farmers we serve, and their investments in soil health on their farms. We applaud the Subcommittee's interest in, and commitment to, learning about the benefits of soil health practices and the efforts farmers are making to blaze a trail in conservation that benefits their lands as well as society broadly.

I am Dr. Shefali Mehta, the Executive Director of the Soil Health Partnership, a program of the National Corn Growers Association (NCGA). Having the opportunity to visit many farms across the world and work with numerous producers, I can attest to the many efforts led by farmers to be stewards of their lands and the impact soil health investments have for long-term agricultural productivity. The Soil Health Partnership began in 2014, when The Nature Conservancy and Monsanto (now Bayer), alongside the Environmental Defense Fund, shared the vision of developing a farmer-led research network which measured the impacts of implementing soil health practices on working farms. True to their vision of being led by farmers—and existing to serve farmers—the Soil Health Partnership partnered with NCGA and continues to be administered as our flagship sustainability program. NCGA represents 40,000 dues-paying corn farmers nationwide and the interests of more than 300,000 growers who contribute through corn check-off programs in their states. NCGA growers are proactively working to support farmers pursuing ways to more fully utilize appropriate sustainability tools. Through the Soil Health Partnership, corn growers are on the ground serving as a resource for other growers adopting soil health improvement practices.

Today, the Soil Health Partnership works alongside more than 220 farmers as they try new soil health practices on their farms. Joined most recently by the National Wheat Foundation, our network spans over 15 states and 100 partner organizations at the Federal, state and county level including state government, commodity associations, nonprofits, foundations, and private companies. We have a team of eight experienced field managers that work hand-in-hand with farmers in

their region. When a farmer joins our program, he or she works with the designated field manager to design an experiment on a field that compares a soil health practice, or combination of practices, to the typical management undertaken historically on the field. Our partner farmers work with us over 5 years to measure the impacts of the practice change. We measure basic soil macro- and micronutrients every year on the field, as well as soil health indicators every other year. Through this process, we are creating an in-depth data set from which to support farmers' decisions and to understand the long-term changes in soil health over time. We look for impacts on yield, input use, and the farmer's profitability. We also examine the near-term risks associated with adoption of practices, and long-term risk reduction and increased resiliency that comes from these practices.

Soil Health Practices and Management Systems

The farmers we work with are exceptional land managers looking for partnership on their journey to improve the economic and environmental sustainability of their farm operations. Many are looking to reduce or eliminate tillage, to try cover cropping, or to experiment with nutrient management in an advanced soil health management system. In addition to these key soil health practices, we are now working with farmers who are incorporating grazing of cover crops as forage for livestock and experimenting with using manure and diverse crop rotations to build soil health. Our goal is to meet the needs of our farmers. This means we have expanded our offerings in line with the needs and requests of farmers trying to add more "tools" to their toolkit and find more ways to create economic diversification and support in this tough climate.

To provide some background on these practices, no-till, strip-till, and reduced tillage are all ways of managing the soil prior to planting. These practices reduce or eliminate plowing (or tillage). Historically, tillage has been used to prepare soil for planting and is used to manage weed pressure. However, tillage can impact the soil in negative ways by contributing to compaction of the soil and soil erosion. Tilling less intensively—or not at all—can reduce soil disturbance, which can minimize compaction, improve soil structure and function, improve soil water holding capacity, and reduce soil erosion.

Growing a cover crop means planting a crop, usually after harvest, primarily for soil health or conservation purposes. Cover crops are not typically harvested or sold, which means that they are not a direct income stream for the farmer. However, for farms that raise livestock and grow crops, cover crops can be used as a forage source for livestock, either by letting the livestock graze the cover crop directly, or by harvesting the cover crop to be fed to livestock.

Reducing tillage, incorporating cover crops, and practicing advanced nutrient management are all key soil health practices that can be incorporated into a soil health management system. They fit within broad soil health principles put forth by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), which include minimizing soil disturbance, maximizing soil cover, maximizing biodiversity, and keeping living roots in the soil.

We recognize these practices are not a silver bullet but must be understood in concert with the specific geographies where they are adopted and the goals and needs of the individual farming operations. Our data illustrate these practices can yield varied outcomes, even when implemented on different fields in the same farms. Our work strives to better understand these impacts so farmers can use these tools with greater efficiency.

On-Farm Benefits and Costs of Soil Health Practices

Although we are still working to quantify the benefits and costs of soil health practices and management systems across our farmer network, we know that managing for soil health can have concrete impacts. Our initial analyses show that farmers participating in the Soil Health Partnership for more than 3–5 years have seen increases in soil organic matter of ⅓ to ½ percent. Though this might not sound like much of an increase, soil organic matter typically changes very slowly with a change in management and is a key indicator of soil health. Increased soil organic matter means that the soil is able to infiltrate and store more water, which can result in reduced runoff and soil erosion, as well as make the soil more resilient to extreme weather events, such as droughts or floods. Soil organic matter increases may also be linked to increased carbon sequestration. These and other increases we have witnessed in our network and our dataset highlight ways of creating soil health benefits at greater rates: strong management practices coupled with support, farmer knowledge sharing, providing the right tools at the right time and the use of multiple practices in concert.

We hear from our farmers that improving soil structure and reducing soil erosion can have other concrete benefits, such as making it easier to work in wet fields earlier in the spring, or reducing time spent managing sediment at the edge of the field. For some farmers who are reducing tillage, there can be clear cost savings through decreased machinery and fuel use, time and labor. Over time, improvements in soil health may result in more productive soil or reduced need a for costly farm inputs. The ability to reduce risks and increase long-term resiliency of the land are also benefits. We are studying these types of questions at the Soil Health Partnership through our on-farm demonstration research plots as well as our unique, long-term data set. Our data indicate that farmers invest in these practices because they believe in the indirect and long-term benefits such as living, healthy soils for their future generations, creating increased land resiliency and knowing they are giving back to the land that sustains us.

Benefits of Soil Health Practices Beyond the Farm

Improvements in soil health can have on-farm impacts, but the impact extends beyond the farm. By reducing nutrient runoff and soil erosion, improvements in soil health can translate into improvements in water quantity and quality. Reducing tillage can increase water quantity over time and growing a cover crop can have a direct impact on water quality by tying up nitrogen in a growing plant and keeping the soil in place in the spring prior to planting when it is perhaps most vulnerable to runoff into streams and rivers. Although many are still studying the capacity of agricultural soils to store carbon under diverse management practices and in different locations, there is research that suggests a vast potential for soil health management systems to reduce greenhouse gas emissions from agricultural production and sequester carbon in the soil. This means that soil health practices and management systems, combined with broader societal efforts, hold the potential to help mitigate climate change.

Soil Health Practices Require Management of Risks and Costs to Implement

Although there are clear benefits of managing for soil health, we must not lose sight of the fact that transitioning to soil health practices and management systems can be both costly and risky for farmers. It may take time for a farmer to determine what combination of practices works well in the context of their production system, and the benefits of improving soil health may only appear after many years.

In the case of cover crops, a farmer has to select a cover crop or cover crop mix, and purchase seed, which has a direct cost. Different species of cover crops work well in different agronomic environments and require some trial and error to get it right. The farmer also has to determine when and how to seed a cover crop before or after they harvest their cash crop in the fall. The timing of cover crop planting is critical to realizing the benefits of a cover crop and getting a cover crop growing in the fall can be difficult as days grow shorter and colder. In the spring, the farmer has to decide when and how to terminate (*i.e.,* kill) their cover crop, in order to make sure that their field is ready to support the following cash crop they are planting in the spring. Farmers have to learn how to manage fertilizer and other inputs in order to support cash crop growth after a cover crop. Additionally, decisions need to be made on what other inputs they can use in their system that will support the growth of the right crops, at the right time. Data from our farmer network suggest that there is not significant yield loss, on average, from using a cover crop—but neither is there a significant yield gain. Further research and information sharing will shed more light on the full costs, and ways to manage these costs of various beneficial soil health practices.

Advancing Adoption and use of Soil Health Management Practices

With farmers leading the way, and by working together with numerous partners, we can better understand the benefits of soil health practices and inform farmers on the best ways to manage the associated risks so that their operations are both economically and environmentally sound. Collaborations are key to successful outcomes in this arena—no one group can go it alone. Through strong outcome-based collaborations, like ours, we have seen greater awareness and adoption of soil health practices. With stronger data and input across our diverse growing regions, we are learning more about the economic impacts to farmers and ways to improve adoption by mitigating risks and improving the bottom line.

We continue to strive to ensure that the farmers we work with have access to the best information to make the right decisions for their farm. Soil health practices and management systems may, but do not always, make short-term economic sense for a farmer. It is our responsibility to continue to study the impacts of adopting soil health practices across the landscape so we can better understand where—and

when—soil health practices are likely to be adopted by farmers, and where these practices have the greatest benefit for society.

As farmers invest in soil health practices, we also want to ensure that they receive compensation for their private investments, which can have substantial public benefits ranging from improving land health, biodiversity, water quality and quantity, reductions in greenhouse gas emissions, amongst others. By supporting farmers making these investments, we increase the overall well-being of farmers and society.

Thank you for your time and your continued support of effective mechanisms that enable farmers to adopt the practices that best fit their operations which create benefits for all of us.

The CHAIR. Thank you very much, Dr. Mehta. We appreciate your comments.

Mr. Anderson, when you are ready, please.

STATEMENT OF NATHAN ANDERSON, SECRETARY, BOARD OF DIRECTORS, PRACTICAL FARMERS OF IOWA; OWNER/OPERATOR, BOBOLINK PRAIRIE FARMS, AURELIA, IA

Mr. ANDERSON. Chair Spanberger, Ranking Member LaMalfa, and Members of the Subcommittee, thank you for the opportunity to appear before you today to testify about securing the conservation and the economic benefits of healthy soils.

My name is Nathan Anderson. My wife, Sarah, and our young son operate Bobolink Prairie Farms, raising corn, soybeans, hay, and cattle on owned and rented land in northwest Iowa. Our farm's mission is to honor God, our family, and our community by caring for the resources to which we have been entrusted. In doing so, we are building a resilient and enduring farm and family.

Today it is my humble privilege to be speaking on behalf of Practical Farmers of Iowa, PFI, and our 3,600 members. Since 1985, PFI has been working to equip farmers to build resilient farms and communities. Farmers guide and lead PFI's programming. Our top priority in our most recent member survey is soil health.

My first glimpse of a clear conservation value of soil health principles was in the spring of 2013. Dad and I, working together on a regular basis, had started using a brains-of-the-day and brawn-of-the-day award to affirm each other's work and contributions. By 2013 we had been using no-till and cover crops for 3 years.

During a devastatingly heavy rainfall event, the water from a neighboring field was streaming off with enough force that you could take a kayak across it. Once that water entered our no-till and cover crop field, the moving water slowed, dropped its load of sediment, and infiltrated. Dad looked out the window through the pouring rain at the disappearing stream of water and said matter-of-factly, "That may be the brains of the year award."

Today I want to highlight the positive economic and conservation impact of soil health improvements on rented land and additional policies Congress could implement to further assist us as farmers.

Using skills and techniques learned from other PFI farmers at field days, NRCS technical assistance and cost-share funding through the Environment Quality Incentives Program, or EQIP, we developed and implemented a management-intensive grazing system. This system plans cattle movement on pasture to positively impact species diversity, carbon sequestration, feed value, and ultimately profit.

By the third year of using this grazing system, we had increased the pounds of beef weaned per acre by 74 percent, a positive impact

of $300 per acre. This grazing system and the adjacent crop field also gave us the opportunity to host a soil health training on our farm for NRCS and partner organizations.

It is imperative that training opportunities like these have continued funding and program support which will allow conservation professionals the chance to interact and learn from on-farm research and networking.

Members of Practical Farmers of Iowa greatly value cooperative learning and research partnerships. We rely on programs like Sustainable Agriculture Research and Education, SARE, and cover crops councils as partners and their impact is magnified through a farmer-led model like PFI's.

We also have private cost-share available through companies like Unilever who are partnering with PFI and investing in soil health practices like cover crops.

Soil health is our top priority and we encourage funding for programs like the Conservation Stewardship Program that directly supports farmers already taking steps to address resource concerns on the land they manage and conduct more conservation work in the contract term.

This and other programs need to continue to improve the flexibility to work on rented land. The soil health technique of using cover crops is a sound agronomic practice and has been proven as such, and because of that I ask you the Subcommittee to move forward provisions directing the Risk Management Agency, RMA, to remove special restrictions placed on cover crops that treat them differently than seed, fertilizer, or other crop protection decisions made between a farmer and their agronomists.

I was once asked the question, "10 years after you die why will it matter that Nathan Anderson farmed that land, who will know, and who will care?" I am still considering that question and have formulated this response. Each one of us who is fortunate enough to farm, own, or manage land leaves our own imprint on it. That imprint can be negative, neutral, or positive and can be seen for generations. Just as we can see the soil-based evidence of manure applications, tillage, fence lines, and travel paths made by farmers decades ago, farmers decades from now will see our own imprint on the land. For the future of food security, of rural communities, and family farms, that imprint must be positive and enduring.

The broad application of basic soil health principles is capable of having that impact. PFI member farmers are ready to work with you to have that broad and enduring impact.

Thank you very much for your time and I look forward to your questions.

[The prepared statement of Mr. Anderson follows:]

PREPARED STATEMENT OF NATHAN ANDERSON, SECRETARY, BOARD OF DIRECTORS, PRACTICAL FARMERS OF IOWA; OWNER/OPERATOR, BOBOLINK PRAIRIE FARMS, AURELIA, IA

Chair Spanberger, Ranking Member LaMalfa, and Members of the Subcommittee, thank you for the opportunity to appear before you today to testify about the importance of soil health and its impact on resiliency of farming in the Midwest.

My name is Nathan Anderson. I, along with my wife Sarah and our young son, operate Bobolink Prairie Farms as part of a multi-generational family farm near Aurelia, in northwest Iowa. I started farming full-time after graduating from Iowa

State University, and raise corn, soybeans, hay and cattle on a combined 1,000 acres of owned (400 acres) and rented (600 acres) ground. Our farm's mission is to honor God, our family, and our community by caring for the resources to which we have been entrusted, in doing so, building a resilient and enduring farm and family. This mission drives our long-term focus on both the owned and rented land we manage.

Today, it is my humbling privilege to be speaking on behalf of Practical Farmers of Iowa (PFI) and its 3,600 members. Since 1985, PFI has been working to equip farmers to build resilient farms and communities. The organization was created by a group of farmers who wanted to learn from each other. Farmers guide and lead PFI's programming; their top priority in its most recent member survey is soil health. PFI helps farmers learn about and improve soil health through farmer-to-farmer education at field days, workshops and webinars. It also helps farmers conduct on-farm research so they and others in the network can learn more about how practices impact their farms. More people are recognizing the value of farmer-to-farmer education and on-farm research, and Practical Farmers' membership levels are at an all-time high.

I have been a member of PFI since 2011, and currently serve on its board of directors. PFI's on-farm research and openness in sharing the resulting knowledge drove my interest in the organization. Thousands of farmers seeking to answer questions that make their operations better, and an excitement to share that information to help other farmers. Most recently I've served on the Welcoming Committee to welcome farmers brand new to PFI and to cover crops and offer trouble-shooting help and support as farmers get started improving the resiliency of their farms.

Our Farm's Focus on Soil Health Principles

I grew up always wanting to farm, and in high school managed and farmed 150 acres under dad's guidance. During my junior year at Iowa State University, when I was looking at grad school and employment options, my dad offered to make space to come back to farm, and I accepted, starting in 2010 with 600 acres of rented land. In 2011, Sarah and I were married, and we brought to the farm a different perspective on the farm management practices, along with different sets of skills and added labor to implement new practices. Then in 2012 we experienced a drought, followed by exceedingly heavy rainfall events in 2013 and 2014 that further informed our management practices. We saw that we needed soil that was more resilient to drought, flooding and heavy rainfall. The way to do that was to build the soil's capacity to both infiltrate and hold water and soil health practices were the way to do that. My experience and education gave me an understanding of the impact below the ground in order to manage the land above ground. Impacts such as rooting patterns, ground cover and tillage.

Basic soil health principles include: Protecting the soil surface with living plants or plant residue, minimizing soil disturbance, growing diverse plants, having living roots in the soil as long as possible, and integrating livestock.[1]

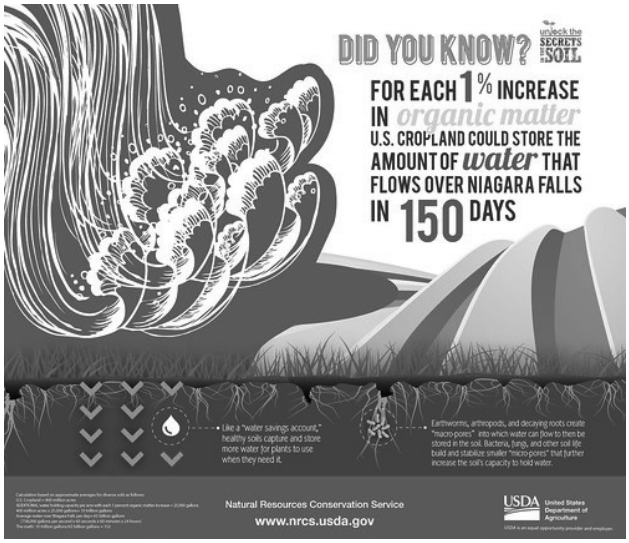
Our farm's first practical application of these soil health principles came in our grazing system management. As beginning farmers on rented pasture with limited resources relative to more established landowning farmers, we had an opportunity of necessity to produce more at a lower cost on a limited footprint. We applied our available labor and management resources as well as basic soil health principles in the development of a management-intensive rotational grazing (MiG) system. Utilizing frequent movements of the cattle herd and short-duration grazing events to have a positive impact on soil health. In the first 3 years of our management-intensive grazing system, on what was rented pasture at the time, we saw an increase in plant diversity and a dramatic increase in pounds of beef weaned per acre—by 74%. MiG increased our carrying capacity and we weaned 6,371 more pounds of beef, which resulted in an increased economic impact of nearly $12,000, or over $300 per acre.

[1] *https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1082147.pdf.*

Table 5: **Calf weaning weight and average daily gain (ADG) relative to acres grazed in 2010 and 2013** [2]

Year	Total pasture size (ac)	Number of calves weaned	Average calf weaning weight (lb)	Average calf ADG (lb/d)	Total pounds weaned (lb)	Pounds weaned per grazed acre (lb/ac)
2010	30.6	12	567	2.26	6,802	222
2013	34.1	24	549	1.96	13,173	386
Average	32.4	18	558	2.11	9,988	304

We've had similar results in our row cropping system. On one rented field, through manure and compost nutrient application, diverse cover crops, and continuing testing and monitoring, we managed a 1.6% increase in organic matter over a 7 year period. This increase in organic matter has improved soil nutrient cycling, making more nutrients available without additions of fertilizer. This organic matter increases available water, soil structure and support for both plants and equipment. USDA–NRCS has shown through rainfall simulation that rainfall hitting a "naked" field not only erodes large amounts of soil but also most of the rain water never infiltrates. This results in thirsty crops during the late summer when rainfall is limited. Because of our increase in soil organic matter through changing our farming practices we are now able to hold more rainwater in the soil and better withstand extreme drought and flood. We've done this while reducing nitrogen application and herbicide passes (input costs), and while achieving increased yields of our primary corn and soybean crops.



[As soil health improves, so too does its hydrologic function. This graphic illustrates how much additional water could be stored in the soil of all U.S. cropland with the addition of one percent of organic matter.]

Sharing information about row crop production and our livestock production separately is a disservice to the benefit of incorporating the two of them together on the same acres. Row crop production with a diverse cover crop that is then grazed by ruminants like cattle provided us the quickest return on our soil health investment. The recent USDA–SARE report, *Cover Crop Economics,* notes that "when cover

[2] *https://practicalfarmers.org/wp-content/uploads/2018/12/13.L.Pasture-monitoring-Anderson.pdf.*

crops are grazed, they can provide a profit in the first year of use if fencing and water are already available."[3]

Many soil health practices take a long time to realize an economic return, but as cited above, grazing cover crops is a practice that immediately offsets the cost of feed; helping farmers net hundreds of dollars per acre. This is a win-win practice that boosts a farmer's bottom line while building organic matter. In addition, *Cover Crops Economics* points out that receiving Federal or state incentive payments while transitioning to cover crop use can make a major contribution to a quick economic return. In Iowa, we have a number of state programs, including the first in the nation crop insurance discount demonstration project by the Iowa Department of Agriculture and Land Stewardship and USDA Risk Management Agency. We also have private cost-share available from companies such as Unilever, who are partnering with PFI and investing in soil health practices such as cover crops.

Soil Health Practices Grow Rural Economies and Support Beginning Farmers

Soil health practices allow for growth of rural economies by "farming in the off-season." Today a young couple wanting to return to a corn and soybean operation may have limited opportunity to build sweat equity and eventually start farming on their own. But soil health practices create an immense opportunity to build operations by farming in the off-season through the establishment of custom cover crop seeding businesses, custom grazing, haying or fencing businesses, and more. For the state of Iowa to properly address soil health improvements we will need to be seeding at least 11 million acres of corn and soybean ground with cover crops, or 60% every fall. To accomplish this, we will need more than 2,000 independent applicators. These custom operations can help the next generation of farmers wanting to put roots down in rural America to become entrepreneurs and revitalize our communities.

These ideas are what lead the founder of PFI, Dick Thompson, to create the organization in 1985. He saw the initial losses of diversity of crops and livestock and worried back then about how farmers could help reduce the loss of the rural population. Fast-forward more than 35 years and we are still working to improve opportunities for young people to have the opportunity to begin farming. The importance of farm diversity is one of the only ways I, as a young farmer, was able to return to my multi-generational farm and get started.

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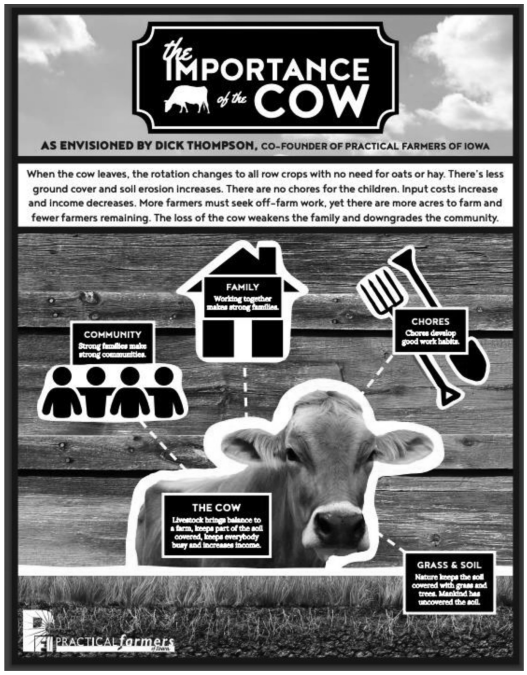
[3] *https://www.sare.org/Newsroom/Press-Releases/When-Do-Cover-Crops-Pay-New-USDA-SARE-Report-Addresses-the-Question*



Land access is commonly surveyed as the most significant limiting factor for beginning and young farmers.[4] With this in mind, our own early focus was to improve the productivity and profitability of the acres that we could access, some owned, most rented. Using data and information from PFI, NRCS, Iowa Learning Farms (ILF) and other sources, we began incorporating diverse cover crops, management-intensive grazing (MIG), no-till, manure and compost fertility sources, and continuing on-farm research and networking.

We have always farmed with the purpose of improving the soils of the land we work on, regardless of whether or not we own the land. I make an extra effort to explain to the landowner the practices I am doing and why I am doing it. Not all landowners may want certain species of cover crops on their land, or some may want their fields to look a certain way, so we make sure to have open communication with our landowners.

Soil health practices on our pasture were initiated with the help of EQIP cost-share funding through the NRCS. The knowledge provided through NRCS planners supported the changes that we made and continue to make.

Soil Health and Extreme Weather

As many of you are aware, this spring was challenging for many farmers across the country, especially in my home state of Iowa. 59 of our 99 counties were declared disaster areas after spring flooding. Even after the flooding subsided rain continued and made it very difficult to plant crops.

While we faced a few challenges, the health of our soil helped to mitigate some of the issues we faced. We were able to plant in fields sooner because the resiliency of our soil supported equipment with wetter than average conditions. Our soil structure minimized the negative impact of sidewall, or seed trench compaction. Improvements in soil health result in widely recognized benefits to surface and groundwater, both on and off farm.

Healthy soils' ability to slow water movement across the landscape is vital as extreme weather becomes more and more common.

My Dad and I, while often working together, have a "brains of the day" and "brawn of the day award." This award serves to affirm the work of each other and sometimes lighten the pressure of working in close quarters with a parent daily. In

[4] *https://newfarmers.usda.gov/access-land-and-capital*.

2013, after a few years of no-till and cover crops, we had a devastatingly heavy rainfall event. The water from a neighboring field was streaming off with enough force you could take a kayak across the field. Once that water entered our field, the force of the water slowed, the sediment it was carrying dropped out, and its impact was lessened. My Dad looked out the window through the pouring rain at the stream of water and said matter-of-factly, "That may be the brains of the year award".

Soil Health Call to Action

Being a fourth-generation farmer in the United States has had its unique set of challenges for our family. My great-grandfather was a tenant farmer in a different area of the county, but he lost the farm in The Great Depression. Then, after arriving back from World War II, his son—my grandfather—worked his way back into a farm of his own. The next generation—my father and uncle—had to deal with some of the hardest times for agriculture in the United States due to the farming crisis of the 1980s. And, while I have not had to deal with any trials quite like they have had, it is up to my generation to ensure that their legacy is carried on.

One of the ways in which we are doing so is through the adoption of new techniques to maintain and improve soil health. While there have been many barriers—such as labor shortages, which make continuing education and implementing practices difficult, and extreme weather conditions—I find that partnerships with government, support from private companies and continuous research and data make it easier to adopt these practices. However, this is not enough, and I believe there are a few areas where Congress can assist.

(1) Because cover crops are proven as a sound agronomic practice, their management should not be segregated from fertilizer, crop protection, and seed selection choices under RMA-policy approval. I believe that RMA should treat cover crops as any other crop input and allow farmers and their agronomic advisors to make the relevant management decisions.

(2) New and beginning farmers who are able to apply management skills to their chosen cropping system can do so through the CSP and EQIP programs, and be supported by training from the BFRD program. However, as I have mentioned, extreme weather is a major barrier we face in our industry. I believe flexibility is needed in these programs to manage a biological system that does not follow calendar dates. Along with this, Federal programs, such as the ones listed above, should be easier to implement by landowners and tenants working in cooperation to benefit from these programs.

(3) Our farm, in the practice of PFI farms, values partnerships with governmental and non-governmental organizations. In 2017, our farm hosted an NRCS soil health training event on our farm, where we had 40 staff participate rather than being in an office all day. PFI farmers continue to lead on-farm research on soil health topics, and it is important that the organizations we partner with can attend events and gain knowledge gleaned through on farm research by the farmers who conducted it. I believe Congress should provide more funding for opportunities like this.

(4) Last, as I have previously mentioned, continued research and data are crucial to our industry. I strongly believe that Congress should appropriate additional funding toward programs like SARE, OREI, and Cover Crop Councils that conduct research on soil health.

Concluding Thoughts

I was once asked the question "10 years after you die, why will it matter that Nathan Anderson farmed that land? Who will know, and who will care?" I'm still considering that question and have formulated this response:

> Each one of us who is fortunate enough to farm, own, or manage land leaves our own imprint on it. That imprint can be negative, neutral, or positive, and can last for generations. Just as we can see the soil-based evidence of manure applications, tillage, fence lines, and travel paths in our own fields that were made decades ago, farmers decades from now will see our imprint on the land. For the future of food security, rural communities, and family farms, that imprint must be positive and enduring. The broad application of basic soil health principles is capable of having the necessary impact.

The CHAIR. Thank you very much.

Mr. Cunningham, please proceed with your testimony.

STATEMENT OF IAN CUNNINGHAM, SECRETARY-TREASURER, NATIONAL ASSOCIATION OF CONSERVATION DISTRICTS; OWNER/OPERATOR, CUNNINGHAM FAMILY FARM, LLC, PIPESTONE, MN

Mr. CUNNINGHAM. Good morning, Chair Spanberger, Ranking Member LaMalfa, and Members of the Subcommittee. Thank you for the opportunity to testify on the important topic of soil health.

I am Ian Cunningham of Pipestone, Minnesota. Along with my son, we operate Cunningham Family Farm in the southwestern corner of the state. We produce corn, soybeans, and beef cattle. Soil health is a top priority across our 800 acre operation.

I also currently serve as the Secretary-Treasurer of the National Association of Conservation Districts. Conservation Districts were founded in response to the poor soil health practices that resulted in the infamous Dust Bowl of the 1930s.

Over the last 80 years we have come to realize that healthy soil is the key to addressing many natural resource concerns. When the soil is healthy and has a cover crop or residue left in the field, there is far less wind and rain erosion. When soils are healthy they can hold and slow water during devastating rain events. Healthy soil holds nutrients in the soil, improving water quality and the efficiency of added nutrients, leading to increased yields.

NACD believes there are five main principles to soil health: maintaining soil cover, minimizing soil disturbance, increasing plant diversity, maintaining living roots in the soil, and the integration of livestock.

While the natural resource benefits of soil health are plentiful, increased adoption of soil health practices is largely driven by the ability to demonstrate economic benefits for producers. I believe that if we can make the argument that benefits outweigh any costs and we can back that argument up with data, we will see uptake increase substantially.

In 2017, NACD adaptive research released a set of case studies through NACD's Soil Health Champion Network that demonstrate economic benefits of soil health practices. The case studies on corn and soybean farms detailed year-by-year budget data on their adoption of cover crops or no-till.

Major takeaways were while planting costs increased by up to $38 an acre, fertilizer costs decreased by up to $50 an acre, repair costs decreased by up to $16 an acre, yields increased by up to $76 an acre, and altogether yearly net income increased by up to $110 per acre.

In my operation we see a very similar story. I am personally proud to be an NACD soil health champion in my community and I am proud of the work I have done to encourage the adoption of practices that improve soil health by my neighbors. I can only do this by being a true believer in how soil health has improved my operation.

While increasing yields and decreasing inputs were the most obvious ways my operation's soil health has benefitted my bottom line, perhaps the greatest economic advantage can be seen when disaster strikes.

During the historic drought of 2012, the combination of all the soil health practices we adopted created a soil health system that

provided more pasture production for our cows and calves, and when we harvested our cash crops we were amazed by the yield compared to other farmers who weren't implementing soil health practices at the same level that we were. This was due to the soil's better rainfall infiltration when it did rain, water holding capacity to get us through the dry periods, nutrient cycling, and other benefits that we can't see with our eyes. This was all created using no-till in our fields, growing cover crops, ensuring a diversity of plants, and integrated grazing and livestock system.

In 2018 we had a different problem when too much rain fell. Much of the excess rain fell during harvest. Farmers who didn't implement soil health practices were fighting mud, tearing up their fields and their equipment. We were able to harvest our crop on time due to better soil structure our soil health conservation system provided.

Our crop insurance agent contacted me in early November asking if I would be filing a claim as so many of the farmers in my areas were doing. I replied I would not since our yields were higher than the insurance guarantee, which was the first time he had heard that from one of his customers. Wet or dry, by following the principles of soil health, our farm is more resilient.

If we are to continue to grow the food, fuel, and fiber our nation and the world will need in the future, agriculture must continue to innovate, making sure our natural resources are protected for future generations.

Ensuring soil health is at the center of every operation is crucial to accomplishing this goal. This Subcommittee has a role to play by supporting farm bill conservation programs, advancing policies that enable the adoption of soil health practices like no-till and cover crops, and by ensuring that NRCS has adequate staff in local service centers to provide the technical assistance that is crucial to the adoption of soil health practices.

As an elected supervisor in my local soil and water conservation district, I know that conservation districts are committed to doing their part to provide locally-led voluntary efforts that will ultimately lead to greater conservation adoption.

Thank you again for inviting me this morning and I look forward to answering your questions.

[The prepared statement of Mr. Cunningham follows:]

PREPARED STATEMENT OF IAN CUNNINGHAM, SECRETARY-TREASURER, NATIONAL ASSOCIATION OF CONSERVATION DISTRICTS; OWNER/OPERATOR, CUNNINGHAM FAMILY FARM, LLC, PIPESTONE, MN

Good morning, Chair Spanberger, Ranking Member LaMalfa, and Members of the Subcommittee. Thank you for the opportunity to testify on the important topic of soil health.

I am Ian Cunningham of Pipestone, Minnesota, and along with my son, we operate Cunningham Family Farm in southwestern Minnesota. We produce corn, soybeans and beef cattle. Soil health is a top priority across our 800 acre operation.

I also currently serve as the Secretary-Treasurer of the National Association of Conservation Districts. NACD is the nonprofit organization that represents America's 3,000 conservation districts, their state and territory associations and the more than 17,000 men and women who serve on their governing boards. Conservation districts are local units of government established under state law to carry out natural resource management programs at the local level. Districts work with millions of cooperating landowners and operators to help them manage and protect land and water resources on all private lands and many public lands in the United States.

Conservation districts were founded with the philosophy that all conservation decisions should be made as close to the local level as possible. Created in response to the Dust Bowl, healthy soil is the very reason why districts came into being. Degraded soil health led to the great loss of topsoil to wind erosion in the 1930s. Conservation districts have helped farmers and ranchers across the country improve conservation on their operation and form the local component of the Federal, state and local partnership of conservation delivery.

Over the last 80 years, we have come to realize that healthy soil is the key to addressing many natural resource concerns. When soil is healthy and protected by cover crops, there is far less wind and rain erosion. Healthy soils can hold and slow rainwater during devastating floods. Healthy soils hold nutrients better, improving water quality and the efficiency of added nutrients. It is clear that healthy soil is the bedrock and should be the priority of our conservation efforts.

NACD believes there are five main principles to soil health: (1) maintaining soil cover, (2) minimizing soil disturbance, (3) increasing plant diversity, (4) maintaining living plants and roots, and (5) the integration of livestock.

The Economics of Soil Health

While the natural resource benefits of soil health are plentiful, we have seen that adoption of soil health practices will be improved if you can show an economic benefit for these practices to a producer. Often, a farmer's first question on these practices will be, "How much is this going to cost me?" If we make the argument that the benefits outweigh any costs, and can back that argument up with data, we will see uptake increase substantially.

In 2017, NACD and Datu Research, LLC released a set of case studies on four corn and soybean farms in the Upper Mississippi River Basin, which detailed year-by-year budget data on their adoption of cover crops or no-till.[1] These farmers shared decisions they made and why; how adoption affected income and yields; and what they learned. Each case study uses budget analysis to measure yearly changes in income that the farmer attributes to adoption, compared to the pre-adoption baseline.

The major takeaways were that although planting costs increased by up to $38 per acre:

- Fertilizer costs decreased by up to $50 per acre;
- Erosion repair costs decreased by up to $16 per acre;
- Yields increased by up to $76 per acre; and altogether[; and]
- Yearly net income increased by up to $110 per acre.

Additional comments from the case study illustrate good advice for those wanting to get into soil health practices:

- The initial investment in learning what is right for your own individual farm can reap serious benefits. Enrollment in a conservation program can be key to make the initial investment cost beneficial.
- Devote time to learning about cover crops before trying them on the farm. The variety of cover crop seed used can dramatically alter both the budget and benefits.
- During bad weather years, the effects of increases in organic matter and the reservoir of water in soils from no-till returned significant benefits.
- Start small enough so it doesn't freak you out, but large enough to matter.

NACD is currently working to expand this research across the country, encompassing different cropping systems, soil types, climates and geographic regions to demonstrate the specific economic benefits of soil health practices.

Education and Outreach

Despite the clear benefits of healthy soil, NACD believes that for a more successful uptake of soil health practices, producers need to be informed of the latest data and research, and this must come from a trusted local source. In some instances, the conservation practices needed to produce healthy soil may seem counterproductive and hearing real world examples from their neighbors is critical.

For example, some may assume planting a cover crop may limit moisture for their cash crop or compete for needed nutrients. In reality, a cover crop creates greater root networks, allowing rainfall or irrigation to be absorbed by and kept within the soil in greater amounts and can actually replenish some of the nutrients needed by

[1] *https://www.nacdnet.org/soil-health-research/*.

the main crop. Tillage used to be the only way to farm because it was the only way farmers knew to control weeds. Farmers believed that tillage was actually improving the health of the soil by mixing it and breaking up compacted soil. We know now that soil needs to be left intact, and tilling the soil actually increases compaction, reduces water infiltration, kills beneficial soil microorganisms, and reduces soil organic matter.

We have learned that combating these myths and spreading information on soil health is best done face-to-face and farmer-to-farmer.

It is for this reason that NACD's Soil Health Champions Network began in 2015.[2] Established in partnership with NRCS through a Conservation Innovation Grant (CIG), the Network promotes soil health education and outreach among America's farmers, ranchers and forestland owners. Today, the Network is comprised of more than 240 landowners and operators who implement conservation practices on their land and champion the benefits of soil health within their communities. (See *Appendix A*) Conservation districts were created so local communities would have a voice in conservation decisions, and NACD's Soil Health Champions Network helps amplify this voice, neighbor-to-neighbor, across the country. To further understand how soil health benefits a producer's bottom line, NACD also held a focus group earlier this year where Soil Health Champions discussed how soil health practices have benefited their operations in the face of extreme weather patterns.[3]

Soil Health on My Operation

I am personally proud to be a Soil Health Champion in my community and I am proud of the work I have done to encourage the adoption of practices that improve soil health by my neighbors. I can only do this by being a true believer in how soil health has improved my operation. My great-grandparents first farmed the land I currently farm in the 1880s. Since then, my family has always worked to be on the cutting edge of conservation adoption. Today, I use cover crops on 100 percent of my land; utilize no-till practices; and have been working with precision agriculture, grid sampling and variable application rates as a way to take my conservation to the next level. I have personally seen how my soil health conservation system has improved weed control, which limits my herbicide purchases and increases my yields, leading to more income with decreased fertilizer costs. With no-till or limited-till, I am able to use my tractor less, ultimately limiting wear-and-tear on my machinery and reducing fuel costs. Reduced fuel use combined with a healthy soil's ability to sequester carbon are significant factors in reducing greenhouse gases.

Although increasing yields and decreasing inputs are the most obvious ways my operation's soil health has benefited my bottom line, perhaps the greatest economic advantage, and sometimes least heralded one, can be seen when a disaster strikes. During the historic drought of 2012, a combination of all of the soil health practices we adopted created a soil health system that provided more pasture production for our cows and calves when forage was scarce and feed costs skyrocketed. When we harvested our cash crops, we were amazed by the yield that was provided compared to other farmers who weren't implementing soil health practices at the same level we were. This was due to the soil's better infiltration when it did rain, water-holding capacity to get us through the dry periods, and nutrient cycling and other benefits we can't see with our eyes. This was all created by utilizing no-till on our fields, planting cover crops, ensuring a diversity of plants, and implementing a managed grazing and livestock system.

In 2018, we had a different problem, similar to the one we are facing currently, where too much rain fell, except that in 2018, the excess rain fell during harvest. Farmers who didn't implement soil health practices had soil that wasn't able to absorb the rainfall and were getting their equipment stuck in the mud, ultimately damaging their equipment. Many chose to wait for the ground to freeze before their crops could be harvested, a significant gamble for any producer. We were able to harvest our crop on time due to the better soil structure our soil health conservation system provided.

Our crop insurance agent contacted me in early November of that year to let me know that due to a price decline, our revenue policy covered more bushels. He asked if we would have a claim, and I replied that we would not since our yield was quite a bit better than the new guarantee. We were the first customer he had heard from who would not be filing a crop insurance claim. Wet or dry, by following the principles of soil heath, our farm is more resilient.

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[2] *https://www.nacdnet.org/get-involved/soil-health-champions-network/*.

[3] *https://www.nacdnet.org/wp-content/uploads/2019/06/NACD-Report-Soil-Health-and-Weather-Extremes.pdf*.

If we are to continue to grow the food, fuel and fiber our nation and the world will need in the future, agriculture must continue to innovate and grow more with less, while making sure our natural resources are protected for future generations. Ensuring soil health is at the center of every operation is crucial to accomplish this goal, and as an elected supervisor at my local conservation district for the past 21 years, I know that conservation districts are committed to provide the locally-led, voluntary efforts that will ultimately lead to greater conservation adoption.

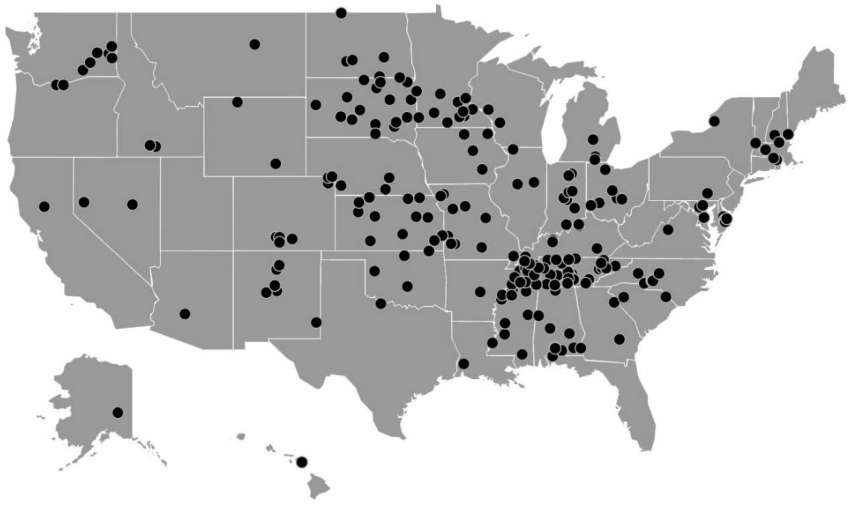
Congress must also stand committed to doing its part. NACD appreciates the 2018 Farm Bill recently passed by this Committee for its commitment to funding programs at NRCS and FSA at the same levels as the 2014 Farm Bill. That is only the first step, however, and Congress must continue to promote voluntary, locally-led conservation by ensuring these programs continue to receive needed funding and ensuring that we reverse the trend of woefully understaffed NRCS service centers. The financial assistance programs provided by the farm bill are critical to further soil health adoption, but we must have the technical experts in local county offices across the country if we are to truly see uptake of soil health practices take place on every agricultural operation. If there is no one in an office to provide technical assistance, we are missing out on a clear opportunity to advance conservation and protect our nation's natural resources.

With the disaster currently effecting my part of the country, flexibility in the prevented planting rules at RMA is very important. I appreciate USDA's recent announcement that this year's date after which cover crops can be hayed and grazed will be moved to September 1.[4] Allowing flexibility in cover crop usage will hopefully lead to greater adoption of cover crops on acres that won't ultimately be planted with the intended cash crop. Greater adoption of cover crops and other conservation practices will help farmers survive future disasters. I personally appreciate Committee Members Angie Craig and Dusty Johnson for introducing legislation and their leadership on this issue.

I appreciate the invitation to speak before the Subcommittee this morning on a topic that is so close to my heart and look forward to answering any question you might have about the need for greater focus on soil health and the economic and natural resource benefits that can be realized.

APPENDIX A

Map of NACD Soil Health Champions Network



The CHAIR. Thank you very much, Mr. Cunningham.
Ms. Douglass, please proceed when you are ready.

[4] *https://www.rma.usda.gov/en/News-Room/Press/Press-Releases/2019-News/RMA-Announces-Change-to-Haying-and-Grazing-Date*.

STATEMENT OF SHANNON DOUGLASS, FIRST VICE PRESIDENT, CALIFORNIA FARM BUREAU FEDERATION; OWNER, DOUGLASS RANCH, ORLAND, CA

Ms. DOUGLASS. Thank you.

Good morning, Chair Spanberger, Ranking Member LaMalfa, and Members of the Subcommittee. Thank you for the opportunity to appear before you today on the important topic of soil health.

I am Shannon Douglass. I am the First Vice President of the California Farm Bureau Federation, representing 39,000 members in California.

My husband, Kelly, and I are first-generation farmers, living in Glenn County with our young son. We raise beef cattle, grow forage crops, walnuts, hay, sunflowers, and various seed crops. We recognize soil health is vital for sustainability, productivity, and profitability on our farm. One method we have personally found effective on our farm is the planting of cover crops to improve soil health.

Our county, Glenn, leads the state in the number of acres contracted for cover crops with NRCS, thanks to the great work locally.

On our farm, we have implemented cover crops to achieve the multitude of benefits possible in a cropping system. These include, but are not limited to, prevention of erosion, improvement of the soil's physical and biological properties, providing nutrients for the soil, the suppression of weeds, availability of water in the soil, and breakage of pest cycles.

We began rotating in our cover crops before planting our sunflower seed crop. Since then we have continued to test different mixes as part of our crop rotation system. We have been pleased with the increase in organic matter, the overall weed suppression, and we anticipate yield increases in the coming years in response to these efforts. We believe these results will give us the ability to continue making the investment of seed and planting costs.

In addition to soil health benefits, we are seeing many of these cover crop varieties serve as habitat for bees and other pollinators, as well as habitat for beneficial insects. There are also varieties that can be utilized to decrease nematode populations in the soil, and we have seen that working for some of our neighbors.

An incentives program available to growers in California is the Healthy Soils Program. It is managed by the California Department of Food and Agriculture. We commend CDFA for the creation of this program, but after researching it for our farm we personally decided that the application process was a bit too cumbersome and time consuming at the time, and know that they are working to streamline that program.

But having said that, the CDFA Healthy Soils Program is important to highlight as a program that is attempting to improve soil health in California. To date, this program has funded 329 projects and claims to have reduced 18,360 metric tons of carbon dioxide. The most common practices for incentives include compost application followed by cover cropping. Funded demonstration projects include a higher percentage for orchards, and the most common practices are cover cropping, composting, and mulching.

To maximize the conservation economic benefits of soil health on the farm, Farm Bureau provides several recommendations in my

written testimony for the Committee's consideration. I wish to highlight three of them.

First, flexibility is needed to ensure that soil health practices and programs are not one-size-fits-all. In California alone there are over 400 commodities grown. Each commodity, each farm, and frankly each region in California has different conservation and economic needs that need to be recognized.

Second, we call for continued research to support strong soil health practices. Areas of research should include the study of diseases that jeopardize soil health, new technologies that have the potential to improve soil health, and the application of agricultural byproducts and soil amendments.

Last, soil health practices must take into consideration other on-farm practices such as those required by laws like FSMA, Food Safety Modernization Act. We must be thoughtful about the intersection of practices required in other laws to ensure that best practices under NRCS are in harmony with food safety and other regulations.

In conclusion, cover crops are one of the many tools that will be effective for some farmers and in some farming systems. With continued research and prioritization of funding, cover crops hold great promise as a tool to combat the increasing pressures on American farmers.

Thank you for the opportunity to testify and I am looking forward to your questions.

[The prepared statement of Ms. Douglass follows:]

PREPARED STATEMENT OF SHANNON DOUGLASS, FIRST VICE PRESIDENT, CALIFORNIA FARM BUREAU FEDERATION; OWNER, DOUGLASS RANCH, ORLAND, CA

Chair Spanberger, Ranking Member LaMalfa, and Members of the Subcommittee, thank you for the opportunity to appear before you today about the important topic of soil health. I am Shannon Douglass, First Vice President of the California Farm Bureau Federation (Farm Bureau).

Farm Bureau is a nonprofit, voluntary membership organization whose purpose is to protect and promote agricultural interests throughout the state of California and to find solutions to the problems of the farm, the farm home and the rural community. Farm Bureau is California's largest farm organization, representing nearly 36,000 members across 53 counties contributing to the largest agricultural economy of any state in the nation. Farm Bureau strives to protect and improve the ability of farmers and ranchers engaged in production agriculture to provide a reliable supply of food and fiber through responsible stewardship of California's resources.

My husband Kelly and I are first generation farmers living in Glenn County with our son where we raise beef cattle and grow forage crops, walnuts, hay, sunflowers and various seed crops. In addition to farming and my position at Farm Bureau, I run a company called CalAgJobs, which connects agricultural career candidates with California's agricultural employers.

Importance of Healthy Soil

Farmers recognize that healthy soil is one of the necessary, critical inputs of a successful farm. Regardless of whether it is the multi-generational farm that continues to produce a safe and abundant food supply or the first-generation farmer, like myself, farming on newly-established agricultural land, soil health is vital for sustainability, productivity, and profitability. Unhealthy soils produce poor crops and poor feed for livestock, requiring soil inputs, while promoting weed growth or no growth at all. In California, in particular, over the past 3 decades, we've lost more than a million acres of farmland, much of which is our most productive, prime, agricultural soils. If our development trends and resource constraints continue, some studies suggest, we will lose another 1.4 million acres by the year 2050. This is also a crucial timeline where our food, fiber, and energy demands are expected to increase by about 50%.

Beyond responding to impending food and land scarcity, healthy soils have been demonstrated to serve as a carbon sink, effectively sequestering carbon in agricultural soils and vegetation. As farmers and ranchers manage more than 1 billion acres in the U.S., we have a wonderful opportunity to share our positive contributions, including to those that may articulate otherwise. The 400 commodities we grow in California, particularly our specialty crops, depend upon the robustness and uniqueness of our soils, for both economic and conservation purposes. It is in our best collective interest to pivot more quickly to a proactive, holistic approach to ensure we are managing our soils and applying practices that maintain and ultimately, improve soil health.

Farm Bureau member-adopted policy confirms a strong interest in soil health. As a grassroots, member-led organization, Farm Bureau members work through a process each year to create and refine Farm Bureau policy that directs the organization's program of action. Ideas and suggestions for the policies originate in discussions among Farm Bureau members at various meetings and gatherings. After consideration by a statewide committee, our voting delegates annually adopt policies at the Farm Bureau annual meeting. Soil health is incorporated and interwoven throughout Farm Bureau's policies and programs of action. This is evident in our support for public policies, programs and legislation, such as the farm bill, that encourage voluntary conservation programs and research to investigate and improve on-farm practices, as well as technological investments that further soil health and sustainability. Farm Bureau supports both public as well as privately-led initiatives to achieve these goals. We also support incentives for promoting carbon sequestration in soils.

Practices On My Operation

Our farm is located in Glenn County, California, which as a county, leads the state in the number of acres contracted for cover crops with the United States Department of Agriculture—Natural Resources Conservation Service (NRCS). A recent soil health cover crop demonstration day in our county attracted 95 grower participants, showing the increasing interest in the practice. Demonstration events such as this in our county are widely attended and successful because of the great outreach efforts to those in industry by our local NRCS office. The technical advisory committee created by NRCS, led by a combination of local farmers, local agronomists and local seed suppliers, has also played a key role in outreach and collaboration. The committee works with our local NRCS agronomist to ensure NRCS recommended cover crop seed mixes are easy to use and readily accessible to growers in the area.

In part because of these types of demonstration events, I have taken steps to improve the soil health on my own farm. Some popular national varieties include the annual cereals and forage grasses. Following seed supplier protocol, we implemented cover crops to achieve the multitude of benefits possible in a cropping system. These include, but are not limited to, prevention of erosion, improvement of the soil's physical and biological properties, providing nutrients for the soil, the suppression of weeds, availability of water in the soil, and breakage of pest cycles. Of course, we are aware that the potential benefits achieved will vary depending on the species of cover crop, the crop cycle, and the location of the operation.

Using the regional tools, progress reports, and plant guides developed by NRCS, we implemented cover crops on our farm in 2016 beginning with rotating them in before planting our sunflower seed crop. Since then, we have continued to test different mixes as part of our crop rotation system. Specifically, we have planted cover crops in the winter in advance of planting and are also integrating cover crops into a newly planted walnut orchard.

We have been pleased with the increase in organic matter, overall weed suppression, and we anticipate yield increases in the coming years in response to our efforts. We believe these results will give us the ability to continue making the investment of seed and planting costs. In addition to soil health benefits, we are finding extension benefits from the utilization of cover crops, as well. For example, we are seeing many of these varieties serving as habitat for both bees and other pollinators, as well as for beneficial insects. There are also varieties that can be utilized to decrease nematode populations in the soil and we have seen those working on the fields of our neighbors.

California's Healthy Soils Program

For our operation, we opted to utilize cover crops without any financial assistance or incentive support, although we are aware that such programs exist. I'll explain our state program, why it wasn't a good fit for my farm, and more detail on how the program works.

In California, one particular incentives program available to growers is the Healthy Soils Program (HSP) managed by the California Department of Food and Agriculture (CDFA). While we commend CDFA for creation of the program, after researching it for our farm, we personally decided the application process was too cumbersome and time consuming. It was ultimately easier to implement the practice ourselves than to put in the time and resources necessary to go through the extensive grant application. Having said that, the CDFA HSP is important to highlight as a program attempting to improve soil health in California.

The HSP was born out of the 2015 International Year of the Soils, which encouraged the State of California to create an interagency plan via the Healthy Soils Initiative to promote the development of healthy soils. The initiative articulated the benefits of soil health: improved plant health and yield, improved biodiversity, habitat development, carbon sequestration, reduced sediment erosion and dust, increased water retention, and improved air and water quality. The initiative promoted five actions:

1. Protect and restore soil organic matter in CA;
2. Identify sustainable and integrated financing opportunities;
3. Provide research, technical assistance and education;
4. Increase governmental efficiency on public and private land applications; and
5. Promote interagency collaboration.

While several agencies had individual actions, CDFA initiated the HSP aimed at incentivizing the use of on-farm soil management practices that improve soil organic matter, sequester carbon and reduce greenhouse gas emissions. In its current form, the program is divided into two funding streams: incentives and demonstration projects.

Incentives are offered to California growers and ranchers who implement specific conservation management practices on their farms and ranches that sequester carbon, reduce greenhouse gas emissions, and improve soil health. Forecasted benefits are calculated using a tool developed by NRCS, Colorado State, CDFA and the California Air Resources Board. This tool is called COMET-Planner. On-farm management practices are also those eligible under NRCS conservation practice standards, and include practices like compost application, cover cropping, no-till, reduced-till, mulching, herbaceous cover, and conservation plantings such as windbreaks and hedgerows.

Demonstration projects are offered to farm operators, industry groups, nonprofits, academia or Resource Conservation Districts providing on-farm projects that collect data or showcase conservation management practices to benefit soil health. These also typically include an outreach and education component and have included practices such as compost application, hedgerow planting, mulching, no-till and cover crop management with grazing and controlled burns.

CDFA is also now offering grants for technical assistance for the HSP. Funds awarded through this competitive grant program are distributed to technical assistance providers including Resource Conservation Districts, the University of California Cooperative Extension, and nonprofit organizations, with demonstrate technical expertise in designing and implementing agricultural management practices to support CDFA's incentive programs. Technical assistance providers help provide hands-on, on-demand application assistance for growers and ranchers applying for a grant and implementing one or multiple management practices.

Grant guidelines are proposed before an Environmental Farming Scientific Advisory Committee convened by CDFA that consists of representatives from academia, other state agencies and departments, USDA, technical advisors and growers. The Committee discusses the program, advises on improvements, takes public comment and makes recommendations to the California Secretary of Agriculture.

The Healthy Soils program originally received its first funding allocation in 2016–17 with $7.5 million from the state administered Cap and Trade program proceeds. In 2018, it again, received $5 million from the Cap and Trade proceeds and $10 million from California Proposition 68: the CA Drought, Water, Parks, Climate, Coastal Protection and Outdoor Access for all Act of 2018. To date, it has funded 329 projects and has claimed to reduce 18,360 metric tons of carbon dioxide, the equivalent of removing approximately 4,000 cars off the road for 1 year. In the awards announced just this month, CDFA awarded $8.7 million for 194 incentive projects and $3.8 million for 23 demonstration projects. The most common practices for incentives include compost application, followed by cover cropping. The funds are evenly dispersed amongst orchards, grazing/rangelands, cropland and vineyards. Funded demonstration projects include a higher percentage for orchards and the most common include cover cropping, composting and mulching. For the current pro-

posed California budget, the state legislature included $28 million to the HSP from Cap and Trade Auction revenues.

Recommendations

To maximize the conservation and economic benefits of soil health on the farm, Farm Bureau provides the following recommendations for the Committee's consideration:

- *Flexibility:* Recognition that there is no one-size-fits-all approach for on-farm soil health practices. In California alone, there are over 400 commodities grown. Each commodity and operation will have different conservation and economic needs to factor and we need to realize that in some circumstances, the practices that have been validated as promoting healthy soils may not make sense. In those circumstances, we can't make value judgments against those operations, but rather, we need to use our motivation and resources to identify new practices that work.
- *Producer Incentives:* Support for programs that create incentives to encourage or recognize activities on working farms that enhance soil health. For example, to help address climate change, we support compensation to farmers for planting crops or adopting farming practices that keep carbon in the soil. Application processes for these programs should be streamlined and should not overburden producers. Compensation needs to be provided so that it actually makes financial and agronomic sense.
- *Soils Research:* Continued resources for research that support soil health practices. Areas of research should include the study of diseases that jeopardize soil health, new technologies that have the potential to improve soil health, and the application of agricultural byproducts as soil amendments. Soil health practices specific to specialty crops should not be overlooked. For example, programs such as the USDA Specialty Crop Block grants could place more emphasis on encouraging specialty crop growers to utilize cover crops or implement other soil health focused practices.
- *Technical Assistance:* Ongoing resources for NRCS technical assistance staff that are commensurate to the voluntary financial assistance available to producers. Resources for ongoing soil mapping and publication of soil survey information are also essential.
- *Wildfire Response:* The utilization of public-private partnerships for replanting fire-ravaged areas with beneficial species ecologically appropriate for the region that stabilize soil and reduce weed invasion.
- *Prioritize Local:* Long-term implementation of on-farm soil health practices will depend on the practicality, feasibility, and availability of resources to the producer. Any soil health program should be locally focused and producer led.
- *Avoid Conflicting Regulation:* Soil health practices must take into consideration other on-farm practices such as those required by laws like the Food Safety Modernization Act (FSMA). We must be thoughtful about the intersection of practices required in other laws to ensure that best practices under NRCS are in harmony with food safety and other regulations. The burden must be placed on the legislators and regulators to avoid regulatory conflict.
- *Other Research:* Further research is needed to document the additional agronomic benefits of soil health practices. For example, research documenting the reduction in water needed for lands with compost applications.

Conclusion

A comprehensive suite of tools is available to successfully manage for soil health. Cover crops are one of many tools that will be effective for some farmers and in some farming systems. It is important to note they will not integrate well with all crops. Any implemented recommendations by private and public sources need to be tailored to the local area relying on the science provided by local experts for maximum effectiveness. With continued research and prioritization of funding, cover crops hold great promise as a tool to combat the increasing pressures on American farmers.

Thank you for the opportunity to testify.

The CHAIR. Thank you, Ms. Douglass.

Mr. Ellis, welcome and please begin whenever you are ready.

STATEMENT OF CHAD R. ELLIS, BOARD CHAIR, NATIONAL GRAZING LANDS COALITION; INDUSTRY RELATIONS AND STEWARDSHIP MANAGER, NOBLE RESEARCH INSTITUTE, LLC, MARIETTA, OK

Mr. ELLIS. Chair Spanberger, Ranking Member LaMalfa, Members of the Committee, thank you for the opportunity to provide testimony on behalf of the National Grazing Lands Coalition as their Chairman, and the Industry Relations and Stewardship Manager for the Noble Research Institute.

Grazing lands are one of America's greatest natural resources. They are vast and they cover over 650 million acres in the U.S. alone. They provide a secure food supply, renewable energy, clean water, carbon sequestration, wildlife habitat, and healthy soils.

To sustain agricultural production, grazing lands must be conserved and properly managed to produce robust resilient stands of grasses and forage. All of this starts below our feet with soil health, the foundation of our operations.

Innovative producers today understand that we do not solve ecological problems by implementing practices, rather by implementing principles.

We can and are addressing ecological degradation by following principles that rebuild ecological process and habitat from the ground up rather than focusing on specific singular species or management practices.

It all begins with maintaining a solid foundation with healthy soils as the cornerstone to any agricultural enterprise. Properly applied, grazing is the capstone of building soil health.

There are five principles that must be implemented to maintain and improve soil health.

The first is armor the soil. Keeping the soil covered is key step to protecting the soil and building soil health.

Second is optimizing disturbance. Tilling the ground alters soil structure and limits biological activity, but not all disturbances harm the soil. In fact, some are quite beneficial when optimized. Grazing, prescribed fire, and herbicide applications all are disturbances that can, if properly managed, be beneficial for soil health. Optimizing these disturbances means ensuring timing, frequency, intensity, and the duration of these activities are implemented in a planned manner.

Our third is increasing diversity. Increasing plant diversity above ground allows for a more diverse community below the ground.

Fourth is keeping a living root in the ground all year. Living roots improve soil structure and provide a food source for beneficial microbes. They also facilitate symbiotic relationships between plants and mycorrhizal fungi.

Fifth is properly integrating livestock. Grazing improves both soil health and plant health. Grazing recycles the nutrients through manure distribution, reduces plant selectivity, and increases plant diversity. When properly and intentionally applied, grazing is one of the most critical factors to improving soil health.

To provide an effective mechanism for implementing the soil health principles and the natural laws of grazing management, the most effective producers develop and follow a grazing plan. The plan allows producers to intentionally manage their land and

achieve the desired outcomes for a livestock operation. A good grazing plan considers two essential components, the nutritional need of the livestock and the health of the plants being grazed.

Grazing plans are in essence conservation plans for the grazing lands. A well-designed and a well-managed grazing plan results in healthy soils and grasses, proper nutrition for the grazing animals, and a greater livestock production at a lower cost.

A proper grazing plan considers first, the stocking rate, meaning the number of animals on a given area of land over a certain period; second, the grazing rotation, which means where to graze, when to graze, and how long to graze; and third is grazing intensity, which is the amount of plant materials to be removed from livestock or rotated to a new area, and following the guiding principles of take half, leave half; and fourth and last is plant rest and recovery, which recognizes that grazed plants are given adequate periods of time to recover.

All of these elements when managed in unison enable producers to increase both their productivity of their operations and health of their soils.

Management of grazing lands is a dynamic process with a complex set of variables. However, as the science of grazing management has evolved, so have livestock producers. Integrating livestock into our agricultural operations is a key component of the five soil health principles.

Today, most effective livestock producers are seeing dramatic improvements in the productivity, in the resilience of their grazing lands, as well as their bottom line. They are also benefitting from the significant improvements and the health of their soils.

Thank you.

[The prepared statement of Mr. Ellis follows:]

PREPARED STATEMENT OF CHAD R. ELLIS, BOARD CHAIR, NATIONAL GRAZING LANDS COALITION; INDUSTRY RELATIONS AND STEWARDSHIP MANAGER, NOBLE RESEARCH INSTITUTE, LLC, MARIETTA, OK

Chair Spanberger, Ranking Member LaMalfa, Members of the Committee, thank you for this opportunity to submit a written statement on behalf of the National Grazing Lands Coalition as their Chairman and as the Industry Relations and Stewardship Manager for the Noble Research Institute.

Established in 1991, the National Grazing Lands Coalition is as a grassroots, nationwide consortium of individual agriculture producers and organizations that support voluntary, ecologically and economically sound management of all grazing lands for their adaptive uses and multiple benefits to the environment and society through science-based technical assistance, research and education.

The National Grazing Lands Coalition is led by a national steering committee dedicated to America's grazing lands resource and its sustainability. The Steering Committee is made up of individuals representing the National Association of Conservation Districts (NACD), National Cattlemen's Beef Association (NCBA), American Forage and Grassland Council (AFGC), American Sheep Industry (ASI), American Farm Bureau Federation (AFBF), Society for Range Management (SRM), the Dairy Industry, the Soil and Water Conservation Society (SWCS), the National Farmers Union (NFU), and the Noble Research Institute, LLC.

Grazing lands are one of America's greatest natural resources. They provide the nation and the world with a secure food supply, renewable energy, improved water quality and availability, productive plants that sequester carbon, robust wildlife habitat, and healthy soils and serve as the foundation for our country's farming and ranching families. Grazing lands contribute $78 billion annually to the U.S. economy by supporting an estimated 60 million head of cattle and eight million head of sheep. To sustain agricultural production, grazing lands must be conserved and

properly managed to produce robust, resilient stands of grasses and forage. All of this starts below our feet with "soil health," the foundation of our operations.

Grazing lands are those lands not cultivated by man. As America developed westward in the 19th century, farmers began to cultivate soils by clearing timber and destroying many of the natural prairies that existed, all in an effort to grow what are now known as commodity crops. The fertile, productive prairies of the Great Plains that once teamed with diverse grasses, forages and large herds of bison were tilled and farmed. These practices depleted the soils of nutrients, organic matter, and biological life. The natural biological processes of grazing by roaming herds and periodic fire that created the natural grazing lands, were no longer at work. Combined with a decade-long drought, these poor management practices contributed to the great Dust Bowl of the 1930s. This disaster brought about the birth of land conservation and the Conservation Act of 1935, which created the Soil Conservation Service, now the NRCS. Notwithstanding, in the 1950s the Green Revolution took hold, and great advancements were made in agricultural technology, including the development of commodity and forage crops that responded well to fertilizer, advanced farm machinery and other technological advancements that expedited crop production with less need for labor.

In the years that followed, the agricultural industry operated on cheap feed, cheap fertilizer and cheap fuel. Our industry and our research during that time focused on the chemical and physical characteristics of soils with little to no consideration of biological interactions within the soil.

In recent years, however, prices for feed, fertilizer and fuel have increased to a point that has become unsustainable for many operations. Many producers have had to make a choice: continue doing what they have always done or work *with nature* to find a new way to farm and ranch. Born out of equal parts necessity and frustration, producers began to experiment with farming and ranching techniques that limited the use of inorganic fertilizer, fuel and feed.

They began to see that limiting or eliminating tillage reduced their fuel bill, using the ageless practice of "cover crops" to keep their fields covered provided numerous benefits to the soil (*i.e.,* preventing erosion, increasing water holding capacity and increasing biodiversity), converting marginal soils to perennial pasture land to eliminate tillage and minimize erosion, and through managed rotational grazing the pastoral lands improved in composition and production due to the recovery allowed between grazing events.

In essence, they built a foundation of principles that many producers follow today to manage healthy soils and restore deteriorated soils. These soil health management principles were set forth to achieve specific goals that are inherent to all soils. They are based on mimicking highly diverse, heterogeneous, native grazing land plant communities by harnessing the power of biologic interactions between plants, soil microbes, fungi and other of life in our soils. These principles build soil aggregation, which further builds soil structure.

These principles have proven the path forward for many innovative producers and substantiated that the conventional farming and ranching practices of the last 6 decades are not the only way.

The following soil health management principles were developed by producers for producers, and these apply to both croplands and grazing lands:

(1) **Armor the soil:** Soil health cannot be built if the soil is moving. Building organic matter on the soil surface armors and protects the soil from erosive processes. Keeping the ground covered also serves as a mitigation mechanism for soil temperature. Excessive increases in soil temperature can have drastic and destructive effects on soil microbial life. Once soil temperatures reach 140 °F, soil bacteria die. The soil must be covered to minimize bare ground, this is largely accomplished by forage and crop residue. In grazing lands, this means managing lands to retain forage cover year round either in the form of growing plants and plant residues.

(2) **Optimize disturbance:** Physical soil disturbance, such as tillage, alters the structure of the soil and limits biological activity. If the goal is to build healthy, functional soil systems, tillage should only be use in specific, limited circumstances. While tillage is a detrimental disturbance, not all disturbances harm the soil. In fact, some are quiet beneficial and should be optimized. Grazing, prescribed fire, herbicide applications, among others, are all disturbances that can, if properly managed, be beneficial. For this reason, we use the term optimize disturbance to ensure that the timing, frequency, intensity and duration of these management activities are implemented in a planned manner. In grazing lands, the act of grazing is a disturbance, but if properly managed, the grazed plants are allowed to regrow. In addition, fire is a type of

disturbance that when administered periodically as a tool can have positive effects on plant composition and reduce unwanted woody plant encroachment.

(3) **Increase diversity:** Increasing plant diversity above ground allows for a more diverse community below ground. Specific soil microbes require specific plant types. The more diverse the microbial population in the soil, the better the plant species will perform due to increased biological activity. In grazing lands, this means inter-seeding forage species into monocultures of introduced pastures and providing appropriate periods of recovery following grazing events.

(4) **Keep living roots in the ground all year:** Soil microbes tend to utilize active carbon first. Active carbon is the exudates from living plant roots. Therefore, to keep soil biology working as long as possible, a living root in the ground is ideal. A living root provides a food source for beneficial microbes and provides opportunity for symbiotic relationships between plant roots and mycorrhizal fungi. In grazing lands, this means inter-seeding cool season forages into warm season pasture and *vice versa* depending on the predominate type of pasture.

(5) **Properly integrate livestock:** Grazing lands naturally evolved under grazing pressure. Soil and plant health is improved by grazing, which recycles nutrients through improved manure distribution, reduces plant selectivity and increases plant diversity. The most important factor in grazing systems is the management of stocking rate and allowing, in some manner, adequate rest periods for plants to recover before being grazed again. This principle is critical to both native and introduced grazing lands.

Principles over Practices

The great challenges facing the U.S. agricultural industry as a whole are numerous and daunting. However, to solve those challenges, one must determine the root of the problem. For much of the past sixty years, the agriculture industry admittedly focused on treating symptoms with practices and inputs rather than addressing the problem with science-based, holistic principles. Innovative producers today understand that we do not solve ecological problems by implementing practices, rather, we implement principles. We can and are addressing ecological degradation by following principles that rebuild ecological processes and habitat from the ground up rather than focusing on specific singular species or management practices. It all begins with maintaining a solid foundation with healthy soil as the cornerstone to any agricultural enterprise. Properly applied grazing is the capstone to building soil health.

Applying the Principles Today

In properly managed grazing lands, whether in introduced pastures or native range, all five of the soil health principles can actively build more productive, more profitable and more sustainable agricultural production systems. In fact, it is often easier to apply the soil health principles to grazing lands (rather than cultivated croplands) because the soil health principle of properly integrating livestock (the grazing animals) is already in place. Healthy grazing lands begin with a management philosophy that properly manages grazing livestock and addresses the physiological needs of the forages being grazed.

Similar to the five soil health principles, there are four guiding principles, natural laws, of grazing management that, when understood and properly implemented, can help restore and rebuild the soil. These principles contribute to improved soil health and the function of both native range and introduced pastures.

(1) K**eep down the shoot, kill the root:** In essence, if plants are grazed too short for too long of a duration, the plant will die. Roots of plants form essential functions: anchor the plant to soil, take up water and nutrients, and if healthy, the roots help the plant mitigate stresses of drought, temperature extremes, and grazing. The top growth of grass plants is directly proportional to root growth. Roots naturally die and are replaced by new roots. However, when excessive amounts of top growth are removed, roots are unable to regrow and replace themselves as they die. The plant becomes weaker and eventually dies. When actively growing leaves are left at an optimum amount, the root system is maintained and supports plant growth. Grassland managers have learned that managing plants and root systems are the keys to a healthy and productive grassland. These managers have adopted a planned grazing approach to their management, which defines a proper degree of grazing use for the key species. Planned grazing prescribes rest and recovery following grazing events to maintain or enhance grasslands.

(2) **Nature abhors a vacuum:** Nature does not like bare ground. Bare ground is soil that is not protected by plants, plant residues, plant litter, gravel or rocks. Bare ground is subject to erosion, rain runoff instead of infiltration, intense temperatures and exposure to the sun.

When grazing lands are disturbed, overly grazed, and managed poorly for extended periods, bare soil is exposed. Grazing lands with extensive bare soil are more susceptible to droughts and are much less productive. Managing grazing lands so that the soils remain covered provides protection from erosion, allows for water infiltration, and builds organic matter, which in turns builds biological activity and soil health. Together these elements improve soil stability and productivity.

(3) **Bare soils decrease moisture availability:** When grazing lands have significant amounts of bare soil or are in the early stages of recovery, they have little organic matter and are prone to erosion, weeds and the effects of drought mentioned above. Rains that fall on bare soil is less effective because less moisture soaks into the soil whether it can be absorbed by organic matter. More water runs off the soil making the affected area more prone to drought. With the direct exposure to the sun, soil surface temperatures of bare soil are elevated creating an environment that reduces or eliminates biological activity in the top layers of the soil. In this condition, soils are less likely to support productive grasses and forages. As a result, less productive, less desirable plants, such as weeds, appear rapidly.

Conversely, rain that falls on grazing lands covered with productive grasses and forages readily infiltrates the soil and is absorbed by soil organic matter. This provides an environment more conducive to the continued recruitment and maintenance of the desired grasses and forages. Healthy grazing lands remain more resilient to drought over time.

(4) **If given a chance, the best-adapted plants will dominate:** In general, nature will bring back the best-adapted vegetation on grazing lands if the producer works *with* nature by following a good grazing plan. These best-adapted vegetation species are more productive, more resilient to drought, and are more profitable than less desirable species. This concept also holds true with introduced pastures. A well-managed, properly grazed grazing land provides nature the opportunity for the grasses and forages that best fit the environment to survive and thrive.

Implementation of Principles and Natural Laws on Grazing Lands

Grazing Plans—To provide an effective mechanism for implementing the soil health principles and the natural laws of grazing management, producers must develop and follow a grazing plan. A grazing plan allows producers to intentionally manage the grazing lands to achieve desired outcomes for a livestock operation. A good grazing plan considers two essential components—the nutritional needs of the livestock and the health of the key plants being grazed and managed, which is impacted by health of the supporting soil.

Grazing plans are, in essence, conservation plans for grazing lands. They include decisions for manipulating the plant community to manage the soil, water, air, plant and animal resources. A well-designed and well-managed grazing plan results in healthy soils and grasses, proper nutrition for grazing animals, and greater livestock production at a lower cost.

There are also four keys to proper grazing management: stocking rate, livestock rotation, utilization rate and plant rest and recovery. All of these elements must be managed in unison to be effective.

Stocking Rate—Stocking rate is arguably the most critical variable in proper grazing management. Stocking rate is the number of animals on a given area of land over a certain period. If intake is not limited, livestock consume about three percent of their body weight of grass and/or forage per day. For all practical purposes, stocking rate is a measure of the grass demanded by the livestock over a period of time.

The amount of grass and forage produced on a given area is a function of many factors, including soil types, forage types (*e.g.,* grasses, legumes), pasture condition, and previous management. However, moisture and temperatures during the growing season also drive production. Forage production is dynamic, and the entirety of the forage produced should not be grazed. As provided above, with proper grazing management, only a portion is grazed and the rest is used to maintain the health and productivity of the grazing land. The portion of the forage that is allocated for grazing is called the available production. It is important that the stocking rate match the available production and be used optimally. Improper stocking of grazing lands leads to over-grazing or under-grazing, neither of which provides favorable

outcomes. Over-grazing for extended periods of time leads to the degradation of the grazing land and an overall reduction in pasture productivity, soil health and livestock production. Determining a proper stocking rate is essential for proper grazing management and requires balancing the animal numbers with available grass and forage production.

Grazing Rotation—Once a proper stocking rate is established, implementing a suitable grazing rotation is the next variable in proper grazing management. A grazing rotation considers where to graze, when to graze, how long to graze, and how long to allow a grazed area to rest and recover. The purpose of a grazing rotation is to manage the impact of grazing on the grazing land while maintaining or improving livestock production.

Livestock are selective grazers, and left unmanaged they tend to [disproportionately] graze more-productive plants over less-productive plants. Livestock also prefer the fresh regrowth over mature leaves. In a continuously grazed pasture, plants that are grazed early in the growing season are grazed repeatedly without adequate time to recover. Since these plants are not allowed to regrow leaves and supply needed energy to the roots through the process of photosynthesis, roots do not regrow adequately to support the plant. Roots of these plants become weakened, depleted, and eventually die. Over time, the more-productive plants are grazed out leaving less desirable, less productive plants, which can lead to deterioration of the grazing land and the health of the soil.

Grazing Intensity—Grazing intensity is the amount of grass and forage removed before livestock are rotated to a new area. Stated another way, it is how short the pasture is grazed before removing the grazing animals. A good grazing management practice is "take half and leave half." Conceptually, this means graze the top half of the leaves and leave the rest to allow for rapid recovery and regrowth. Ideally, every plant in the pasture would be grazed evenly at this level. Taking more than 50% of the leaf production stops root growth and extends the recovery time. Grazing 50% or less of the leaf area of plants has little or no effect on root growth and plant regrowth. This expedites recovery and increases the productivity of grazing lands. Other benefits of grazing less intensely include increased root production, rooting depth, and plant residue, which increases soil organic matter, water holding capacity, pasture production, and soil health. When properly stocked with a good grazing rotation, grazing intensity can be managed such that the majority of the plants in a pasture are grazed at 50% or less during each grazing rotation throughout most of the growing season allowing for optimum growth and production of the grazing land.

Rest and Recovery—The final aspect to consider in grazing management is the rest and recovery period. After being grazed, plants need an adequate recovery period. The more severe the grazing intensity, the longer it takes for the plants to fully recover. Soil moisture and seasonal temperatures also affect the rest and recovery period. In favorable moisture conditions, the recovery period is shorter than in low moisture conditions. As moisture becomes more limiting, longer rest and recovery periods are required. It is important to determine the recovery period based on the key species in the grazing land being managed. In a native grass pasture, the key species are those more productive, more palatable species that have a longer recovery period than the less desirable species. Introduced pastures usually have a shorter recovery period than the native prairies and have to be managed differently for optimum results. Well-managed rest and recovery periods increase pasture production and offer greater potential for livestock production.

Conclusion

Management of grazing lands is a dynamic process with a complex set of variables that must be taken into account. However, as the science of grazing management has evolved, innovative producers have mastered the understanding of the natural laws of grazing management. Many have seen dramatic improvements in the productivity and resilience of their grazing lands. They have also observed great improvements in soil health and ecosystem function because they have embraced and are managing for the soil health principles; many even before the soil health principles were specifically identified. It is the challenge of organizations, such as the National Grazing Lands Coalition and the Noble Research Institute, to continue to education land managers, farmers and ranchers to ensure proper management of grazing lands becomes the norm for producers focused on the long-term economic viability and ecological sustainability.

The CHAIR. Thank you very much.

Members will now be recognized for questions in the order of seniority for Members who were here at the start of the hearing. After that, Members will be recognized in order of their arrival.

I first recognize myself for 5 minutes.

Mr. Anderson, I truly appreciate your very personal story that you told related to your family farm and what motivates you day to day. I have hosted roundtables in my district and heard from growers and conservationists about how important voluntary soil health management practices are to them, and it is important for us here in Congress to hear voices like yours as we develop and oversee the Federal policies that are intended to support and scale the adoption of soil health management.

Across the country, non-operating landowners control 41 percent of U.S. farmland, and you said that you rent approximately 60 percent of the acreage that you farm. I am curious if you can talk a little bit about your experiences as an operator; specifically, what factors motivated you to use cover crops on your farm and how we can help encourage non-operating landowners to support soil health practices and how can we help on land that you rent and not just land that you own?

Thank you.

Mr. ANDERSON. Thank you. That is a very good question and I will do my best to respond in detail as best I can.

As an operator, as a renter, implementing soil health practices it is imperative that I and that others in my similar situation focus on practices that can provide an immediate return, and grazing management is one of those that can provide an opportunity to increase profit on rented land short-term and long-term.

Cover crops in situations that they can be grazed are another scenario that can provide a first-year return on investment, provided there is an opportunity, given the weather, to graze those cover crops.

Another point of use for cover crops that can provide a positive return in a first year, and this is from recent SARE data, Sustainable Agriculture Research and Education data, is areas that have herbicide-resistant weed populations where that cover crop can provide weed suppression resulting in a decreased herbicide use.

Those are three of the top areas as operator on rented land to focus efforts.

A couple other thoughts on the remainder of your question, because it is a very good and detailed question that I don't think any of us all have the answer to, which is why we are here. There are opportunities, especially for rural entrepreneurs, to become more involved in particularly the cover crop industry and in grazing management that provide a way for beginning farmers and changed-career farmers to come back and implement those practices, provide their management skills using the knowledge and data that are available to implement change on the landscape. A focus on rural entrepreneurs that are beginning businesses or growing businesses in the area of soil health would be tremendously beneficial.

The CHAIR. Thank you very much.

And in my remaining time I have a question for Dr. Mehta.

I appreciate that you spoke about the financial and technical barriers to soil health management. I would like to insert for the record a USDA SARE report focusing on the economics of cover crop adoption. And my question for you is are there any existing programs or pilots that are especially encouraging when it comes to more at-scale adoption of these practices?

[The report referred to is located on p. 51.]

Dr. MEHTA. Absolutely. That is a great question and it is one that we face daily with our farmers and farmers throughout the U.S.

We are seeing a range of programs that are tackling the financial side and the technical side. They are rather different, so I am just going to tackle the financial piece first.

As we have just heard from everyone to the left of me, they take quite a bit of risk on themselves and there is quite a leap of faith in recognizing that these practices will work, and while we are seeing the long-term risk reduction in resiliency, there are near-term cost issues that can come up.

In our data we have seen, we like for some of the farmers' risks to be reduced within 3 years. The reality is it can take 6, 7 years. We have had farmers even after a decade get hit, especially whey they have tenure situations.

Anything that can be done around cost-sharing. The NRCS Program around cost-sharing has been helpful. We have heard of several of the programs farmers are being able to take advantage of and really utilize.

We are also starting to lean heavily on the private side as well because looking to lenders and agricultural, especially on the banking side, to help incorporate the use of cover crops and all of these reduced tillage practices are extremely important. That is not to say that the government programs are not sufficient, but we think government programs can't go it alone. We have been advocating along with The Nature Conservancy and Environmental Defense Fund to take into account the fact that again, many of the farmers you have heard from should have benefits in their lending practices and other mechanisms.

And at the state level we have seen many effective programs. They actually are some of the ones that are maybe best because they are localized and can target the needs that are specifically of the needs of the farmers and specific weather issues that they may be facing at any given time.

The CHAIR. Thank you very much for your response. It made me think of Mr. Cunningham's story of not needing his crop insurance because of his use of cover crops.

I would like to now recognize Ms. Pingree from Maine.

Ms. PINGREE. Thank you, Madam Chair, and thank you to you and the Ranking Member for holding this hearing and to all of you for making the journey to Washington and presenting such eloquent testimony. It has really been great to hear all of you.

One thing I just wanted to quickly say in the sense for the Committee reference, some of you have referenced the important role that the USDA plays in helping farmers, and Mr. Cunningham, you noted that the NRCS is critically important but centers are woefully understaffed, and I just want to amplify this for the Com-

mittee. In a hearing earlier this month in another Subcommittee we heard about understaffing at ARS, and I just have been hearing a troubling understaffing of departments at USDA, also the climate hubs which are critically important in some of the issues that we are working on.

I just want to put that out there for the Committee. We have to continue to probe with USDA if positions are being filled. There is no hiring freeze but there seem to be less people to do these important jobs, and so many of you have talked about the importance of having that support.

A couple things I want to touch on in my short time. In order for some of these pilots and future programs on allowing farmers to benefit economically from using good soil practices, and we have all talked about a lot of things that it does for your yield and resilience, but also in being in carbon markets in the future and some of the potential that that has.

One of the issues is how we are going to measure the outcomes. Mr. Anderson, in your great testimony you talked about that you managed a 1.6 percent increase in organic matter over a 7 year period. What tools were you using to do that, and could all of you just spend a second after that talking about how you see measurement and what seems to be effective or what you think should be done?

I will start with Mr. Anderson.

Mr. ANDERSON. The tools we use to measure, to begin with our baseline data is rigorous soil testing data that we use on a zone sampling system across our fields. We are doing that on a regular basis which allows us to monitor organic matter as well as other nutrients.

The in-field practices that we were using in those fields primarily consisted of no-till, cover crops, and then growing highly-productive crops. For example, corn, that contributes in its very large root mass contributes a lot of organic matter and carbon sugars into the soil to build organic matter. Those are the primary three ways, cover crops, productive crops, no-tillage.

Ms. PINGREE. And I guess just to follow up and also ask anyone else who wants to answer this, one of the ideas in allowing farmers to benefit in a carbon market about the organic matter that they are retaining or increasing is how we have a universal tool that we can agree on to measure that.

Do you want to add anything else or does anyone else want to throw something in on that?

Dr. MEHTA. SHP is very involved with several carbon market and ecosystem services market developments, and exactly to your point, it is a way for us to monetize the work that our farmers are already doing.

We actually also developed our own carbon and setting framework. Just to highlight what Mr. Anderson just shared is creating these markets that take into account the fact that you have very different changes. What we are seeing in our 220 farms, even if you apply the same practices, the outcomes on organic matter are quite different, but it goes a little further than that.

When we start to look at depth, what is actually happening in terms of carbon sequestration that directly goes to greenhouse gas emissions, that is varying by soil type, by farm operation, and by

state. We continue to support the development of these, but we really advocate for using broader, more diverse input so you truly capture what all of our farmers are doing rather than having kind of over-sampled or selected of certain groups that are there.

We continue to encourage it and hope that we start to see more and more partnerships between our government and our private companies as these develop.

Ms. PINGREE. Yes. And do you see it as kind of a balance of measuring the inputs and practices along with the outputs?

Dr. MEHTA. Absolutely. And as much as we are pushing, and all of us here are pushing the edge quite frankly of what we know in soil science, even the last 9 months that I have been with SHP, what we thought we knew has actually changed and we have had to update our protocols already three or four times. What we continue to advocate for is more research.

I agree that the land-grants and extension have been underfunded, understaffed. These are long-term research goals and a lot of our partners have been cut, so the more we can do around what you just highlighted, the better we are going to actually be able to pinpoint the carbon savings and get that to our farmers.

Ms. PINGREE. Thanks. That is really helpful.

Anyone else want to add in?

Mr. CUNNINGHAM. Well, I would just like to say in 2004 I traveled to a conference in Des Moines and the idea was a private-sector carbon market, and I was very excited about it. But as it was explained, by the time all the middlemen and bankers and insurance companies got done with taking their cut, there was no money left for the farmer that was actually sequestering the carbon.

I adopted a theory that perhaps it is better to pay people to do things that have multiple benefits, carbon sequestration being one of them, rather than trying to insure and re-insure and quantify and measure and have the person actually doing the good thing see none of the financial benefit.

Ms. PINGREE. Great. Well, I am out of time, but you have outlined something that frequently happens to farmers, that they get the short end of the stick or not the money that they deserve.

But thank you all and your testimony has been great.

The CHAIR. The chair now recognizes Congresswoman Axne from Iowa, for 5 minutes.

Mrs. AXNE. Thank you, Madam Chair, and Ranking Member, and thank you to everybody on the panel for being here today, especially Mr. Anderson. Thank you.

And as Mr. Anderson so eloquently stated, Iowans are very connected to our soil, as many of you can imagine. Our agriculture communities unfortunately right now are struggling due to flooding as well as low-commodity prices from tariffs and uncertainty, and many of our constituents' livelihoods are really at stake from our agriculture industry, and we know that they are heavily intertwined with the soil health.

The crisis is clear. Iowa's *black gold,* if you have heard that term, is at risk, and we are losing our topsoil at an alarming rate of 5.5 tons per acre per year. According to the USDA Natural Resources Conservation Service, Iowa lost an average of 6.8″ of topsoil since 1850. If we don't find a way to conserve and preserve our soil,

farmers are going to pay the price first, and when Iowa farmers pay the price, the country pays the price and the world pays the price as well.

An estimated yield reduction is 10 bushels of corn per acre with the loss of this much topsoil, and in 2018 our Iowa farmers' average yield was 196 bushels per acre. There is no room for our farmers to lose 10 bushels more per acre.

And as a former employee at the Iowa Department of Natural Resources, I am personally familiar with the 2013 Iowa Nutrient Reduction Strategy. This strategy calls for 10 million acres of cover crops within 20 to 30 years to preserve the Mississippi River and improve water quality. But in the last report, Iowa had only 760,000 acres of cover crops or 7.6 percent of the way there in 2018.

I am grateful that you are all here today, and very grateful for Mr. Anderson's testimony today, and I want to recognize Nathan and his lovely wife, Sarah, and their son, and for being a Board Member of the Practical Farmers of Iowa. We are very appreciative of your voice, and as you have heard, he has been implementing conservation practices and educating people across our state as well.

Getting to my question here, one of the best indicators of healthy soil is organic matter, and Ms. Pingree just touched on that. But Mr. Anderson, you said in your testimony that you managed a 1.6 percent increase in organic matter in your soil over a 7 year period, and that is pretty remarkable.

I would like to take this a little bit further in a couple of questions. What financial benefits have you seen on your farm from implementing these conservation practices?

Mr. ANDERSON. Thank you for your kind comments as well. I appreciate those as a fellow Iowan.

The economic rewards from those practices first and foremost are increased yield. We have been able to see a stability in yield throughout years of drought and heavier rainfall. Due to our soil conditions, soil landscape positions, as was commented earlier there is a wide variety in changes that occur, but as a collective farm throughout the operation, we are able to see those benefits across the operation.

Primarily in our grazing system, extending the grazing season so our costs for our livestock operation are decreased by having more feed available for them has also been a significant economic benefit for us.

Mrs. AXNE. Thank you so much.

And part of your work for Practical Farmers has been educating and helping other farmers. What are some of the barriers that you have seen from your neighbors from starting or maintaining some of these conservation practices?

Mr. ANDERSON. One challenging barrier that exists in Iowa and throughout rural America is just an access to labor. A number of these practices require labor and management, and for a large number of rural crop farms that is very difficult to find and difficult to hold on to throughout the season.

As I mentioned earlier, it is a great opportunity for beginning farmers and rural entrepreneurs to fill in that area, but that has definitely been a challenge.

And one of the other ways that we are making progress in is farmer-to-farmer learning. One of the top ways that farmers implement changes is by learning from other farmers, and one of the other top ways is by doing it themselves on their own farm. The more that we can accomplish those two things, the more success we will have.

Mrs. AXNE. I appreciate that.

I ask the whole panel, overall why do you think more farmers aren't cover cropping, especially if the return on the investment is high financially and ecologically? And I would offer that to anybody.

Mr. CUNNINGHAM. Mrs. Axne, I believe that farmers are very proud in what they do and they really believe that what they are doing is the very best way to do it or otherwise they wouldn't be doing it that way. Quite often we see field days where we have hundreds of people attend, and one generation gets pretty excited about doing some soil health things and the—and perhaps the generation that has been used to doing it another way and is doing it at the very best way in their own mind has a hard time changing.

I spoke at a field day with another producer from a nearby county and it was a father and son and the son had come back from college and was excited about soil health and had actually worked as a student intern with one of the top researchers in the country, and they had a hundred acres and the grandfather had a hundred acres. The grandfather said, "I want you to farm my land the way I have always farmed it, but you can do whatever you want on your own land." And after 1 year the grandfather came to them and said, "I want you to farm my land like you are farming your land." Now if they had forced it on the grandfather he probably would have said no way, but by seeing the success that his son and grandson had had, he decided that he would like his land farmed that way too.

Dr. MEHTA. Very quickly. What we are seeing as we ask our farmers, and we have a lot of field days and the question persists, in this climate what would it take for you to adopt cover crops, no-till, and broader, and what they are coming back with is, remember, we have 40 shots in our lifetime to get it right. Every time we change our system we have to ride the risk, and given what is happening in the climate we are trying to balance all of the additional risks that we know and don't know with new practices.

It is not that they are not looking at the cover crops. They are looking holistically and saying, "What happens if, I was just in Nebraska, we have another flood like this? What happens if I can't actually make my combine payment for this year?" And so they are essentially saying, "If I holistically look at my business case, if I inject something like a cover crop or switch to a no-till will my system be able to handle that additional risk?" Again, the more we can do to de-risk it, the easier it is for them to adopt.

The CHAIR. Thank you. The chair now recognizes Ranking Member LaMalfa, for 5 minutes.

Mr. LAMALFA. Thank you again, Madam Chair. I apologize for having to step out in the hallway for a meeting that was brought to me here, so I do appreciate all the panel here again for your time and long-distance travel to be here.

Mr. Anderson, I enjoyed your comments and the deep thought a while ago about 10 years after what kind of mark had we made, and that is something I think about around here too as far as what is it that we have gotten done. And then somewhere a few seconds after I said something about manure applications and hopefully nothing new to that around here, but thank you.

Ms. Douglass, again, great to have you here. You had mentioned in the goal we have towards better soil practices and such that the implementation of a California HSP, which is it looks like just a few years old here, you said the claim is 329 projects so far have been funded and put into place and some of the things you are looking at are more flexibility within that program and then that they don't conflict with other desired needs such as FSMA.

Could you elaborate a little bit more on—and my thought was do those 329 projects seem like they are reaching the goal for as large as California is and for as long as the program has been around? And then a little bit more on some of those barriers, for example, with your own operation of why you have gone on yourself and done some of the work but you didn't avail yourself of some of the grants that were available to maybe take it to a higher space? Please elaborate on that.

Ms. DOUGLASS. Yes. The first part of that being the Healthy Soils Program in California, and we are a big state so there is definitely more work to be done, and I know there were some challenges with that program as far as the outreach that CDFA was needing to do to try to get people to apply. And as a grower you had to go to an informational session and learn how to work the software and go online and how to figure that out. And then it was just a very cumbersome time-consuming process——

Mr. LAMALFA. That takes everybody over 60 out, right?

Ms. DOUGLASS. It was very complicated. The workshop alone was 3 hours or maybe 4, and we just opted not to do it and instead start doing the investments ourselves on a smaller scale, where we might have done it on a larger scale if it was a more simplified process.

They just did the third round, which is the one they just announced, so it is a pretty fresh program, and I know this time they simplified it for growers. We don't really have any extra time happening at my household these days, so we did not attempt to apply the second——

Mr. LAMALFA. Coming into the third round they have done things to simplify it?

Ms. DOUGLASS. Yes. My understanding is that this last round they have. I have not seen those, like I said, for ourselves, but I can tell you the first round, that was why they had not nearly as much participation as they would have liked in that first one, because we need it to be simple and efficient.

Mr. LAMALFA. And so the Federal nexus with us here today, how does that aid in what you are talking about with that program?

Ms. DOUGLASS. They are two very different programs. I can tell you that in our local county the NRCS programs are working very well. We are very fortunate to have had a regional agronomist with NRCS that was invaluable. And as you talked about staffing earlier, I know our local NRCS Office would state that that was such a critical component, because having a regional agronomist they were able to work with a technical advisory committee and make sure that they were working with the farmers, with the local seed suppliers, to find simple options that would work and make sure that the NRCS recommendation for seeds to be planted as cover crops were available for purchase locally and easily. And I know that has helped us and I believe that is a big part of why we have led the state. Our county anyhow has led the state in terms of the acres.

Mr. LAMALFA. Those two were well and parallel, not like some of the concerns you were having in your third concern a while ago with conflict like on FSMA? The NRCS is working? They are parallel goals?

Ms. DOUGLASS. Yes and no. The FSMA concern is still a new one. It is going to be very important, because in California how we are using the cover crops is a bit differently. We are generally not grazing those cover crops, and the reason we can't graze those cover crops is many parts. We just farm a little differently, of course.

But one of the issues in FSMA is making sure that you do not have any animal manure, for example, in your fields, and that is really challenging to do. And if you are planting a cover crop and you are bringing in the bees and the butterflies and the ladybugs, that is all wonderful. You are also bringing in the deer and deer are a known *E coli.* carrier. And there is some concern that we are doing this great practice, we are happy to do it, but if we are attracting deer and therefore attracting the manure that comes with them, that could be a real problem at the intersection of food safety and soil health practices. We would really like those to be able to work together because it is such an important issue, but that is a concern for many of our growers, in particular for the orchards.

Mr. LAMALFA. Yes. Thank you.

We need to lock some of these people in the same room and get this worked out because that manure application used to be looked at as a pretty good thing even on our own rice fields in the past, so yes. That has to be sorted out.

Thank you, Madam Chair. I yield back.

The CHAIR. The chair now recognizes Mr. O'Halleran from Arizona.

Mr. O'HALLERAN. Thank you, Madam Chair, and Ranking Member for scheduling this bipartisan hearing on soil health and its conservation and economic benefits. I want to thank the panel for being here also today.

This issue is very important to farmers and ranchers across my district. Practices for maintaining good soil health can help tackle drought and production. According to the USDA's recent report entitled, *Cover Crop Economics: Opportunities to Improve Your Bottom Line in Row Crops,* the use of cover crops can improve soil moisture and holding capacity. The same report demonstrated that cover crop usage can help increase yields for farmers. One year

after using cover crops, farmers experienced an average increase of ½ percent for corn and 2.1 percent for soybeans.

These practices can also produce cost-effective results and help conserve the environment.

Mr. Cunningham, from your perspective what kind of financial and technical support is most necessary and effective to support farmers taking on cover crops?

Mr. CUNNINGHAM. Well, I believe the first step is always having someone who is an expert to have a conversation with, and when you go to the local service center and the NRCS person is either not in or covering several counties, that is a barrier.

We are fortunate in Minnesota to have robust soil and water conservation districts. Quite often we know the NRCS programs and are able to have that conversation, but to actually get it done, we need people on the ground.

From 2010 to 2017, NRCS staffing in Minnesota fell from 419 to 243, and I believe that it has accelerated since then and we do have some new positions being hired, but they are new unless they were able to headhunt soil and water conservation district people that have experience in the conservation field. I believe the pendulum is starting to swing in the right way about having that technical assistance.

Then there is also the EQIP Program. There is the CSP Program and there are opportunities perhaps with growing some cover crops that are beneficial to pollinators. I am not sure exactly where those programs would fit in, but we do have tools. Quite often our—we just had a EQIP signup for cover crops on preventative planning in Minnesota, and within a very short period of time they had twice the applications that they had the money for.

There is a great need out there. There is a great interest, but as Dr. Mehta said that we need to insulate that transition time with some financial incentives.

Mr. O'HALLERAN. Thank you.

Mr. Ellis, you spoke about the importance of developing a grazing plan so that producers can successfully manage multiple elements in unison.

What are the essential components of a grazing plan? Is there a role for USDA in supporting the development of these plans?

Mr. ELLIS. Yes, sir. The key component and the number one component of a grazing plan is really the stocking rate. That is the number one and it is the hardest for producers to come up with. That technical assistance, that boots-on-the-ground, is critical. I would say that not only do we need more employees but we need processes for those employees who are out in the field helping us and help empower those producers.

The grazing plan also kind of helps. We need to know where we are today and kind of set that baseline and that monitoring and help those producers be able to kind of see where they are and track, as well as track the weather and all these other components to their operation to move forward to be successful in their grazing management.

Mr. O'HALLERAN. Thank you very much.

I guess what I have heard today so far is that we don't have enough technical people, we don't have enough funding from my

perspective to have those technical people, the educational part of it is complicated and in need of a review, and Madam Chair, with that I yield back.

The CHAIR. Thank you very much.

The chair now recognizes Mr. Allen from Georgia.

Mr. ALLEN. Thank you, Chairwoman, and thank you panel for being with us today.

Georgia is the home to one of the top public universities, the University of Georgia. Also being a land-grant university, the College of Agriculture and Environmental Sciences is a leader in research and extension. The Department of Crop and Soil Sciences currently has a number of soil health programs that address soil conservation, economically- and ecologically-sound agricultural production, as well as maintenance and long-term enhancement of soil health. Many of these programs are supported through state, industry, and USDA funding.

We have talked about expertise and where do we get this expertise. And my question really to anyone on the panel and all of you who want to comment on this is, could you talk about the important role of land-grant universities and the role they play in research and technology and innovation, especially as it relates to soil health? And can you provide an example of when your organization has worked with a university or utilized their services to better serve your local farmers, ranchers, and communities?

And I will just open that up. We will just start here and go down the line.

Dr. MEHTA. Oh, we are lucky we are in over 15 states and we work with the land-grant in every single state we are in, but we get to do something extra. We work with a lot of the land-grants that are in your state, partly because of the reason you said.

Everyone has a strength and we bring in as much as we can. We have seen some of the passion that has come from our researchers. It has been extensive.

We talked about the funding cuts that are affecting NRCS in technical. We are experiencing them on the university side, so since they are going to be going through that at the state level, some of the programs that have maybe been there for a longer time are being affected. There is a lot of variability, so what we are trying to do is manage across them.

What I would say is first of all you have a young, excited, passionate generation. I have seen ag schools across the country, starting to see a lift. It is wonderful for me as a much older alumni.

Land extension is extremely powerful, but again, does need support in funding, a lot of times directed support from state level.

And then the other piece is some of the targeting around research. We have effective research coming through on cover crops, perennials for example. Almost all of your states have something on the cover crop side. The challenge we have is how do you translate that so it is usable, and that is where we are kind of missing a gap on the research end.

If we can really help support the land-grants and get that through, but they are one of our most effective partners.

And we continue to have that.

Mr. ALLEN. Mr. Anderson, and allow time for the others. I have 2 minutes and 18 seconds.

Mr. ANDERSON. Okay. Quickly, the role of the land-grant in soil health we are fortunate in the State of Iowa to have Iowa State University, and the role that they play in agriculture across the state is tremendous. We are fortunate with the Wallace Chair, Matt Liebman, who conducts soils based and cropping systems research in diverse cropping systems, which is really critical to apply across a wide range of geographies.

It is difficult because we are working with very complex biological systems and across wide geographies. It is difficult to get good data that is repeatable. It is important that we have that data and then the real world application of that information.

Mr. CUNNINGHAM. Well, I had an experience with a cow-calf production day and the person expert from the university was speaking about cover crops, and he said, "Well, make sure that you grow something that there won't be refusal and waste." And I thought, "Well, but you don't want bare soil, bare soil is a bad thing." And he said, "But it will plug up your field cultivator." I said, "You don't need to use your field cultivator." There is a little bit of gap between the book learning that perhaps a university setting may have and experiment station research and what is going on in the real world.

Mr. ALLEN. Maybe you need to teach college.

Mr. CUNNINGHAM. I have been asked to speak at the University of Minnesota and North Dakota State.

Mr. ALLEN. I understand that, yes.

Mr. CUNNINGHAM. Yes.

Mr. ALLEN. Yes, ma'am.

Ms. DOUGLASS. I will give you a little bit of a different angle on the colleges, and I think that they are providing some great work and doing great things, but in California for example, well, nationwide actually we have two jobs for every graduate in agriculture coming out of an agricultural college nationwide.

In California if you look at crop science, soil science, agronomy-related issues, we have 4.6 job opportunities for every one of those grads coming out of school in California.

Mr. ALLEN. Wow. That is great.

Ms. DOUGLASS. We need more of them and that is probably one of the challenges that our NRCS Offices in particular have had is finding people who are experts in soil health that have this agricultural background, and I think that is an important area to note.

Mr. ALLEN. Okay. Mr. Ellis, we have 16 seconds.

Mr. ELLIS. Yes, sir. Yes, we cherish our relationships with Oklahoma State University and Extension. They are extremely important.

I will add one point that wasn't stated that is very important, is the 4–H Program.

It is really about going into that youth and starting from that ground level from our future farmers and ranchers.

Mr. ALLEN. Right. Thank you so much and I yield back.

The CHAIR. Thank you so much, Mr. Allen.

We would love to pursue a couple more questions. I know some of our participants and witnesses today do have a hard stop, so I

am going to be mindful of time, but I invite anyone who would like to ask a second question to do so.

Mr. ALLEN. Yes, I had one other one that I just wanted an answer to this question right here that was brought to my attention. Cattle graze on nearly ⅓ of our continental United States land mass providing an economic driver to maintain those important grasslands across the country. However, some people think that the grasslands should be maintained without cattle, failing to understand the environmental value of grazing. What are the benefits of having cattle graze our rangeland as opposed to leaving it ungrazed? Could you answer that question?

Mr. ELLIS. Yes, sir.

So, when we think about our plains, they evolved around two key components. One is grazing and the other is fire. We had the buffalo grazing and as well as these fires, and so our grasses in our native rangelands really function around that, and so that is one of the things that hurts us is that when we don't graze, we are hurting and setting back these plants and the environment that grew around it in this ecological process.

You can kind of think about it from an aspect in that leaves are basically solar panels.

They are taking that energy from that sunlight, bringing that energy back into the root system.

When we are not grazing, we are starting to get descent plants and not green, growing, healthy plants and so that hurts us in the long-term. Proper grazing is essential as well as our prescribed fires in the plains.

Mr. ALLEN. Why are we having the debate on grazed *versus* ungrazed?

Mr. ELLIS. I think, sir, is that some of us have a conservation-minded, which is having that conservation in mind, is really grazing and the proper management and land stewardship and this land stewardship ethic, and then there is another side of us that look at preservation.

Mr. ALLEN. Yes.

Mr. ELLIS. That we are better off to set it aside and let it work naturally, but when we think about the aspect again is grazing and fire, that is how the landscapes were formed, in that aspect and that process. By removing it we are not really doing good by that preservation mindset. It is all about conservation.

Mr. ALLEN. Anyone else like to comment on that?

Mr. CUNNINGHAM. Well, my neighbors sometimes wonder why we are not using that pasture. We have a 20 paddock system so our cattle are in an individual paddock, much less in it than out of it, and the same thing goes with a lot of range systems that may be grazed 2 or 3 days out of the year and then have 400 days of rest. They look at these beautiful diverse wildflowers and all this stuff and go, well, there is no cattle there. Well, the cattle were there and that is why it looks as nice as it is. It is a disconnect of people not knowing about natural systems, but large herbivores are a very necessary and beneficial component of perennial systems that include plants.

Mr. ALLEN. Is it a seasonal thing?

Mr. CUNNINGHAM. Well, it is a management thing.

Mr. ALLEN. Right.

Mr. CUNNINGHAM. We want to graze intensively and provide a long rest.

Mr. ALLEN. Any other comments? Okay.

Thank you. I yield back.

The CHAIR. Thank you. For the next 5 minutes I recognize myself and then I will proceed back into the order we were using before so Members are prepared.

Mr. ALLEN. I'm sorry.

The CHAIR. That is okay.

Soil health and water quality are inextricably linked. My constituents and I have seen firsthand with this with the Chesapeake Bay, and because of this we have seen partnerships that include farmers, agribusiness, environmentalists, sportsmen, homeowners, and others, folks who come together around a shared goal of the Chesapeake Bay's health. I thought of that motto when I read about the Soil Health Partnership.

Dr. Mehta, can you talk with us about any lessons learned about these outcomes focused on collaboration as the Soil Health Partnership has grown? Any words of wisdom that you may have for others?

Dr. MEHTA. Thank you. That is a great question and the Chesapeake Bay has absolutely been a role model for many of us.

Collaborations are extremely powerful, especially in agriculture and environmental issues. A couple of items: First, it takes investment and time to truly mobilize a group. It is not easy but it is worth it, especially when you have a group with different objectives and cultures.

There are five areas that really help drive a successful collaboration and the Chesapeake Bay was an example we see with HSP and others.

One, defining your shared objective up front, establishing boundaries and working norms, identifying intermediate or tangible goals, getting some early wins. A lot of us were in it. These are long-term outcomes, so being able to really produce some quick ones, and again the folks on the panel have identified some. Continuing to make sure that the overall end goal is not lost so that a collaboration has an actual high-impact flowrate of success.

And the last kind of word of advice is don't shy away from unlikely partners. The fact that the Environmental Defense Fund, The Nature Conservancy, Monsanto and the Corn Growers came together to do SHP says, and it is one of the most impactful cross-sector programs I have seen, is sometimes having the most differing diverse opinions and perspectives actually produces some of the most impeccable collaborations.

The CHAIR. Thank you very much.

The chair now recognizes Mr. LaMalfa for an additional 5 minutes.

Mr. LAMALFA. Well, thank you again.

I just wanted to follow up, Shannon, on our previous thoughts. I don't know if I left you the time on there about those 329 projects in California. Do you feel like that is keeping par with the potential for the amount of time it has been in place? Is it where it should be or is it behind because you felt the difficulty with accessing it?

Ms. DOUGLASS. I don't know how the CDFA staff feels about where they are and what their goals exactly were. I know that early on at least they were behind based on they had opened an additional round of funding within a year. They would still like to see more projects and part of that is it is, number one, a new program. It is a unique application process.

Like I said, it was a bit cumbersome. I know they worked on streamlining that, so there is more to go. There are still some barriers and of course we are using cover crops but differently in California, like I mentioned before. For example, our neighbors with orchards when they are putting cover crops in those orchards it is going to be a little different to plant those than it would be for our friends in the Midwest. And so they don't always necessarily have that equipment still, because once you have gone to trees you don't necessarily have much need for some of those planters.

And so there are some of those barriers and I think that the Healthy Soils Program is helping with some of that, and hopefully we see increased adoption as a result of those efforts.

Mr. LAMALFA. Okay. Would you want to touch on real quickly your work in CalAgJobs to branch out?

Ms. DOUGLASS. Yes. I do work off-farm where I help recruit people into agricultural roles. I am co-owner of a business that promotes agricultural career opportunities and then does some actual headhunting, so to speak, of those roles. When we talk about the shortage of candidates for some of these roles, I know very firsthand how critical that is, particularly in California.

Mr. LAMALFA. Yes. We need more people that know how to access all that technical stuff to sign up for the program, right?

Ms. DOUGLASS. We do. We need them to know all that and all the agronomics with it.

Mr. LAMALFA. All right. Thank you.

Chad Ellis, returning to the cattle grazing and the benefits *versus* some folks' concern about it being not beneficial on rangelands, on grasslands.

Now, where I come from in northern California, you probably worry about prairie fires, and we worry a lot about forest fires and such, and then there are a lot of areas where the foothills meet the forest, so you have that integration of grasslands and sparse forests and then getting into dense forests.

Talk to me a little bit, please, the panel, please, about more of the benefits of cattle grazing. Now, again, we have in the flatland areas we will have wetlands, we will have certain types of meadowfoam is one of the, is a species out in California there is a lot of concern about. There is the debate between cattle grazing, is it actually making it better for some of these native grasses and native species to grow well *versus* not. And so talk about that, please, in fire suppression and in terms of the native species that we are actually trying to preserve.

Mr. ELLIS. One thing is that when we are thinking about grazing we need to be intentional on how we graze, and that is the key component of the Grazing Management Plan of actually planning and utilizing the livestock as a tool. Depending on your goals and objectives, depending on a particular invasive species or from plant

or animal, we can basically prescribe that grazing to meet the goals and the habitat for those animals.

I think that is a key component is that it is being intentional, it is being used as a management tool to move forward to help the overall plan.

And, fire ends up being, depending on the area and where you are at, becomes a very useful tool integrated within that grazing in that it helps, one, mitigate some of the wildfire issues, it helps re-strengthen and have that new growth of plants and forages for that grazing opportunity.

Mr. LAMALFA. Well, if all we suffer is wildfire out there, there are ranchers that graze right up to a fence line. You can see where fires occurred.

Mr. ELLIS. Yes.

Mr. LAMALFA. Fire stops at the fence line, and so we have folks that are in different areas of government that are thinking about doing some pilot programs to see how grazing could help suppress fires, like, well, welcome aboard.

But let us just keep going I guess, so anything more on cattle being a tillage tool, like when we are talking the meadowfoam again? The cattle out working the soil, my understanding is actually helpful to make meadowfoam and some of these other species grow back.

Mr. ELLIS. In that grazing management we can increase the stock density to kind of help utilize that hoof action to draw some of that tillage and some of those things, and again it is to meet those goals and objective. But cattle are a great tool. Aldo Leopold, Father of Conservation said that cattle, fire, the axe were those key components and tools for conservation that he set forth.

Mr. LAMALFA. It is having a prescription really, not overdoing it, not underdoing it?

Mr. ELLIS. Correct. Yes, sir.

Mr. LAMALFA. Thank you, Madam Chair.

The CHAIR. Thank you.

The Chair now recognizes Congresswoman Pingree from Maine.

Ms. PINGREE. Thank you.

I know we are getting to the end here, so I will try to speed up my time, but I do want to say I love that term *hoof action.* I don't think I have heard that before, but kind of picture cows dancing in the fields, till it up a little bit.

You have all done such a good job of talking about how this has benefitted you and other farmers, but it is consistent that you talk a little bit about the need to de-risk, whether it is more funding, technical assistance. We have talked about some of that, but I am interested if I could just get each of you to quickly answer the question, like what are the things that we should put most of our focus on, given that there are all kinds of benefits to this in general, in terms of preventing soil loss and carbon sequestration, nutrient management around watersheds? I mean, there are a lot of reasons this should be important.

Where should our focus be? The funding opportunities to help people get through the challenges of not having the right equipment or making that leap when it is difficult? And also on the de-

risking side, are we doing enough to tie our conservation programs to these practices incentivizing farmers?

Mr. Cunningham, you mentioned crop insurance and you didn't need it, so should we be doing more on the crop insurance side to kind of de-risk crop insurance a little by requiring these practices be coupled with that?

I will stop talking and if each of you have something to say, I am happy to hear it.

Mr. CUNNINGHAM. Well, I guess while we are talking about crop insurance, as you recall in my testimony, fall of 2018 was extremely wet. We went into the freeze-up time saturated. A lot of ground didn't get planted. Our ground that did get planted got planted late. I had the crop insurance adjustor out to look at the places that just wasn't physically possible to plant by the final planting date, and the field that I had terminated and had dead material on it, took a picture of that, and he was quite happy. And we went over to another field where it was intended for corn and the cover crop had not been terminated yet and he says, "Well, I am nervous taking a picture of this because you got all this stuff growing out here." And I said, "Well, now that is a cover crop. It was planted in November. If it was going to be a cash crop or a seed or a grain crop I would have managed it much differently." He thought someone at the company might not like the looks of this.

But I believe crop insurance has come a long way. There was a time a few years ago where I had grazed a winter annual cover crop in the spring with some cattle and I was denied coverage because it was considered something I shouldn't do, and unfortunately that portion of the field was not able to be included in my production history and it yielded ten percent more than the rest of the field did just by the benefit of grazing.

Ms. PINGREE. Thanks. Anybody else want to weigh in?

Mr. ANDERSON. A couple thoughts. The State of Iowa has a pilot program to offer crop insurance premium discounts to farmers who have implemented cover crop practices on their farm and then certified those cover crop acres with their local USDA FSA Office. Those acres are then verified and that discount is then applied to the crop insurance premium for that crop. That is an excellent way that the crop insurance program with a state program is recognizing some of those benefits.

The one recommendation that I would have is for cost-share programs that are implementing these soil health practices, to be distributed over a period of years it allows that farmer, landowner, or farm manager the ability to learn with that cover crop, reduce the risk in those first few years as they learn, and include an education and networking component as part of that cost-share, because again, farmers learn well from other farmers.

Ms. PINGREE. Yes.

Ms. DOUGLASS. I would add that the flexibility in the programs is important and I think that making sure these decisions are able to be made on a local level because, as you've heard, there is so much difference not only state to state, but within the regions.

I also think that the research component is still very important because there it is not like there is one recipe for cover crops, there is one mix. There are many, many varieties and mixes that we are

choosing from to try to figure out what is going to work best on our farm and with our cropping system.

And then also that continued research into where food safety and these cover crops intersect. That is going to be hugely important in California and we could have a whole lot of acres utilized if we are confident in what that looks like.

Ms. PINGREE. That is great.

Mr. ELLIS. I would add that a free market approach to some of these that can kind of parallel and work together with our Federal funding, beyond just carbon markets, but water quality, water quantity, all of these other ecosystem services that all of us on this panel are working really hard from our land stewardship perspective and what we are producing on our properties.

And the other key is really technology, thinking of it from a technology, from new sensor technologies, other things that can help develop some decision supports for decision tools for the producer to help mitigate some of that risk.

Ms. PINGREE. Great.

The CHAIR. Thank you.

The chair now recognizes Mrs. Axne.

Mrs. AXNE. In 1990 small- and medium-sized farms accounted for nearly ½ of all agriculture production in the U.S. and today they make up less than ¼ of that production. And nobody knows better how to protect their soil than our actual small- to mid-sized farmers and I truly believe that, but I have concerns about large industrial farming, making a profit off our soil fertility and of course contributing to the problems with our waterways as well.

My question to the panel is, are we doing enough to ensure that large industrial farmers are participating in conservation efforts?

Dr. MEHTA. We do have a few farmers in our network who would fit that definition and it has been interesting because we keep asking this question, why are you here and your counterparts are not. And so based on their responses I would say we are not doing enough, because largely the incentives, if we think of the spectrum of farmers, the self-selected spectrum that tends to show up, again the folks that are sitting here, it is this particular group that has a particular connection to the land and has a certain size. You are not necessarily going to see the benefits of some of these programs if you are in some of those larger buckets.

And being able to expand the flexibility and to take into account what are the specific needs and nuances, that could incentivize those programs. The other piece is really using the other lever of the free market mechanisms because they might respond more heavily to market-based mechanisms than government. Those two in tandem could be quite effective.

And I think that is where we are seeing, at least on our end, why some of them are signing up for our network is we have a 5 year program. We offer a much longer length of time to be with us, so at least they say, "Well, we see the improvement and we see that there are certain benefits that we couldn't get if we had gone through a government program."

There is a great space there and that is a great question, because if we could tackle it we would have a major impact on our land.

Ms. DOUGLASS. It is really important to look at making sure farmers of all scales are considering these practices, and for some of the larger farms it is probably going to be economics that get them to consider these.

I can tell you that the outreach in California was generally focused on smaller farmers, and that is great for the educational purposes, but when we talk about trying to get more acres and if you are interested in things like carbon sequestration, for example, those are the farmers we really need to bring onboard to have more impact. I think that, hopefully, it is going to be economics that really do that and get them onboard.

I haven't seen really strong data though on who is picking them up and who is not. I mean, I know obviously what cross-sector most of us seem to represent, but it is important that all shapes and sizes are represented so that we all get the benefit.

Mrs. AXNE. Thank you.

The CHAIR. Thank you very much to our witnesses for being here today. Thank you to Ranking Member LaMalfa and to our other Members for participating in this hearing.

We have heard about the benefits of soil health management for producers and for the rest of our communities.

We have heard about the financial and technical costs for adopting them at scale, which we know is necessary.

We have work to do and the job before us is a serious one. The good news is we are in this together and we see strong results, and so thank you very much for participating and telling us about your experiences, your research, and your knowledge base.

I thank you all for being here, and under the Rules of the Committee, the record of today's hearing will remain open for 10 calendar days to receive additional material and supplementary written responses from the witnesses to any question posed by a Member.

This hearing of the Subcommittee on Conservation and Forestry is adjourned.

Thank you.

[Whereupon, at 11:33 a.m., the Subcommittee was adjourned.]

[Material submitted for inclusion in the record follows:]

SUBMITTED REPORT BY HON. ABIGAIL DAVIS SPANBERGER, A REPRESENTATIVE IN CONGRESS FROM VIRGINIA

Sustainable Agriculture Research and Education (SARE)

Ag Innovations Series Technical Bulletin

Peer-reviewed research findings and practical strategies for advancing sustainable agriculture systems

Cereal rye is the most widely planted cover crop in the United States, being used on several million acres for erosion control, weed suppression and soil improvement. *Photo by Edwin Remsberg.*

Cover Crop Economics

Opportunities to Improve Your Bottom Line in Row Crops

June 2019

Contents

Available at: *www.sare.org/cover-cropeconomics*, or order free hard copies at (301) 779–1007.

When it comes to making the big decisions about managing a farm, whether it's to grow a new crop, buy an expensive piece of equipment or upgrade infrastructure, farmers are business people first. If the idea doesn't work out on paper, either by cutting costs or raising revenue, then it likely won't happen.

With the decision to adopt cover crops, a conservation practice that is becoming increasingly popular throughout the country, the economic picture can admittedly be hard to decipher at first. This is because a simple, 1 year budget analysis of cover crops, one that just compares the cost of seed and seeding to the impact on the next crop yield, may indeed show a loss.

Yet most farmers who have long-term experience with cover crops and who carefully keep their books have discovered that cover crops do in fact pay. These farmers usually look at cover crops from the broad, holistic standpoint of how they will improve the efficiency and resiliency of the entire farm over time.

"Look at cover crops as an investment rather than a cost," advises Justin Zahradka, who farms 900 acres in North Dakota and has been planting cover crops since 2011. Cover crops allow Zahradka to extend the grazing season for his livestock, grow his soil's organic matter and maintain more consistent yields in wet or dry years.

Or, as he puts it, cover crops help him "be more productive on each acre." (Zahradka's farm is profiled later in this bulletin.)

Cover crop acreage increased 50% nationally from 2012 to 2017.
(USDA Census of Agriculture)

Tennessee farmer Ray Sneed plants a five-species cover crop mix to accomplish multiple management goals, in particular to control weeds and improve irrigation efficiency. *Photo by Pete Nelson, AgLaunch Initiative.*

Every business-savvy farmer knows that some purchases cannot be evaluated solely on their first-year financial impact. Buying new farm machinery or applying lime to acidic soils are typical examples of purchases that come with longer payback periods. Similarly, crop insurance seldom pays for itself the year it is bought. In the same manner, because cover crops gradually improve soil health and the productivity of fields, their economic value is best understood over a multi-year period.

Under circumstances where cover crops are the only change made to farm management, it can take a few years for cover crops to fully pay for themselves. But, as farmers gain experience and expand the number of fields that are cover cropped, they find a variety of ways to accelerate the return on their investment. In some situations, cover crops can provide a positive return in the first year or 2 of use.

This bulletin will describe seven specific situations in which the profitability of cover crops can be accelerated. These situations reflect both common production challenges that row crop farmers face (for example, herbicide-resistant weeds) and opportunities (for example, the transition to no-till). Much of the baseline economic information that underlies the financial analysis of these situations derives from 5 years of data from the National Cover Crop Survey conducted by SARE and the Conservation Technology Information Center (CTIC) for the 2012–2016 growing seasons. Farmer profiles share real-world examples of how the multifaceted benefits of cover crops translate into profitability.

Three key takeaways on cover crop economics have become clear through our analysis:

1. A thorough evaluation of cover crop economics looks at the overall changes farmers typically make to crop management over a multi-year period of using cover crops. Farmers who are most satisfied with their return on investment take a holistic look at how they manage their overall cropping system and often make a suite of changes that improve overall efficiency, rather than alter just one practice (such as planting a cover crop).
2. In most cases, farmers need to use a multi-year timeline to evaluate the return from cover crops, much as they would for applying lime or buying equipment. While an economic return can come relatively quickly in certain situations, such as when using cover crops for grazing or to control herbicide-resistant weeds, the maximum return will build steadily over several years as the soil improves and as the farmer gains experience incorporating cover crops into their overall system.
3. One of the most-often-cited economic benefits of cover crops by experienced users is their impact on the resiliency of the cropping system. Farmers are finding that by helping to minimize drought-related yield losses or sometimes allowing earlier planting in a wet spring, cover crops serve as a type of crop insurance. As with ordinary crop insurance, the premium you pay for cover crops will pay off big in some years, but not every year.

How to Get a Faster Return from Cover Crops

When evaluating average fields in average weather conditions, it can take 3 or more years for cover crops to pay off if no incentive payments are obtained and no special circumstances exist. However, every farmer has their own challenges and opportunities that can affect this picture. Therefore, when evaluating the economics of cover crops, it can be helpful to consider common situations or scenarios under which they will pay for themselves more quickly, often within a year or 2. Seven situations in which cover crop profits are accelerated are listed here and then described in more detail in a later section of this bulletin.

Cover crops can pay their way more quickly when:

1. Herbicide-resistant weeds are a problem
2. Cover crops are grazed
3. Soil compaction is an issue
4. Cover crops are used to speed up and ease the transition to no-till
5. Soil moisture is at a deficit or irrigation is needed
6. Fertilizer costs are high or manure nutrients need to be sequestered
7. Incentive payments are received for using cover crops

Many farmers may experience more than one of these situations. Cover crops will quickly pay off when two or more of these situations occur together. The farmers profiled in this bulletin reflect this view that cover crops are most profitable when they provide benefits in multiple areas.

For example, Tennessee farmer Ray Sneed plants a five-species cover crop mix with multiple goals in mind. “Each species has a job, and those jobs are based on where I have problems,” says Sneed, who farms 10,000 acres of corn, soybeans, wheat and cotton.

His mix includes tillage radishes, crimson clover, wheat, cereal rye and turnips. Their primary jobs are to scavenge nutrients, alleviate compaction, improve water infiltration and suppress weeds. After 6 years of cover cropping, Sneed is saving money by using less irrigation water, fertilizer and herbicide. “We’re learning that we can use some of these species to offset the costs of growing our crops,” he says.

Before getting into the detailed economics of these seven situations, the first step in this bulletin is to summarize some baseline data on cover crop yield impacts and to outline assumptions on cover crop costs and returns. These numbers will provide a baseline for the seven specific situations in which cover crops can provide a reasonably fast economic return.

How Do Cover Crops Impact Yield Over Time?

Almost any farmer with several years of cover crop experience will report that they have seen improvements in both the soil and crop performance over time. “You will have a cost savings if you stay with it,” Sneed says. To better understand how

the number of years spent planting a cover crop impacts crop yield, data was collected from farmers responding to the SARE/CTIC National Cover Crop Survey.[1] Farmers who planted cover crops on some fields but not on others, and who otherwise managed those fields similarly, were asked to report on respective yields (*Table 1*). Though not all farmers had comparable fields with and without covers to report on, there were still several hundred farmers who provided yield data each year. The biggest yield differences were reported after the drought year of 2012, with average reported yield increases of 9.6% in corn and 11.6% in soybeans. Based on the high corn and soybean prices following the 2012 drought year, cover crops provided a helpful profit boost that year.

Table 1. **Percent increase in yield for corn and soybeans following cover crops *versus* comparably managed fields with no cover crops[1]**

Crop Year	Corn	Soybeans
2012	9.6%	11.6%
2013	3.1%	4.3%
2014	2.1%	4.2%
2015	1.9%	2.8%
2016	1.3%	3.8%

[1] Data is from the SARE/CTIC National Cover Crop Surveys conducted annually for crop years 2012–2016.

It is important to point out that although the several hundred farms reporting data represent a good-sized data set, these were self-reported numbers. Also, it was clear that yields from field to field varied, with a few fields having yield losses after cover crops and with some fields showing no difference. Many farmers reported a yield increase on their fields, but individual experiences varied. While the SARE/CTIC survey data set is by far the largest set available on cover crop yield impacts, it is worth noting that other cover crop studies have reported a range of yield impacts, from minor losses to minor increases in corn yields. For soybeans, some studies have shown that yields are unchanged with cover crops, while others have shown a modest improvement in yields. Fewer data reports are available on the yield impact of cover crops on other cash crops.

Crimson clover is the most popular legume cover crop in the United States. Photo by Rob Myers, North Central SARE.

[1] The National Cover Crop Survey was conducted for 5 years covering the 2012–2016 cropping seasons. The survey was done by Conservation Technology Information Center staff with funding from SARE. In years 3 to 5 of the survey, partial funding was also provided by the American Seed Trade Association. Typically, about 2,000 farmers filled out the survey in years 2 to 5 of the survey, while in the first year 759 farmers responded. The full reports on the survey are available at *www.sare.org/covercropsurvey*.

For cropping years 2015 and 2016, the survey included an additional question: How many years have you consecutively used cover crops in the fields for which you are reporting yields? Using those 2 years of data, a simple linear regression analysis was done to look at yield response. The farmer data set for those 2 years is very similar in a number of metrics, indicating a high percentage of the same farmers filled out the survey both years, so it was deemed valid to take an average of the 2 years of data (crop years 2015 and 2016), covering yields of about 500 farmers each year. From that regression analysis, *Table 2* was constructed to look at how yields change in response to duration of cover crop use in a field.

Table 2. **Percent increase in corn and soybean yields after 1, 3 and 5 years of consecutive cover crop use on a field, based on a regression analysis of data for crop years 2015 and 2016** [1]

	One Year	Three Years	Five Years
Corn	0.52%	1.76%	3%
Soybeans	2.12%	3.54%	4.96%

[1] 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.

The regression analysis of yields based on duration of cover cropping clearly showed that corn and soybean yields increased in response to the number of years that cover crops were planted in a field. This is presumably a reflection of improvements in soil health.

Creating a Baseline for Cover Crop Costs and Returns

Table 3 shows the typical costs of seeding cover crops. Some farmers are able to buy cover crops for as little as $5–$10 an acre if they are using common cereals such as oats, wheat or rye, and especially if the seed is available locally with no shipping costs or has been grown by the farmer. At the other end of the spectrum, for complex mixes that include pricier legumes, it is possible to spend as much as $50 per acre on cover crop seed. However, this is not typical among grain farmers when planting cover crops on large acreages. (Expensive cover crop mixes with legumes are more common on organic farms and vegetable farms.)

Table 3. **Cost of seeding cover crops**

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***

Likewise, the cost of seeding cover crops can really vary. If someone is hiring cover crop seed spreading, an aerial applicator may charge $12–$18 per acre, while a fertilizer dealer might charge $8–$15 per acre. If the seed is broadcast with a fall fertilizer application, the cost of seeding is basically covered as part of the fertilization cost.

A cover crop interseeder can broadcast several hundred acres of cover crop seed in a day, allowing ag retailers and farmers to get cover crop seed established efficiently and early in the fall. *Photo by Rob Myers, North Central SARE.*

If cover crop seeding is done using the farmer's own equipment, the cost will depend on the width of seeding equipment and whether it is done as a separate trip over the field or combined with another field operation. A small 10′ drill might have an operation cost of over $10 per acre when labor is included, while operating a 40′ row crop planter will likely cost under $10 per acre. If broadcasting cover crop seed and lightly incorporating it with a vertical till tool, there is no extra labor or fuel cost since the vertical tillage is done anyway. However, there would be a one-time cost for modifying the tillage tool with an air seeder, which might amortize to $4–$5 per acre depending on the amount of use. In short, it is possible to buy and seed cover crops for as little as $10–$15 per acre, or to spend three to four times that amount.

The national SARE/CTIC survey showed a median seeding cost of $25 per acre in 2012. Although seed costs for some cover crop species have declined since 2012, that figure will be used for the analysis reported on here. The same survey had farmers reporting a median seeding cost of $12 per acre if they hired it out, making a total cost of $37 per acre for seeds and seeding. If the cover crop overwinters and needs to be terminated in spring, that can add an extra cost of $10–$12, but for this analysis it is assumed that a burndown spring herbicide application is being made anyway, since this is a common practice among corn and soybean farmers.

To better show how the economics of cover crops change with improvements in soil health and under special situations, *tables 4* and *5* on corn and soybeans (respectively) were compiled from a variety of data sources. (See table footnotes.) The numbers are based on a combination of SARE/CTIC survey data, published input prices, research data and analysis by the authors of this bulletin. Prices shown are from spring 2019 unless otherwise noted. Where estimates were made on a few of the numbers, the goal was to be as realistic as possible based on reported farmer experiences. Some farmers report higher cost savings or greater yield increases than what is shown, but for the majority of situations, *tables 4* and *5* should give an idea of approximate returns on typical corn and soybean farms.

Similar tables could be built for other summer annual crops that might be rotated with cover crops, such as cotton, sorghum or sunflowers, but less farm-based data is currently available on the yield impact of cover crops with other commodities. The authors did not attempt to do an analysis of cover crop economics for vegetables, fruits or other specialty crops but expect a similar pattern of increasing economic return would be found as soil health improves over time.

Tables 4 and *5* show the impact of cover crops on farm profitability under each of the seven situations outlined in the previous section. An important thing to keep in mind when reviewing the tables is that while some farmers will have none of the seven special situations that apply to them, others will have more than one. For example, they may be grazing a cover crop while also cutting back on their use of fertilizer, or they may be getting an incentive payment while at the same time addressing a compaction issue. Thus, there is an opportunity to gain even more net profit by combining strategies or by addressing more than one yield-limiting factor in a field through use of cover crops. Again, this becomes especially true as soil health improves over time.

Another consideration is that *tables 4* and *5* present information on corn and soybeans separately. Farmers are encouraged to look at their overall system and think about how cover crops fit into their crop rotations. For example, some farmers have gone back to adding a small grain into their rotation with corn and soybeans. If the small grain is winter wheat, it may be possible to either double crop beans or plant a cover crop "cocktail" mix after wheat harvest. Then the cover crop mix can be grazed in early fall and possibly again in late fall and/or spring, depending on the balance of warm season annuals and cool season annuals in the cover crop mix. Such a system may provide faster soil health benefits as well as a nice income from the grazing, but of course it depends on having access to grazing animals.

Finally, the details about how the economic assumptions were established for each cover cropping situation are captured in the table footnotes. Each farmer's experience with cover crops will vary based on their particular situation. Readers are encouraged to substitute their own local conditions and numbers to evaluate the potential return from cover crops over time.

Table 4. **Impact of cover crops on costs, returns and net profit for corn following 1, 3 and 5 years of cover crop use and with various management scenarios**

Budget Item (All figures are per acre)	Years of Cover Cropping		
	One	Three	Five
Estimated input savings when using cover crops			
Fertilizer [1]	$0	$14.10	$21.90
Weed control [2]	$0–$15	$10–$25	$10–$25
Erosion repair [3]	$2–$4	$2–$4	$2–$4
Subtotal	**$2–$19**	**$26.10–$43.10**	**$33.90–$50.90**
a. Savings on inputs (the low end of the subtotal range from above)	$2	$26.10	$33.90
b. Income from extra yield in normal weather year (survey data) [4]	$3.64	$12.32	$21
c. Cost of seed and seeding (survey data) [5]	$37	$37	$37
Net return in a normal weather year (a + b − c)	**−$31.36**	**$1.42**	**$17.90**
Special situations where cover crops can pay off faster			
I. When facing severe herbicide-resistant weeds [6]	$27	$27	$27
Adjusted net return	**−$4.36**	**$28.42**	**$44.90**
II. Potential grazing income [7]	$49.23	$49.23	$49.23
Adjusted net return	**$17.87**	**$50.65**	**$67.13**
III. Compaction addressed by cover crops [8]	$15.30	$15.30	$15.30
Adjusted net return	**−$16.06**	**$16.72**	**$33.20**
IV. Assisting the conversion to no-till from conventional [9]	$23.96	$23.96	$23.96
Adjusted net return	**−$7.40**	**$25.38**	**$41.86**
V. Income from extra yield in a drought year (survey data) [10]	$58.70	$75.73	$92.55
Adjusted net return	**$27.34**	**$77.15**	**$110.45**
VI. Extra fertilizer savings from improved fertility [11]	$15.20	$15.20	$15.20
Adjusted net return	**−$16.16**	**$16.62**	**$33.10**
VII. Federal or state incentive payments received [12]	$50	$50	$50
Adjusted net return	**$18.64**	**$51.42**	**$67.90**

[1] Assumes no fertilizer savings in year 1, then a savings of 15 pounds of nitrogen per acre in year 3 and 30 pounds per acre in year 5, at $0.38 per pound. Also assumes a phosphorus saving of 20 pounds per acre in year 3 and 25 pounds per acre in year 5, at $0.42 per pound.

[2] The first year assumes a reduction of one herbicide pass if sufficient cover crop biomass is achieved. Savings are higher in later years due to reducing by two passes or by using less-expensive herbicide products.

[3] Based on the cost of machinery operations and labor to repair gullies and clean ditches (assumes average cost, but fields will vary).

[4] Assumes a corn price of $3.50 per bushel and a 200 bushel yield times the percent yield increases shown in *Table 2*.

[5] Costs for seed, seeding and termination can vary from a low of about $10 to over $50 per acre; most farms estimated to be $25–$40 per acre.

[6] In a field with a severe herbicide-resistant weed infestation, this figure assumes that a thick-biomass cover crop will reduce herbicide and labor costs and will reduce dockage for weed seed at harvest.

[7] 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% due to hoof action and selective grazing. Assumes average feedlot waste of 22% for hay fed (88% 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.

[8] This is based on a University of Minnesota machinery cost estimate for subsoiling at $15.30 per acre (2017 data used for machinery costs).

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

[10] Assumes a corn price in drought of $6.89 per bushel and reduced base yield of 142 bushels per acre × percent yield increase for drought. Numbers are based on actual national average corn yield for 2012 and national average corn price in the 2012–13 marketing year (USDA–NASS).

[11] Assumes using legumes as a cover crop and that overall improved soil health allow nitrogen to be cut by an extra 40 pounds per acre over basic fertilizer savings.

[12] The basic NRCS EQIP rate in the majority of Corn Belt states starts at $50 per acre or higher; some states have lower rates.

***Table 5.* Impact of cover crops on costs, returns and net profit for soybeans following 1, 3, and 5 years of cover crop use and with various management scenarios**

Budget Item (All figures are per acre)	Years of Cover Cropping		
	One	Three	Five
Estimated input savings when using cover crops			
Fertilizer [1]	$0	$6.30	$8.40
Weed control [2]	$0–$15	$10–$25	$10–$25
Erosion repair [3]	$2–$4	$2–$4	$2–$4
Subtotal	**$2–$19**	**$18.30–$35.30**	**$20.40–$37.40**
a. Savings on inputs (the low end of the range from above)	$2	$18.30	$20.40
b. Income from extra yield in normal weather year (survey data) [4]	$11.45	$19.12	$26.78
c. Cost of seed and seeding (survey data) [5]	$37	$37	$37
Net return in a normal weather year (a + b − c)	**−$23.55**	**$0.42**	**$10.18**
Special situations where cover crops can pay off faster			
I. When facing severe herbicide-resistant weeds [6]	$27	$27	$27
Adjusted net return	**$3.45**	**$27.42**	**$37.18**
II. Potential grazing income [7]	$49.23	$49.23	$49.23
Adjusted net return	**$25.68**	**$49.65**	**$59.41**
III. Compaction addressed by cover crops [8]	$15.30	$15.30	$15.30
Adjusted net return	**−$8.25**	**$15.72**	**$25.48**
IV. Assisting the conversion to no-till from conventional [9]	$23.96	$23.96	$23.96
Adjusted net return	**$0.41**	**$24.38**	**$34.14**
V. Income from extra yield in a drought year (survey data) [10]	$65.24	$69.80	$74.36
Adjusted net return	**$41.69**	**$70.22**	**$84.54**

Table 5. **Impact of cover crops on costs, returns and net profit for soybeans following 1, 3, and 5 years of cover crop use and with various management scenarios—Continued**

Budget Item (All figures are per acre)	Years of Cover Cropping		
	One	Three	Five
VI. Extra fertilizer savings from improved fertility [11]	$7	$7	$7
Adjusted net return	**−$16.55**	**$7.42**	**$17.18**
VII. Federal or state incentive payments received [12]	$50	$50	$50
Adjusted net return	**$26.45**	**$50.42**	**$60.18**

[1] Assumes no fertilizer savings in year 1, then a savings of 15 pounds of phosphorus per acre in year 3 and 20 pounds per acre in year 5, at $0.42 per pound.

[2] The first year assumes either no herbicide savings or a possible saving of $15 per acre by avoiding a fall herbicide pass ($7.50 per acre for the chemical and $7.50 per acre for application). The third and fifth years assume using a less expensive residual chemistry that costs $10 per acre, with the possibility of saving $15 per acre in the fall.

[3] Based on the cost of machinery operations and labor to repair gullies and clean ditches (assumes average cost, but fields will vary).

[4] Assumes a soybean price of $9 per bushel and a 60 bushel yield times the percent yield increases shown in *Table 2*.

[5] Costs for seed, seeding and termination can vary from a low of about $10 to over $50 per acre; most farms estimated to be $25–$40 per acre.

[6] In a field with a severe herbicide-resistant weed infestation, this figure assumes that a thick-biomass cover crop will reduce herbicide and labor costs and will reduce dockage for weed seed at harvest.

[7] 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% due to hoof action and selective grazing. Assumes average feedlot waste of 22% for hay fed (88% 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.

[8] This is based on a University of Minnesota machinery cost estimate for subsoiling at $15.30 per acre (2017 data used for machinery costs).

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

[10] Assumes a soybean price in drought of $14.40 per bushel and reduced yield of 39.6 bushels per acre × percent yield increase for drought. Numbers are based on actual national average soybean yield for 2012 and national average price in the 2012–13 marketing year (USDA–NASS).

[11] Assumes that overall improved soil health allows an additional reduction in phosphorus of 10 pounds per acre ($0.42 per pound) and 10 pounds per acre of potassium ($0.28 per pound) over basic fertilizer savings.

[12] The basic NRCS EQIP rate in the majority of Corn Belt states starts at $50 per acre or higher; some states have lower rates.

An In-Depth Look at Management Situations Where Cover Crops Pay Off Faster

As outlined earlier, there are several different management situations where cover crops pay off faster than usual. Generally, these faster returns occur where farmers are either addressing a specific problem such as herbicide-resistant weeds or soil compaction, and/or where they are seizing opportunities in other aspects of their crop and soil management in order to be more economically efficient overall.

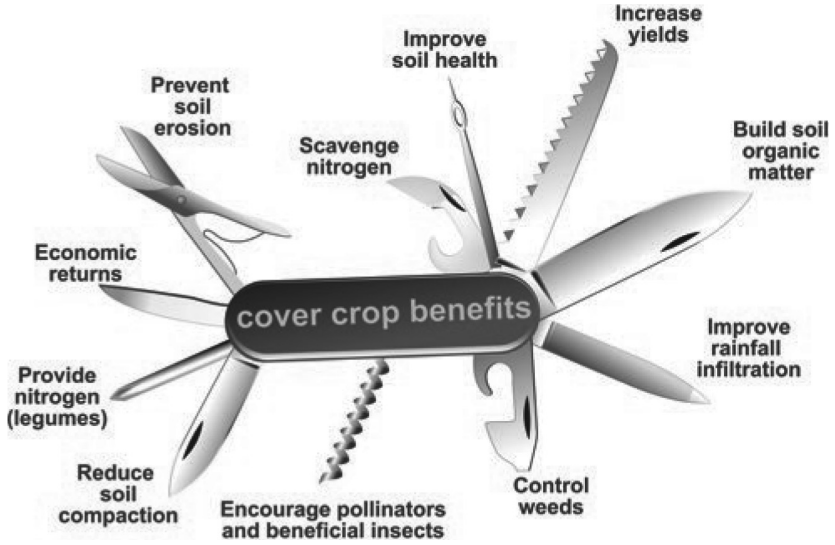
For example, Alabama farmer Annie Dee has been combining cover crops with other conservation practices for many years because of the multiple cost-saving benefits she sees. "If we get a big rain, the cover crops help keep soil from washing away," says Dee, who farms 4,000 acres of corn and soybeans, with another 3,500 acres of forages and cattle pasture. "They also help build up the fertility of the soil and keep the weeds down."

By using the baseline numbers on cover crops from the preceding section and then adding in the economic impact of these various management scenarios, a more specific set of economic numbers can be generated. These management-specific numbers are summarized in the "Snapshot" sections at the end of each management section. The intent here is to help producers identify those profitability factors that are relevant to their own farms.

When looking at the management situations that follow, producers or farmer advisors should keep in mind their goals for the cover crops they plan to use on each field, such as helping with compaction (*Figure 1*). This can help guide their selection

of cover crops, help set realistic expectations on potential returns and help suggest what other management changes might be needed to improve overall efficiency.

Figure 1: **The many benefits of cover crops**



The many benefits that cover crops provide contribute to increasing yield response and lower input costs over time. *Illustration by Carlyn Iverson.*

1. When Herbicide-Resistant Weeds are a Problem

In the 2016–17 National Cover Crop Survey, 59% of farmers reported having herbicide-resistant weeds on some of their fields, and that percentage is expected to continue rising. Due to the rapid spread of herbicide-resistant marestail, Palmer amaranth and waterhemp, along with other herbicide-resistant weeds, farmers are having to spend more on herbicides while often getting worse results. In some situations, entire crop fields have been abandoned to weeds, particularly in the South. Even where partial control of these challenging weeds is obtained, yield losses occur and the crop delivered to the grain elevator may be docked substantially in price for weed seed contamination. This problem is only going to get worse in many areas. For example, a weed scientist from Southern Illinois University recently reported that some marestail weeds in Illinois are now showing resistance to four different classes of herbicide chemistry.[14]

While no single crop management strategy can completely resolve the situation with herbicide-resistant weeds, cover crops are proving to be an effective tool in farmers' toolboxes for controlling these weeds. For example, when asked if cereal rye was helping with herbicide-resistant weed control, 25% of the farmers in the SARE/CTIC survey said it always helped and 44% said it sometimes helped, while 31% said they saw no difference. In some cases, the farmers were able to get by with just one application of post-emergence herbicide instead of two, or were able to go with a less-expensive residual herbicide chemistry when they added cover crops to their weed control strategy.

This potential savings in herbicide costs will not necessarily pay for the full cost of cover crop seeding, but when combined with possible yield advantages and avoiding dockage fees or even yield losses at harvest, it may provide a positive return in the first year or 2 of cover crop use. More specifically, using cereal rye biomass to get by with one less pass of post-emergence spray, along with lower-cost residual herbicides, can lead to savings of $35 per acre or more when an herbicide-resistant weed infestation is severe and would otherwise cause yield loss and potential weed seed dockage in harvested grain.

Where the cover crop investment is most likely to pay is when cereal rye and/or other covers grow long enough to create a biomass blanket that reduces weed seed emergence and growth. If the cash crop is "planted green" into the cover crop (seeded while the cover crop is still living), weed control is usually increased, particularly if planting in a no-till fashion with significant rye residue providing a weed protec-

tion mat on the soil surface. Recent work by the University of Nebraska has shown that cover crop rye biomass of 3,300–3,600 pounds per acre had a dramatic impact on weeds in corn, reducing both weed biomass and weed density by 90%.[1] (Note: If using cereal rye before corn, adjustments to your nitrogen fertilization strategy are recommended.)

Nebraska results with soybeans were more variable, depending on the amount of cover crop growth, but higher cover crop biomass generally led to better weed control. University of Wisconsin researcher and SARE grantee Erin Silva has found that allowing rye to accumulate 8,000 pounds of aboveground biomass, such as occurs with a dense stand of rye at flowering stage, is important when roller-crimping it for organic weed control in soybeans. Getting a large amount of biomass from rye may require boosting the cereal rye seeding rate, an extra cost of $5–$10 per acre.

Alabama farmer Annie Dee uses different cover crop mixes depending on her crop rotation and management goals. *Reprinted with permission,* ***Progressive Farmer,*** *mid-February 2019.*

Snapshot: The financial impact from herbicide-resistant weeds

Cover crops can pay off in year 1 for soybeans and in year 2 for corn, assuming savings of $27 per acre from using cover crops when a substantial or severe herbicide-resistant infestation is occurring. Using the calculations summarized in *Table 4* for corn, the increased net profit from cover crops average −$4.36, $28.42 and $44.90 per acre after 1, 3 and 5 years of planting a cover crop. Using the calculations summarized in *Table 5* for soybeans, the increased net profit from cover crops average $3.45, $27.42 and $37.18 per acre after 1, 3 and 5 years. (See *tables 4* and *5* for details.)

The $27 per acre savings is based on a comparison of using cover crops with an herbicide program to deal with herbicide-resistant weeds *versus* using herbicides alone. Keep in mind that the occurrence of herbicide-resistant weeds normally drives up overall herbicide costs, as more expensive residual herbicides are used. Of-

tentimes an extra post-emergence herbicide treatment is employed (making a second or third post-emergence application). Specifically, the $27 figure is based on a savings of $12 per acre due to one fewer post-emergence spray (assuming Roundup Powermax at $4.50 per acre plus $7.50 per acre application cost) and $15 per acre for a lower-cost residual herbicide chemistry.

This analysis assumes that a farmer who uses cover crops to combat herbicide-resistant weeds would still apply both residual herbicides and at least one or two post-emergence herbicide passes to deal with them. The difference that a cover crop can make in this situation is to provide enough weed control that the farmer can avoid buying the more-expensive herbicides that would otherwise be required in order to deal with an escalating weed problem.

There may also be additional savings from not having dockage fees for weed seed contamination in the harvested grain, and from being able to buy less expensive commodity seed (such as using Roundup Ready soybeans as opposed to new varieties that have stacked traits for resistance to both Roundup and dicamba).

Farmer Profile *Justin Zahradka, Lawton, N.D.*

Justin Zahradka, a fifth-generation farmer in North Dakota, grazes his cover crops for optimal benefit. *Photo by Lon Tonneson,* ***Dakota Farmer*** *magazine (Farm Progress Companies).*

Positive Returns from Grazing Cover Crops

Primary Cover Crops: *oilseed radishes, turnips, cereal rye, oats, peas, sorghum sudangrass and hairy vetch*

Justin Zahradka is no stranger to change, and he's even more familiar with innovation. Farming the same ground his family homesteaded in 1898, Zahradka is the fifth generation living on and working their Walsh County, N.D., operation. His path to farming and adoption of cover crops began in 2011, while still in high school, with the purchase of bred heifers. Focused on data and economics even at that early point in his career, Zahradka participated in a data gathering project that examined the costs and benefits of cover crops and grazing. With support from state SARE funding, Zahradka found that cover crops enabled him to "be more productive on each acre." Based on his work with cover crops and his overall qualifications, Zahradka was named FFA's National Star in Agriscience for 2015.

Since that time, he has explored a number of commercial enterprises for his farm including feeder cattle, custom grazing and row crops, and he ended up with the diversified crop and livestock operation he currently operates. Cover crops have been a common denominator throughout every shift in his operation, which has grown to 900 acres including a 160 head cow-calf operation and 500 acres of row crops. On his row crop acres, Zahradka initially focused on just a couple cash crops along with cover crops, but, driven by his bottom line, he has since modified his rotation to include corn, soybeans, spring canola and wheat, with half his land in forages for year-round grazing.

Preferring mixtures to the use of single species, Zahradka typically plants a combination of oilseed radishes, turnips and cereal rye after wheat. Those acres will routinely be grazed from the end of September into November, extending

forage production for his cattle. Acres targeted for forage production might see a mixture of oats, peas, sorghum sudangrass and vetch. "Those interested in a cover crop mix should start simple with one grass, one legume and one brassica in a mixture," Zahradka advises. "Most importantly, look at cover crops as an investment rather than a cost."

Continuous use of cover crops has netted a small but sustained 0.1% annual increase of soil organic matter in his soils, which has been verified by soil test data. When considering the value of his investment in cover crops, Zahradka also points to the resiliency of his soils in both wet and dry years and the benefit of an extended grazing season for his cow-calf operation. His data supports the conclusion that profits per animal can be greater when incorporating cover crops into an operation. In addition, Zahradka's labor is decreased by having the livestock "do the feeding," which enables him to expand his operation without the need to add full-time hired labor. "Cover crops can help improve your quality of life," Zahradka says. "The operator gains labor savings by letting the livestock do their job."

2. When Cover Crops are Grazed

Among the several ways that cover crops can boost profits, grazing them is one of the most likely ways to provide a positive first-year return. Whether grazing cover crops pays back the first year depends on the amount of cover crop growth, the length of the grazing period and the costs for fencing and a water supply, if those are not already in place. Where grazing infrastructure is present, even a modest amount of grazing from cover crops will normally pay for seed costs while also providing some soil improvements. Getting early fall establishment of fast-growing covers such as cereals and/or brassicas (such as turnips, radishes, canola, *etc.*) can boost your financial return well above cost of cover crop seeding.

Some farmers doing cover crop grazing find they get optimum returns by using intensive grazing management techniques with low-cost, portable electric fencing and regular moves of livestock between paddocks. Daily or near daily moves not only lead to more efficient use of cover crop forage but also reduce potential hoof damage to crop fields. In established no-till or minimum-till fields with good cover crop stands, soil structure combined with the root anchoring ability of the covers helps minimizes any potential issues from the cattle grazing.

Integrating livestock with cover crops can be a major plus for long-term soil health. The urine, manure and saliva from grazing animals has been found to stimulate soil biology. This is not surprising given that our soils, whether prairie or forest, evolved with herbivores impacting the soil biology. In fact, there is some evidence that grazing cover crops, especially where significant biomass is achieved, may be one of the fastest ways of building soil organic matter and soil biology. More research on this is needed, but early on-farm results look promising.

Since many farmers don't have or want livestock, they may think cover crop grazing does not apply to them. However, they may have family members or neighbors who would be interested in custom grazing their ground, bringing in temporary electric fencing and providing a rental payment that can boost profitability. Some families have found that cover crop grazing can help employ an additional family member on the farm without having to expand crop acres.

How a producer integrates livestock into their operation will affect the economic value they see from grazing cover crops. A cow-calf operator who intends to extend their grazing season in the fall and spring may value cover crops based on the reduced amount of hay they need to buy. A backgrounding operation may focus more on the quantity and quality of the forage, and thus would value cover crops based on daily gains and fed cattle market values Whether or not a producer intends to graze both in the fall and spring, the seeding rates, available forage, value of hay and amount of selective grazing by livestock will all impact the financial benefit.

Snapshot: The financial impact of grazing cover crops

Cover crops pay off in year 1, assuming an annual return of $49.23 per acre from grazing. Estimated returns for corn average $17.87, $50.65 and $67.13 per acre after 1, 3 and 5 years of planting a cover crop. Soybean returns average $25.68, $49.65 and $59.41 per acre after 1, 3 and 5 years. (See *tables 4* and *5* for details.) The assumed annual return includes assumptions that portable electric fencing is already on hand and water is accessible; costs for installing new fencing or a water supply would delay profit on grazing to year 2 or possibly longer. Practical Farmers of Iowa, in a detailed on-farm study of cover crop grazing, also found that grazing provided a net profit in year 1 for each of the farms studied.[6]

Photo by *Mike Rankin,* ***Hay & Forage Grower.***

Farmer Profile *Mike Taylor, Helena, Ark.*

Helena, Ark., farmer Mike Taylor with his children Merrie Leigh (left) and Wells. Taylor's attitude toward soil health includes a desire to leave the land in good shape for his children. *Photo by Chris Bennett,* ***Farm Journal.***

Addressing Compaction, Erosion and Weeds

Primary Cover Crops: *cereal rye and mixes*

A sign hangs in Mike Taylor's shop that reads, "You do not inherit the land from your ancestors, you borrow it from your children." Taylor and his father vividly remember 1992 as a year that challenged that statement. High wind conditions combined with their light, sandy soils resulted in sandblasting and a near-total loss of their cotton crop. The following year they began adding cover crops into their cotton rotation to keep their soil in place, and their use of cover crops has increased every year since. Cover crops are now normally used on

90% of their roughly 4,000 acres of row crops in east Arkansas near Helena. "I want my ground to be there for my kids," Taylor says.

Taylor plants cereal rye as his cover crop of choice in their corn, soybean, peanut and cotton rotation, but he has incorporated blends as well and has even made use of 12- and 13-way mixes. He primarily seeks to prevent soil erosion and promote root growth below the soil surface. Cover crops have also helped to control herbicide-resistant Palmer amaranth and horsetail (marestail) on the farm.

For producers in his region considering a cover crop, Taylor advises to "drill it in and plant early." He has tried many options for planting but prefers his no-till drill because it allows him to cut back his seeding rate and he always gets a stand. Taylor has seen producers who plant too late and terminate too early to receive maximum benefits, making their cover crops less profitable. In 2018, Taylor had some issues with slugs for the first time and is searching for a cost-effective remedy if they recur.

Taylor likes to point out that many people focus on annual expenses and potential savings with cover crops, but one area that has not received the same amount of attention is the change in equipment needs. To address his hardpan issues, Taylor drills cover crops instead of running a subsoiler tillage tool, thereby avoiding the fuel and labor cost associated with using his high-horsepower tractor. "I look at my no-till drill as my subsoiler," he says.

Taylor also notes that cover crops seem to resolve the soil crusting issues they historically had. Thus, they rarely need to run their rotary hoe. A trackhoe implement, which was purchased years earlier to dig out eroded soil that filled up drainage ditches, is now seldom needed since cover crops have significantly reduced erosion on his fields. The machinery cost savings and better weed control have positively impacted his bottom line and help justify his effort to increase soil health, ensuring his children will have the same opportunity to farm.

3. When Soil Compaction is an Issue

With farmers planting more acres than ever before, the time window to get into and out of fields for planting, harvest and other operations is smaller than ever. Unfortunately, the sense of urgency to get over a lot of fields quickly can lead to situations where farmers are using large, heavy equipment on fields where moderate to high moisture leads to compaction. Once the soil is compacted, not only do yields sometimes drop by 10–20%,[7] but future rainfall infiltration is also negatively affected. This leads to a vicious cycle of muddy fields and compacted tracks that hurt crop stands, root growth and ultimately yields. The compaction, if widespread enough, can even delay the ability to get into the field in the future because of reduced drainage in compacted areas.

Although prevention is the best solution, farmers facing compacted soils may feel little choice other than to buy deep subsoiling tillage equipment. This may require upgraded horsepower tractors to operate, not to mention expensive fuel and labor costs. When adding the extra equipment, fuel and labor costs, the cost of subsoiling a field to address compaction can be $15 per acre or more.[11] Even worse, the benefit from subsoiling is often very temporary as high-clay subsoils swell back together and new compaction occurs.

Deep-rooted cover crops can provide a less costly and longer-lasting solution to compaction issues. A 4 year research study on soil compaction at Ohio State University showed that soils compacted with a 20 ton grain cart yielded better when soybeans were grown after cover crops compared to using annual subsoiling. In the same study, corn after cover crops yielded just as well as corn after subsoiling, with the notable exception of the 2012 drought year, when the cover crop plots yielded better than subsoiling.[13]

Particular cover crop species such as cereal rye and radishes, if allowed enough time to grow, often root more deeply than summer cash crops such as corn and soybeans. The macropores created by those deeper roots help get air and water deeper into compacted soils. These deeper cover crop roots create paths for the cash crop roots to more effectively grow through the compacted zones in the next season. The living roots of cover crops also stimulate earthworm populations, which through their tunneling also start to improve compacted soils.

In the long-term, improved soil organic matter from cover crops, especially when combined with less tillage, helps to build soil aggregates, which provide more structure and strength to the soil so that compaction is prevented in the first place. Think of driving a vehicle across a dense turf sod compared to a bare soil after a rain. Where would the vehicle get stuck? Combining no-till and cover crops can create an effective, long-term solution to soil compaction, allowing earlier spring plant-

ing and wider time windows to access fields for time-sensitive operations such as harvest.

Snapshot: The financial impact of addressing compaction with cover crops

Cover crops break even for corn in year 2 and provide a net profit for soybeans in year 2, assuming savings of $15.30 per acre from not having to do annual subsoiling. Returns for corn average −$16.06, $16.72 and $33.20 after 1, 3 and 5 years of planting a cover crop. Soybean returns average −$8.25, $15.72 and $25.48 after 1, 3 and 5 years. (See *tables 4* and *5* for details.) A positive net return could be delayed to year 3 if subsoiling is done less frequently than on an annual basis.

Cover crops that can root deeply, such as radishes, can help alleviate soil compaction. *Photo by Rob Myers, North Central SARE.*

Farmer Profile *Ralph "Junior" Upton, Springerton, Ill.*

Illinois farmer Ralph Upton began planting cover crops decades ago to control erosion. Now they play an important role in maintaining the overall resiliency of his soil. *Photo by Ciji Taylor.*

Deeper Rooting Builds Resilience into the Cropping System

Primary Cover Crops: *cereal rye, ryegrass and hairy vetch*

Junior Upton's history with cover crops began almost 50 years ago with frost-seeded red clover into winter wheat. Producing corn and soybeans on 1,800 acres about 100 miles east of St. Louis, Mo., Upton recalls that his original interest in cover crops and no-till arose from a desire to limit soil erosion. Although he has never lost sight of this benefit, his many years of planting cover crops and seeing the enormous positive impact they have on the resilience of his soil has expanded his appreciation of them. Cover crops have literally improved his ability to weather storms, he says.

Upton has experimented with multiple cover crop species, including buckwheat, radishes, rapeseed, cereal rye, vetches and ryegrass. He explains that trial and error along with in-field research through partnerships with programs such as SARE have enabled him to pinpoint cover crop mixtures that work with his management system. Upton no-till drills a three-way mix of cereal rye, ryegrass and hairy vetch after both corn and soybeans. He has a specific reason for each cover crops he relies upon. Cereal rye helps with weed control and soil erosion, and is a great companion crop for the other cover crops. The root system of ryegrass helps to break up the fragipan in his soil and also assists with weed control. When managed properly, hairy vetch generates both supplemental nitrogen and additional weed control.

Upton recalls introducing ryegrass into his system and seeing roots 48″ deep, growing through the fragipan, even though above-ground biomass was less than 5″ tall. Being vulnerable to droughts was an ongoing concern in the past, but now cover crops have helped to alleviate some of that worry by improving both the water-holding capacity of his soil and the rooting depth of his corn and soybeans. "Dry weather killed me in the past due to a fragipan," Upton explains. "I had been farming the top 5″ of soil, where now I use 4′ of soil."

When discussing his conservation practices, Upton quickly points to his focus on the bottom line and how his farm management has changed over the years. Switching to no-till and cover crops in the mid-1990s decreased his capital outlay for equipment and lessened his fuel bill. Now, after years of experience, Upton has tweaked his management again. By using different seed maturity groups and slightly later planting dates, he has been able to reap additional soil health benefits, reduce fertilizer inputs and get better weed control. He has also seen improved profit, in part due to better yields where he has used cover crops. Upton recommends that producers take the time to evaluate their own situation, soils and management priorities. "What works for me may not work out as well on someone else's farm," he says.

The bottom line for Upton is that every acre on his farm is destined to have a cover crop. He looks forward to additional breeding work with cover crops and hopes to take advantage of additional benefits in the future, such as increased nitrogen availability.

4. When Cover Crops are Used to Speed and Ease the Transition to No-Till

Some of the earliest grain crop farmers to adopt cover crops in recent decades have been no-tillers. In fact, *No-Till Farmer* magazine reported that 83% percent of their no-till farmer readership used cover crops on at least some of their fields in 2017.[2] However, a new trend has become apparent with the rapid expansion of cover crops, which is that a segment of conventional till farmers using cover crops have become motivated to transition to no-till or strip-till. Many cover crop users have cited their increased appreciation for soil health as a reason for making changes to their tillage system.

While the triggering effect cover crops have on reducing tillage is notable, what is more important economically is that cover crops seem to ease the transition to no-till. Farmers have been advised for decades that they can expect an initial yield dip when changing to no-till but that if they stick with it, after 4 to 5 years their yields will be restored to previous levels and will probably improve in drought years. More research is needed, but there are many anecdotal reports of farmers who use cover crops finding less of a yield dip when transitioning to no-till on a given field compared to transitioning without cover crops.

A specific approach that some farmers have followed is to plant a cereal rye cover crop before soybeans and then begin the no-till process in the spring, in this case by no-till planting the soybeans into the rye residue. Changing to no-till without a cover crop would cause less aeration and possibly more initial compaction in a field compared to a conventionally tilled field, but the use of rye offsets these negatives. The root macropores from the cover crop, along with increased earthworm activity, will help improve initial aeration of the soil and reduce crusting and compaction. The stimulated soil biology from the living cover crop roots can also speed the growth of mycorrhizal fungi, allowing fungal hyphae to form, which provide more nutrients and potentially more moisture to the cash crop roots.

By using a cover crop before starting no-till, it may be possible to avoid taking the typical yield penalty that a no-till transition may otherwise incur.[8] No-till leads to cost savings from reduced labor and machinery expenses, and using cover crops to minimize a potential yield penalty provides an added financial benefit. The pairing of cover crops and no-till will lead to significant long-term improvements to soil health and crop performance, much more so than using either practice alone.

Snapshot: The financial impact of using cover crops to ease the transition to no-till

Cover crops pay off starting in their second year of use for corn and break even during the first year of use with soybeans, assuming savings of $23.96 per acre from using cover crops to help the transition to no-till. The assumed savings are from the reduced fuel and labor costs of doing one fewer fall tillage pass and two fewer spring tillage passes. Returns for corn average −$7.40, $25.38 and $41.86 per acre after 1, 3 and 5 years of planting a cover crop. Soybean returns average $0.41, $24.38 and $34.14 per acre after 1, 3 and 5 years. (See *tables 4* and *5* for details.)

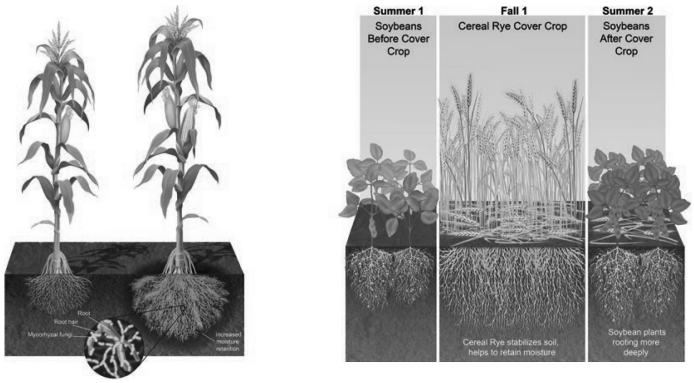
5. When Soil Moisture is at a Deficit or Irrigation is Needed

One of the most dramatic examples of cover crop benefits occurred during the severe, widespread drought of 2012. On thousands of midwestern and western farms, crop growth suffered from rainfall levels that were far below normal. However, a pattern began to emerge when farmers found that corn or soybeans following cover crops were doing better than those in their conventional fields. This frequent observation was later supported by yield data. Farmers responding to the National Cover Crop Survey reported an average yield increase of 9.6% in corn that followed a cover crop and an increase of 11.6% in soybeans. Even more remarkable, in the seven states hit hardest by the drought, yield increases were even larger: 11% for corn and 14.3% for soybeans.

Cover crop mulches significantly reduce moisture loss from the soil, such as with the cereal rye residue shown here between soybean rows. *Photo by Rob Myers, North Central SARE.*

Looking just at those farmers who had 1 year of experience with cover crops leading up to the drought, their average yield increase in cover-cropped fields was 6% for corn and 11.4% for soybeans. With the high prices after harvest that year (national average prices of $6.89 for corn and $14.40 for soybeans), cover crops more than paid for themselves in the 2012 drought year, even after just 1 year of use. Note that this conclusion is based on average yield response, using the survey regression analysis on yields. A small portion of individual fields and farms had yield losses following cover crops, while others had even larger yield increases.

There are several reasons that cover crops can increase soil moisture and reduce yield losses caused by drought (*Figure 2*). One reason is that cover crops help improve rainfall infiltration through an increased number of macropores, both from cover crop roots and from increased earthworm activity. Once the rain has soaked into the soil, it is more likely to stay in the root zone, partly because the cover crop residue on the soil surface reduces evaporation. That residue can also keep the soil cooler, which further reduces moisture loss and crop stress, and allows soil microbes to operate more beneficially. Over time, improving soil health can lead to increased moisture-holding capacity in the soil as organic matter increases and soil aggregate structure improves. However, even in the short-term, cover crops can stimulate mycorrhizal fungi, and those fungi can help drought-shortened crop roots better access moisture and nutrients.



Cover crops can increase soil moisture in a number of ways: stimulating the growth of mycorrhizal fungi on crop roots, providing surface residue, creating root channels for the following crop to use, and improving both

rainfall infiltration and the soil's water-holding capacity. *Illustrations by Carlyn Iverson.*

Cover crops can pay significant dividends by improving soil moisture management in fields that often suffer from moisture stress, such as lighter-textured soils or fields in marginal rainfall areas. The improved infiltration from cover crops can also increase the efficiency of irrigation and reduce evaporation. Steve Stevens, an Arkansas cotton farmer, estimated that when he uses cover crops he can save about $0.06 per pound of cotton produced ($60 per acre) through reduced irrigation expenses.[9]

Noah Williams, who farms 2,800 dryland acres in eastern Oregon, has found cover crops to be a benefit even though he has very limited rainfall. Working with his local USDA Natural Resources Conservation Service (NRCS) soil conservationist, Williams monitored soil moisture levels in fields left fallow and in fields planted to cover crops in place of fallow. Overall, soil moisture was about the same between fallow and the cover crops. But after a rain, Williams observed that the moisture reached the 2′ depth zone of the soil profile in his cover cropped fields, whereas that zone was dry in the fallow system. When combined with grazing, Williams says, "Cover crops are paying for the cost of seeding."

Snapshot: The financial impact of cover crops during a drought

Based on data from the 2012 drought, cover crops significantly boost yield (on average) during a drought year, and **cover crops pay off in year 1.** Returns for corn average $27.34, $77.15 and $110.45 per acre after 1, 3 and 5 years of planting cover crops. Soybean returns average $41.69, $70.22 and $84.54 per acre after 1, 3 and 5 years. (See *tables 4* and *5* for details.) For the purpose of this analysis, the 1, 3 and 5 year increments mean that cover crops had been used for that amount of time when a drought occurred.

6. When Fertilizer Costs are High or Manure Nutrients Need to be Sequestered

Clover cover crop roots form nodules with symbiotic bacteria that fix nitrogen, reducing the need for applying nitrogen fertilizers. *Photo by Rob Myers, North Central SARE.*

Cover crops are often an essential part of an organic farmer's strategy to supply nutrients to their crops, particularly through nitrogen-fixing legumes. Some legumes, such as hairy vetch and Austrian winter peas, can supply over 100 pounds of nitrogen per acre if allowed to grow until they flower. However, for conventional farmers, it has normally been cheaper to obtain nitrogen from synthetic fertilizer than from cover crops. This is particularly true for corn, which is planted before legumes have much chance to grow in spring.

New developments in understanding soil health and soil-nutrient cycling are leading to a recognition that cover crops can do more than just fix nitrogen (assuming

the cover is a legume). They can play an important role in sequestering nutrients from manure or nutrients that are left at the end of a cash crop season. This sequestration can prevent those nutrients from being lost from the root zone. Nitrogen sequestration is particularly important, given its mobility in the soil and the chance of both nitrogen leaching and denitrification (when soil nitrogen goes into the atmosphere as a gas).

Soil biology also plays a greater role than previously understood in soil- and crop-nutrient dynamics. Cover crops, by increasing the portion of the year with living roots in the soil, stimulate soil biology and can enhance the growth of mycorrhizal fungi, particularly if soil disturbance is minimized. These changes in soil biology can begin in the first year of cover crop use, and they continue as soil health improves. Fungi and bacteria contribute nutrients to plant roots in exchange for carbohydrate exudates from the roots. Cash crops may also root more deeply following a deep-rooted cover crop, and earthworms create nutrient-rich tunnels that roots can access. These changes can occur in the soil fairly quickly, allowing a short-term fertility response. In the long-term, organic matter starts to improve, which also increases the pool of nutrients annually available in the soil. For these reasons, modest fertilizer cost savings are often possible with cover crop use, including where legumes are used to fix nitrogen. Moreover, the amount of those cost savings increases over time as soil health improves.

Researchers and farmers are still working to understand the optimum amount of fertilizer efficiency that can be achieved with cover crops. From what is currently known, the most straightforward steps are to soil test regularly for phosphorus and potassium levels and to consider using sensor technology or tissue testing to evaluate in-season nitrogen needs in corn. The inseason nitrogen evaluation can be used to guide side-dress fertilizer applications rather than applying all the nitrogen fertilizer before planting the cash crop. Using the latest soil health tests can also provide insights on how to best manage a field's fertility.

For now, we know that fertilizer needs will gradually decline over time as cover crops improve soils and after a few years may lead to a savings of $10–$40 per acre in fertilizer costs for corn and $5–$10 for soybeans. Soybean savings are lower due to the fact they produce their own nitrogen. The biggest potential in saving fertilizer costs is from using legume cover crops that can fix sufficient nitrogen to contribute to commodities such as corn, sorghum or cotton, but the overall improvements in soil health and increased mycorrhiza can certainly provide fertility dividends as well.

Snapshot: The financial impact of extra fertilizer savings

Cover crops break even in year 2 for corn and pay off by year 3 for soybeans, assuming a field situation where soil fertility can be improved by cover crops. Returns for corn average −$16.16, $16.62 and $33.10 per acre after 1, 3 and 5 years of planting a cover crop. Soybean returns average −$16.55, $7.42 and $17.18 per acre after 1, 3 and 5 years. (See *tables 4* and *5* for details.) See the footnotes in *tables 4* and *5* for details on specific fertilizer assumptions.

7. When Incentive Payments are Received for Cover Crop Use

Most crop farmers across the United States are eligible for cover crop incentive payments through the NRCS. In recent years, thousands of farmers have received payments in support of cover crops through the NRCS Environmental Quality Incentives Payment (EQIP) program. These payments are intended to help farmers begin the process of cover cropping. They should not be looked at as a long-term subsidy, but they can be helpful during a 3 year transition period to cover cropping.

The NRCS cover crop payment rates vary by state, often starting at $50–$54 per acre for the "basic" cover crop rate of a single species and increasing with the use of multi-species cover crop mixes or for special categories (such as organic farming or being a beginning farmer or socially disadvantaged farmer). Iowa is an example of a state with lower rates, starting at $34 per acre and going over $50 per acre for special situations. The highest EQIP cover crop incentive rates can be $60–$75 per acre or more, depending on the level set by the state NRCS office. (See *Table 6.*) EQIP contracts for cover crops are typically for a 3 year period, and renewal is possible if state criteria are met.

Table 6. **Examples of NRCS EQIP incentive rates [1] for cover crops in FY 2019**

	Basic Rate	Multi-Species Rate	Highest Rate
Alabama	$50.98	$57.05	$75.22

Table 6. **Examples of NRCS EQIP incentive rates [1] for cover crops in FY 2019—Continued**

	Basic Rate	Multi-Species Rate	Highest Rate
Arkansas	$39.24	$44.10	$58.86
California	$50.55	$56.62	$74.47
Georgia	$49.95	$56.02	$67.23
Illinois	$51.32	$57.39	$75.80
Indiana	$28.18	N/A	$33.83
Iowa	$33.83	$37.88	$56.81
Kansas	$41.11	$45.96	$58.23
Maryland	$50.81	$56.88	$68.26
Michigan	$51.35	N/A	$61.62
Minnesota	$34.02	$38.07	$62.76
Missouri	$51.58	N/A	$61.90
Montana	$50.67	$56.73	$60.80
Nebraska	$26.96	$33.97	$52.88
New York	$53.54	$59.61	$71.53
North Carolina	$50.95	$57.02	$75.16
North Dakota	$16.89	$26.48	$45.39
Ohio	$49.90	N/A	$59.88
Oregon	$33.44	$37.48	$56.22
Pennsylvania	$53.59	$59.66	$79.23
South Carolina	$50.94	$57.01	$61.13
South Dakota	$28.35	N/A	$42.53
Texas	$19.59	$36.69	$55.04
Vermont	$51.03	$57.10	$75.30
Virginia	$51.35	$57.41	$68.90
Washington	$50.13	$56.20	$73.75
Wisconsin	$51.18	$57.25	$68.70

[1] The basic rate is for a single species of cover crop; multi-species is the rate for two or more species of cover crops. The highest rates generally are for either organic and/or beginning farmers and/or historically under-served farmers.

Another NRCS program that supports a wide variety of conservation practices, including cover crops, is the Conservation Stewardship Program (CSP). Under CSP, farmers typically agree to do a suite of conservation practices, which can include cover crops, during a 5 year contract period (renewal is possible). As with EQIP, CSP payment rates for cover crops vary by state.

Some state agencies also offer cover crop incentive payments, often through local soil and water conservation districts. Some of the programs are available to any farmer in the state, while others are targeted to specific watersheds. Sometimes the funding is through a state agriculture department, and in other cases it is through a state natural resources or conservation agency. These payment rates also vary, typically starting at $30 per acre and in a few cases reaching upwards of $60 to $80 per acre, such as in the Chesapeake Bay area.

Whether the payments come from state or Federal sources, financial assistance can make the transition to using cover crops affordable. Going simply by the median national cover crop seed cost of $25 per acre and a median cost of contracting out seeding at $12 per acre,[5] incentive payments will quite often completely pay for the cost of using cover crops.

Snapshot: The financial impact of incentive payments for cover crops

Cover crops pay off in year 1, assuming an incentive payment rate of $50 per acre, based on typical NRCS EQIP rates in the Corn Belt. Returns for corn average $18.64, [$]51.42 and $67.90 per acre after 1, 3 and 5 years of planting a cover crop. Soybean returns average $26.45, $50.42 and $60.18 per acre after 1, 3 and 5 years. (See *Tables 4* and *5* for details.) The majority of states have a "basic" cover crop incentive payment rate of $50 per acre or more, and rates for multi-species cover crops, beginning or organic farmers, or under-served audiences can be even higher. A minority of states have a basic cover crop incentive rate below $50 per acre. (See *Table 6.*) Applications for incentive payments are not guaranteed to be funded, but as long as guidelines are met, generally a majority of applications are approved. As stated previously, these incentive payments should be viewed in the context of providing transition support rather than as a long-term economic subsidy.

Farmer Profile *Ken Rulon, Rulon Enterprises, Arcadia, Ind.*

Ken Rulon (far right) with family members who help manage their 6,000 acre farm in Indiana. *Photo courtesy Ken Rulon.*

Data Drives Fertility Decisions

Primary Cover Crops: *cereal rye, annual ryegrass, oats, radish, clover, rapeseed and hairy vetch*

To say that data drives decisions for Ken Rulon is an understatement. Utilizing 1 acre grid sampling for twenty-four years, Rulon and his family have learned there is a linear relationship between soil organic matter and yield. "The data is clear. We need something growing on the soil at all times," Rulon says. He farms approximately 6,000 acres with his family in north central Indiana. This fourth-generation family farm has used no-till management since 1989 and started using cover crops around 2006. Their general philosophy is that conservation is the best economic model and that oxidizing soil carbon through tillage is not sustainable long-term.

Once they combined cover crops with no-till, Rulon's soil organic matter levels increased more than 1% over the next decade on some fields. With cover crops, he documented increased soil moisture during the growing season, decreased soil surface temperatures, increased soil aggregate stability, increased soil organic matter levels and improved yields.

One of Rulon's primary goals with cover crops has been to increase soil organic matter levels and reduce input costs. He notes that research at Purdue University found cover crops reduced nitrogen leaching by 50%. Through his own experience, years of cover cropping has allowed Rulon to cut fertilizer use and still maintain adequate soil fertility levels. He reduced phosphorus inputs by 20 pounds per acre, potassium by 30 pounds per acre and nitrogen by 35 pounds per acre. In-field trials conducted for multiple years with multiple rates of nitrogen fertilizer demonstrate that 165 pounds of nitrogen per acre achieves maximum economic yields for his operation. This compares to the more typical rate for his region of 200 pounds of nitrogen per acre for corn.

The cost savings that come from reducing his fertilizer inputs has not resulted in lower yields. In fact, Rulon's operation consistently achieves yields higher than the county average. Multiple years of yield data confirm a yield benefit of approximately 7 bushels per acre for corn and almost 2 bushels per acres for soybeans.

Profitability aside, Rulon believes managing a sustainable operation implies they must meet their present needs without sacrificing the future. That is why he appreciates the role cover crops and no-till play in protecting the soil, sequestering carbon and improving the overall resilience of the farm. "We encourage everyone to develop data for their operation to find the system that works best on your soils and in your region," Rulon says.

Potential Impact of Cover Crops on Land Rentals and Tenancy

Efforts to identify how cover crops influence land values and rents are in their early stages. However, it is easy to imagine that because cover crops improve soil health, which in turn improves field productivity, they could in time raise land values. This could benefit both the farmer and the landowner.

Incentive payments offered through NRCS are higher when planting a multi-species cover crop mix. The mix in this field includes oats, proso millet, canola, sunflowers, dry peas, soybeans and pasja turnips. *Photo by Mark Liebig, USDA ARS.*

For the farmer

Farmers who rent cropland or farm under crop-share tenant agreements know that having good relationships with relevant landowners is important. With an increasing number of landowners expressing interest in having their land managed with good stewardship, there are opportunities to enhance relationships with landowners by using cover crops. The National Cover Crop Survey found that 61% of farmers using cover crops had support from their landowners to do so, and only 5% had landowners who opposed cover crops; the rest were either neutral or the farmer did not know the landowner's attitude toward cover crops.[5]

Looking ahead, farmers seeking to expand their acres could cite their cover crop experience as a selling point for winning a new lease agreement, at least with conservation-minded landowners. Greater access to land may be one of the hidden economic benefits of being a cover crop farmer. A young farmer in Missouri recently reported that his use of cover crops had given him an advantage when he picked up an extra 150 acres to rent. The rental rate he offered to pay was a little lower than other farmers who bid to rent the ground, but his emphasis on cover crops was attractive to the landowner.

For the landowner

Many landowners value conservation and certainly all want the value of their farmland maintained or enhanced. As understanding of soil health measurement continues to grow, we can expect that soon it will be possible to gauge farmland productivity with selected soil health measurements, at least in aggregate. Where landowners have documented improvements in soil health, such as long-term increases in soil organic matter, it should be possible to gain economic value from that increased soil health. That economic value associated with soil health may reflect itself in increased land prices should the land be sold at some point.

Fall Line Capital is an example of how land investment and management is changing. Clay Mitchell, an Iowa farmer who cofounded Fall Line and is now a managing director, has sought to improve soil health on the farms they invest in through the use of cover crops and other conservation strategies such as no-till. A key goal for the company is improving the overall value of the land as part of the value proposition for their investors.

Looking Ahead on Cover Crop Economics

Two new trends are likely to impact cover crop economics going forward, in terms of both on-farm and off-farm economics. (See the section *The Off-Farm Impacts of Cover Crops.*) One trend is the rising interest of food, beverage and clothing companies in documenting the sustainability of their supply chain. These companies are

identifying cover crops as a relatively easy way to document which fields are being managed in a more sustainable fashion. Using cover crops may increase a farmer's access to these companies' markets, or in some cases, lead to incentives. For example, Unilever has done pilot projects to encourage cover crops in Iowa by paying a $0.10 premium per bushel of soybeans, as well as more standard per acre incentive payments.

Likewise, a number of U.S. commodity buyers, including Cargill, Tyson, General Mills, Unilever and Wal-Mart have shown strong interest in the use of cover crops to improve soil health and sustainability within their supply chain. In 2018, Tyson announced efforts to improve environmental practices, including cover crops, on 2 million acres of corn in close proximity to select mills. Wrangler Jeans launched their "Tough Denim, Gentle Footprint" initiative that encourages cotton growers to use soil conservation practices, including cover crops.

The second trend is the interest in developing "ecosystem services markets." The underlying concept is that farmers will receive financial incentives from the private sector for doing conservation practices such as cover crops. The Soil Health Institute has been working with the Noble Research Institute to set up a sizable new ecosystem services market. Initially, this market will be offered to producers in the Southern Plains, but will likely expand to other geographic areas later on. The exact details were still developing as this publication went to press.

The Off-Farm Impacts of Cover Crops

The real-world effect of farm activities extends well beyond the farm gate. Collectively, the activities of farming operations affect not only regional ecosystems but also rural communities and society as a whole. As part of a holistic review of cover crop economics, it is worth noting some of the ways that cover crops can influence off-farm economics, especially in a consumer culture where buyers increasingly want to know the origin and environmental impact of the products they buy.

Researchers have found that cover crops are very effective at protecting water quality. Here, cover crops are growing in fields along the Chesapeake Bay. *Photo by Edwin Remsberg.*

Water Quality

Everyone wants clean water, whether it is safe drinking water or clear lakes and rivers. Unfortunately, nitrates and phosphorus have become a water quality issue in many areas due to a variety of nonpoint sources. Hypoxic (low oxygen) zones in the Chesapeake Bay, Gulf of Mexico and elsewhere are caused by the presence of too many nutrients like nitrogen and phosphorus. In these areas, fish and shellfish cannot survive due to a lack of oxygen, and as a result local fishing industries suffer millions of dollars of losses per year. Concern over these hypoxic zones has caused policymakers and farmers to work to reduce nitrogen and phosphorus loads to U.S. waterways, including the Mississippi River Basin. Agriculture is by no means the

only source of nutrients to the Gulf and other waterways, but it is a significant source, which means that producers have an opportunity to reduce pollutant loads and improve water quality.

Cover crops represent one of the best ways farmers can improve water quality while also contributing to the profitability of their operation. Cover crops reduce nutrient losses by holding the soil in place and taking up excess nitrogen from the soil during winter months. A review of numerous research studies showed that they provide a median reduction of 48% in nitrogen leaching from farms.[17] In addition, cover crops have shown to reduce soil erosion, on average reducing soil loss by 20.8 tons per acre compared to conventional fields.[18] Cover crops also promote rainfall infiltration, which increases water flow into the soil profile by more than six-fold in some systems. The more water that enters the soil profile, the less runoff that flows over the field and the less total risk of erosion. Eroded soil particles carry sediment with them into waterways.

Closer to home for Iowa farmers, the state of Iowa is increasingly concerned about the human health consequences of nutrient water pollution and is actively looking for solutions. Some utilities in the state have invested over $1.6 million in recent years to improve their nitrate removal systems due to high levels.[15]

Infrastructure Costs

When cover crops improve rainfall infiltration and reduce soil erosion, the potential benefits extend beyond curbing pollution. It is possible that by reducing sediment loads to waterways, cover crops may actually reduce how often waterways must be dredged, thus saving taxpayer dollars. And, with increasingly heavy rainfalls occurring in recent years, the promise of better infiltration means that cover-cropped farmland could reduce flood risk and mitigate the costs associated with post-flood cleanup like repairing damaged bridges. A recent report by the Union of Concerned Scientists discussed how building healthy soils could reduce runoff and flood frequency by 20% in flood years.[1] Using cover crops and no-till over the majority of a watershed to improve rainfall infiltration can also lessen the need for costly work to raise dam heights in order to deal with more rain.

Carbon

Carbon dioxide concentrations in the Earth's atmosphere have led state and Federal governments across the globe to consider policy measures aimed at pulling down carbon and storing it, with the ultimate goal of mitigating climate change.

The soil is one of the Earth's largest carbon reservoirs, and cover crops are one practice that actively promotes carbon sequestration. A literature review found that cover crops can sequester a median value of 0.58 tons of carbon per acre.[16] The societal benefits of carbon sequestration can be realized in reduced costs associated with a changing climate; the direct economic value of a ton of carbon was listed as $15.10 in the state of California in 2018.[3] It has been suggested that farmers should be compensated at $16 per acre per year for sequestering soil carbon and for provisioning other ecosystem service benefits to society.[10]

Biodiversity

Wild insects, birds and mammals can benefit from cover crops, too. Groundcover increases the available forage and habitat for these animals, especially during seasonal changes when birds are migrating and when winter food may be tough to find. For example, an Illinois research project documented more waterfowl and songbirds where cover crops were used compared to fields without covers.[19] For pollinators, cover crops provide forage, which helps keep these beneficial insects healthy and fed.

Increased biodiversity may also benefit state tourism by allowing better hunting opportunities for birds and deer during the non-growing season.

Cover crops can represent a recreation opportunity by helping to provide year-round food and habitat for wildlife such as deer. *Photo Courtesy the Missouri Department of Conservation.*

Other Potential Societal Savings from Cover Crops

The biggest single outlay by the Federal Government in support of crop farms is for crop insurance. From 2007 to 2016, the Congressional Research Service (CRS) calculated that the net cost of Federal crop insurance was $72 billion. Looking ahead, CRS projects that Federal crop insurance will cost $77 billion from 2018 to 2027. Cover crops are certainly not a replacement for the Federal Crop Insurance Program, but there is evidence that widespread use of cover crops over multiple years can reduce some of the costs of crop insurance for taxpayers. This is because cover crops improve soil resiliency, which helps reduce yield losses in drought years.

The Bottom Line on Cover Crops

To be sure, determining the economic impact of planting a cover crop is not as simple as a 1 year, cost-and return analysis. Ultimately, the decision to plant a cover crop should be viewed as an investment in the long-term resilience of the farm. Many factors, from particular on-farm challenges to the gradual accrual of soil health benefits, will influence when cover crops start to pay off.

Four types of cover crops, including annual rye, oilseed radish, crimson clover and rapeseed, are being seeded into wheat stubble. Photo by Dianne Johnson, USDA NRCS.

When do cover crops start to pay?

With all of the variables described in this bulletin, **it's probably safe to say that often, by year 3, cover crops will be paying for themselves, if not earlier.** There are times when that return on investment could take a little longer, but there are even more situations in which that return can be accelerated. This happens most often when a cover crop is meeting particular on-farm needs, such as dealing with herbicide-resistant weeds, reducing soil compaction, helping with soil moisture management and soil fertility, or providing grazing opportunities.

What is the soil health impact from cover crops 3 to 5 years down the road?

After 3 to 5 years of annual use, well-managed cover crops should start to bring about soil health improvements that improve yields and save on input costs. Not all soil health measures will respond equally fast. For example, earthworm activity and some bacteria and fungi will respond within the first year of cover crop use. However, it can take 5 years or more before soil organic matter starts to noticeably improve, depending on how the cover crops are managed and what tillage is done. A key point is that cover crop benefits keep accruing over several years. The economic return at year 5 should generally be greater than year 3, and year 7 should be greater than year 5.

What is the bottom-line economic impact?

A positive first-year return from cover crop use will often occur during drought conditions, where cover crops are grazed (assuming that grazing infrastructure is already in place), or potentially in a situation with challenging herbicide-resistant weeds. When converting from conventional till to no-till, cover crops can help ease that transition, making it possible to break even in year 1 for soybeans and to make a small return by year 2 with corn. When compaction or soil fertility is limiting yield, cover crops may provide a positive net return by the second year. Receiving incentive payments from Federal or state government programs can also make it possible to immediately pay for the cost of cover cropping during a transition period.

Under the most conservative assumptions for the analysis reported here, where there are no particular issues being addressed, no incentive payments or grazing, and normal rainfall, it will take on average about 3 years of planting a cover crop for the practice to break even or provide a net profit, not unlike applying lime to address soil pH. By year 5, on most fields, cover crops should be producing a modest profit due to a combination of yield increases and somewhat lower production costs.

The contribution cover crops make to farm resiliency is also under-appreciated. Consider that the majority of farmers carry crop insurance to reduce risk. Cover crops are a form of risk management like crop insurance; investing in them to improve soil health will help reduce future risk from weather extremes. Significant cover crop payoffs have been documented in drought years, where yield increases of more than 10% may be seen. Even in wet years there can be a noticeable benefit

from the improved aeration and soil structure provided by cover crops, allowing spring planting or fall harvest to start 2 to 3 days earlier following cover crops.

Ultimately, a broad-based, holistic perspective is helpful in factoring in all the different ways that cover crops can benefit a field and a farm. As farmers gain experience with cover crops, they end up making other management changes that complement the cover crops and maximize their overall economic efficiency while improving the sustainability of their farming livelihood. The bottom line is that cover crops should be valued both for their immediate benefits and as an investment in the long-term success of the farm.

Resources and References

The NRCS "cover crop economics tool" is a free downloadable spreadsheet that evaluates the cover crop payoff period based on the user's data. Interpretative materials and supportive videos are also available through the NRCS website. Additionally, NRCS has an extensive series of soil health fact sheets and videos available through their website. Search "NRCS soil health." SARE has multiple publications and online resources pertaining to cover crops, including:

- Managing Cover Crops Profitably (*www.sare.org/mccp*)
- Building Soils for Better Crops (*www.sare.org/bsbc*)
- The Cover Crops topic room, an extensive set of cover crop resources (*www.sare.org/covercrops*)

The nonprofit Soil Health Institute offers a growing number of publications and videos pertaining to cover crops and soil health. See *www.soilhealthinstitute.org*.

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SUBMITTED STATEMENT BY BEN SCHOLZ, PRESIDENT, NATIONAL ASSOCIATION OF WHEAT GROWERS

Chair Spanberger, Ranking Member LaMalfa, and Committee Members, I am Ben Scholz, a wheat farmer from Lavon, Texas and President of the National Association of Wheat Growers (NAWG). NAWG represents wheat growers across the nation and works with a team of 21 state wheat grower organizations to advocate for the wheat industry. Thank you for the opportunity to submit testimony regarding soil health. The National Wheat Foundation (NWF), of which NAWG is the only member, serves as the national center for wheat research information, education and outreach.

Wheat growers see conservation as the heart of farming. Farmers want to leave the land in better condition than they found it which means including management practices aimed at improving soil health into their operations. It may come as no surprise to Members of the Subcommittee, but the reality of wheat production in the U.S. is that acres planted to it have been on a steady decline. To address this decline while promoting long-term sustainability, the National Wheat Foundation is investing in programs to help growers have a better understanding of the link between crop rotation, on-farm management practices, yield and quality of the wheat crop harvested. Let me remind you, wheat is a "food" crop. Unlike the other large acre, feed grain commodities in the U.S., quality of wheat is measured at the first point of delivery and reflected in the price a wheat grower receives. Wheat growers are motivated to look at all management practices that will improve the quality of wheat for millers, bakers, and ultimately, the consumers of all products made from wheat.

In late 2017, the National Wheat Foundation joined the Soil Health Partnership (SHP). The Soil Health Partnership is a farmer-led initiative that fosters transformation in agriculture through improved soil health, benefiting both farmer profitability and the environment. SHP's mission is using science and data to support farmers in adopting practical agricultural practices that improve the economic and environmental sustainability of the farm. Administered by the National Corn Growers Association, the partnership has more than 140 working farms enrolled in 14 states. The SHP brings together broad and diverse partners to work towards common goals, with initial and continuing funding and guidance from NCGA, Bayer, the Environmental Defense Fund, the Foundation for Food and Agriculture Research, The General Mills Foundation, Midwest Row Crop Collaborative, National Wheat Foundation, Natural Resources Conservation Service, The Nature Conservancy, the Pisces Foundation and the Walton Family Foundation. NWF and SHP are working together to demonstrate the soil health benefits of management practices and crop rotations that include wheat. Data will be collected to help assess the impact of different systems on productivity, profitability and wheat quality. SHP and NWF are working with wheat farmers to set up research trials and demonstration sites to move the project forward.

NWF and NAWG see wheat production having a key role in soil health. Wheat cropping systems provide opportunities to improve soil health. Improved soil health offers a potential link to grain quality as well as grain yield that we would like to further understand and share across wheat production systems. Our ability to quantify and communicate the connection of soil health helps wheat farmers and their supply chain partners ensure a productive, long-term supply of high-quality U.S. wheat. Through wheat's involvement in SHP, we hope to gain more information about the management practices needed to improve soil health, the soil health benefits on productivity, then share the information with growers and throughout the supply chain.

An important part of soil health practices and conservation tillage for wheat growers is access to appropriate crop protection tools. Glyphosate is an exceptional product for wheat growers because of its ability to effectively control a broad spectrum of plants post-emergent. Rather than using tillage to eliminate emerged weeds in their fields prior to planting, growers, instead, apply a labeled treatment of glyphosate to the weed growth. Undesirable plants that would otherwise provide competition for water and nutrients to the crop are controlled without using a tillage trip across their fields. Thus, glyphosate allows for direct seeding without disturbing the soil. This conservation tillage practice enables growers to leave the crop residue on the surface of the field. Maintaining residue on the field without disturbing the soil with tillage protects the soil from wind erosion, preserves moisture, preserves nutrients, and improves soil health. Direct seeding and conservation tillage have proven to sequester carbon in the soil, producing a carbon sink on farms. Keeping residue on the field serves as a mulch, allowing the soil to retain moisture and increase water filtration into the soil, reducing the amount of water that runs off the field. I have been practicing no-till/minimum till for more than 10 years and

according to USDA, conservation tillage practices were used by wheat growers on 67% of wheat acres in 2017, up from under 40% in 2004. Reducing tillage trips across the field is a conservation practice wheat growers know has a positive impact on soil health and on their ability to produce a quality crop over wide variation of climatic conditions. Conservation practices preserve the environment and improve soil health, sustaining the long-term viability of the farming operation. This would not be possible without the use of glyphosate. This unique product is critical to the sustainability of wheat production in the United States long-term.

Wheat growers across the country are also working directly with their local Natural Resource Conservation Services and Farm Service Agency offices to participate in USDA conservation programs. Working lands conservation programs such as the Environmental Quality Incentives Program, the Conservation Stewardship Program (CSP) and the Conservation Reserve Program provide valuable assistance to wheat growers. For example, under my CSP contact, one of the practices I am doing is to take tissue tests to lean results from soil test recommendations and application of nutrients. This helps me understand the impact of the nutrient application on the crop.

Whether working directly with USDA programs, state programs, or adopting conservation practices on their own, wheat growers are committed to managing their operations in a manner for long-term productivity, profitability and sustainability—economically and environmentally. We are investing in research to more clearly show the links between soil health, wheat crop quality and yield. We look forward to continuing to work with this Subcommittee on these important issues.

Sincerely,

BEN SCHOLZ,
President,
National Association of Wheat Growers.

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