THE SUSTAINABLE U.S. PORK FEED BLUEPRINT

FARMERS FOR SOIL HEALTH

United Soybean Board

National Corn Growers Association

Pork Checkoff

THE SUSTAINABLE
U.S. PORK FEED
BLUEPRINT

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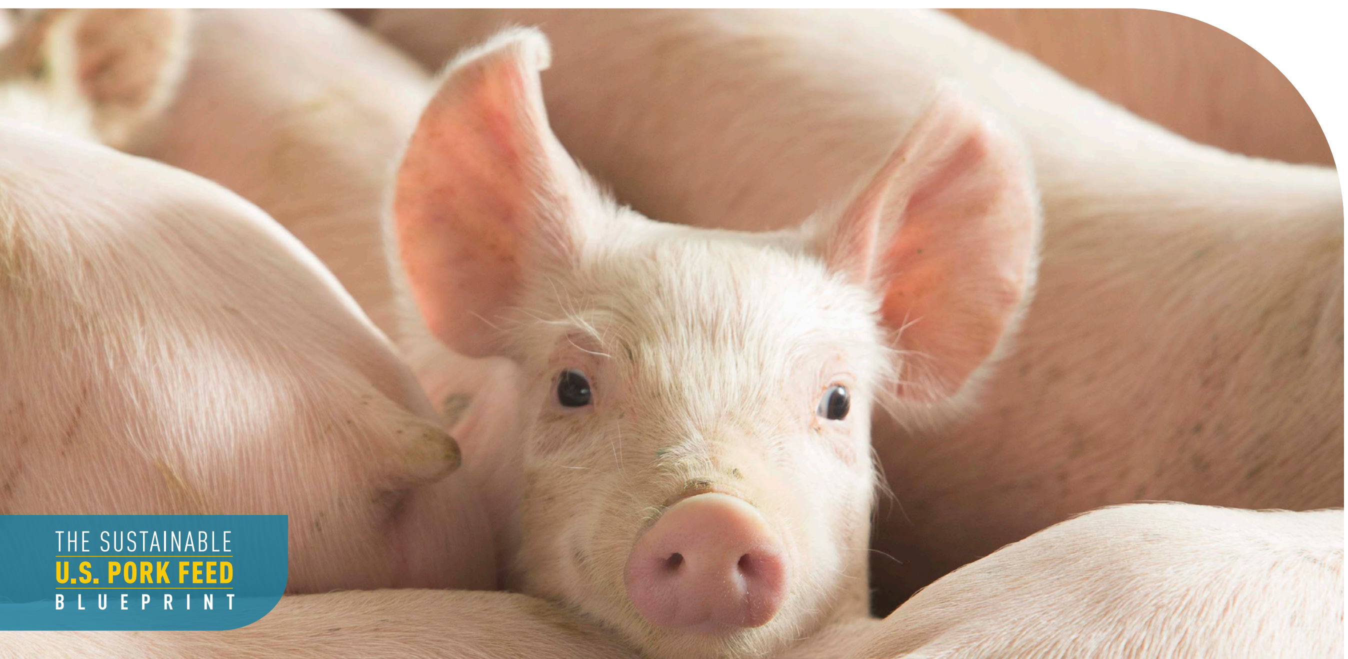
Foreword

Nearly every link in the food supply chain has faced a growing number of questions in recent years about food ingredients. The focus of these inquiries has increasingly shifted from the composition of the ingredients to production practices and environmental impact.

Corn and soybean farmers have long been committed to providing the ingredients livestock customers need. Now, increased demand for sustainably sourced feed ingredients means it is more important than ever for the U.S. corn and soybean industries to demonstrate their commitment to sustainable production standards.

In recent decades, through innovation and efficiency, animal feed has proven to be an essential part of the solution to make the livestock production chain more sustainable. Working toward more sustainable animal feed presents opportunities to improve animal nutrition, grow customer trust and brand loyalty, build more resilient supply chains, reduce costs and strengthen supplier relationships.

This blueprint highlights the collaboration of U.S. pork producers with U.S. corn and soybean farmers who have already made big strides to improve the sustainability of crop production and, ultimately, pork production. Sustainability improvements by corn and soybean farmers create environmental benefits for animal feed production, which ultimately benefit the retail customer to create a protein supply chain fit for the future.



United Soybean Board:
Ralph Lott, Chair
Seneca Falls, NY

National Corn Growers Association:
John Linder, Chair
Edison, OH

National Pork Board:
Gene Noem, President
Howard County, IA

Pork Sustainability Begins with Corn and Soy

Sustainability doesn't start with the pig. It starts with what's in their trough — mostly corn and soybean meal. Each year, 60% of all U.S.-grown soybean meal goes toward feed rations for poultry and swine domestically.[1] In 2020, nearly 39% of corn bushels produced were used as a component in animal feed.[3] Animal agriculture is the No.1 customer of the U.S. soybean[2] and corn industries.[3] With more than 115 million hogs marketed by pork producers annually,[4] the farmers responsible for growing corn and soy also assume some of the responsibility for improving the sustainability of pork products.

The sustainability practices implemented by corn and soybean farmers address the specific challenges on their individual farms and also meet the needs and demands of their customers and the environment. Farmers work to protect the water, air and land — the foundation of their economic stability as well as elements essential to the health of the planet. Through these sustainability practices, farmers aim to reduce greenhouse gas emissions, increase energy use efficiency, increase land use efficiency, improve soil conservation and soil health, promote water management and grow biodiversity.

Sustainability is recognized as a competitive advantage for agriculture. Sustainable farming is one tenet of the U.S. Soy Advantage,[5] which serves as the foundation of the U.S. soybean industry and focuses on investment in continuous improvement and meeting customer needs. The additional elements of the U.S. Soy Advantage are exceptional composition, consistent supply and innovation beyond the bushel.[6]
U.S. corn farmers are also focused on sustainability and being stewards of the land. The National Corn Growers Association formed the Corn Sustainability Advisory Group, consisting primarily of corn farmers from across the country. This group developed the U.S. Corn Sustainability Goals and the NCGA Sustainability Report to share the U.S. corn sustainability story and continue to grow competitive market demand for this crop.[7] Additionally, NCGA and the Environmental Defense Fund joined forces to create the Success in Stewardship Network,[8] which connects farmers to programs that aid in overcoming barriers to conservation.[7] The agriculture industry acknowledges and applauds the commendable

Animal agriculture is the No. 1 customer of the U.S. soy and corn industries.

efforts of retail and food companies to reduce U.S. agriculture's environmental footprint across the supply chain and meet corporate sustainability targets. Additionally, in 2020, the U.S. Department of Agriculture announced a goal of reducing agriculture's environmental footprint by 50% by 2050 as part of the Agriculture Innovation Agenda.[9] With approximately 180 million acres combined, corn and soybeans account for more than half of all acres of U.S. row crop production. And that's where U.S. corn and soybean farmers come in.

We understand the importance of working together to collaborate on the shared goals of implementing best practices, tracking progress and continuing to drive continuous improvement at the farm gate. Through leadership, innovation, engagement and collaboration, we present this blueprint as a tool that supports our goal to demonstrate continuous improvement in sustainability.

About This Blueprint

The following blueprint aggregates a collection of best management practices commonly used on farms today. We look forward to continuing to build on this information by encouraging the adoption of these practices on more corn and soybean acres. By working together with stakeholders like the Environmental Defense Fund, we hope to continually reaffirm the U.S. corn and soybean value chain as a trusted leader in environmentally sound, socially responsible and economically viable agricultural production.

Our Partners

The **United Soybean Board's** 78 volunteer farmer-directors work on behalf of the more than 500,000 U.S. soybean farmers to achieve maximum value for their soy checkoff investments.[10] These board members invest and leverage checkoff funds to focus investments into three key areas — education, promotion and research — to foster demand for U.S. soybeans. That preference is based on U.S. soybean meal and oil quality and the sustainability of U.S. soybeans, which helps deliver maximum ROI for U.S. soybean farmers.[11]

The **National Corn Growers Association** represents nearly 40,000 dues-paying corn farmers nationwide and the interests of more than 300,000 growers who contribute through corn checkoff programs in their states. NCGA and its 50 affiliated state organizations work together to create and increase opportunities for corn growers by investing in research, promotion and educational opportunities in a variety of areas, including ethanol, sustainability and trade.[12]

The **National Pork Board** funds national and state programs in consumer education and marketing, retail and food service marketing, export market promotion, production improvement, science and technology, swine health, pork safety, and environmental management and sustainability. The National Pork Board and its 15 producer-directors represent the 60,000 pig farmers in the United States who pay into the pork checkoff, which funds research, promotion and education efforts on behalf of the U.S. pork industry.

For the past half-century, the U.S. pork industry has made significant strides in reducing the environmental impact of pig farming.[13]

The **Environmental Defense Fund** provided additional feedback and contributions to this blueprint. EDF creates transformational solutions to the most serious environmental problems by linking science, economics, law and innovative private-sector partnerships. With more than 2.5 million members and offices in the United States, China, Mexico, Indonesia and the European Union, EDF has staff working in 28 countries to turn solutions into action.[14]

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KEY INDICATORS

By adapting tried-and-true practices and adopting new methods and technology, corn and soybean farmers and pork producers seek to **deliver a sustainable product** for their customers and, ultimately, the consumer.

Key Indicators of Improvement in Environmental Outcomes

In terms of sustainability improvements in the pork supply chain, intention without action is not enough. It is one thing to strive for change; it is another to plan for and measure it. That is why the United Soybean Board, National Corn Growers Association and National Pork Board all have established sustainability goals that they will use to measure success within the next decade. These organizations, and the corn and soybean farmers and pork producers they represent, are committed to a state of continuous improvement in terms of sustainability.

Although a wide variety of sustainable improvements are being implemented across the industry, USB, NCGA and NPB have identified and focused on meeting goals in four major areas.

INCREASE
ENERGY USE EFFICIENCY

REDUCE
GREENHOUSE GAS EMISSIONS

IMPROVE
LAND USE EFFICIENCY

INCREASE
SOIL CONSERVATION

INCREASE ENERGY USE EFFICIENCY

Running a successful farm requires energy. However, as technology has evolved and improved over the years, energy use efficiency has improved along with it. From 1980 to 2020, the energy used to produce a bushel of corn and soybeans, measured in BTUs per bushel, has decreased by 55% and 45%, respectively.[1]

This energy savings can be attributed to the creation and adoption of tools such as biotech seeds, which reduce the number of pesticide applications — and therefore trips through the field with equipment — required to produce a crop. Diesel engines and the increased use of renewable fuels such as ethanol and biodiesel in on-farm equipment have also helped manage energy use levels. Farmers have been able to improve micro-level energy use on the farm while they measure impacts at the macro level by tracking reductions through the life cycles of the products they produce, such as those of renewable fuels.[2]

Both USB and NCGA have goals in place to strive for an increase in energy use efficiency in corn and soybean production. USB aims to increase energy use efficiency by 10%, measured in BTUs per year, by 2025[3] from a 2000 baseline,[4] while NCGA's goal is to increase efficiency by 13% by 2030 from a 2020 baseline.[5]

REDUCE GREENHOUSE GAS EMISSIONS

The journey toward decarbonization and reducing greenhouse gas emissions is a priority for pork customers around the globe. Therefore, it is a priority for corn, soybean and pork producers as well.

From 1980 to 2020, soybean production saw a 42% decrease in pounds of CO_2-equivalent gases emitted per bushel, while corn production saw a 48% reduction per bushel.[1] Greenhouse gas reduction is partially a result of improving soil health and water management. Conservation tillage and no-till systems reduce emissions by cutting out extra equipment passes. Efficient irrigation water use also has a positive impact on greenhouse gas emissions.[6]

NPB's goal states, "By 2030, the U.S. pork industry will reduce GHG emissions by 40% from a 2015 baseline." This goal will be measured by the carbon emissions per pound of pork produced and levels of renewable energy generation and carbon sequestration by producers.[7]

USB and NCGA have established their own goals to reduce greenhouse gas emissions in soybean and corn production. For USB, that goal is to reduce greenhouse gas emissions from soybean production by 10%, measured in pounds of CO_2-equivalent gases emitted per year by 2025[3] from a 2000 baseline.[4] NCGA intends to cut greenhouse gas emissions by 13% by 2030 from a 2020 baseline.[5]

IMPROVE LAND USE EFFICIENCY

As the global population grows, agricultural production must grow alongside it to keep up with the increased demand for food, fuel and fiber. As crop production increases, what often happens is less productive land is brought into production, leading to the need for more resources to make the land viable to produce a crop. As agricultural land expands, it also encroaches upon the natural habitats of living ecosystems.

To avoid this, maintaining and improving yields on existing cropland is crucial, and it is a priority for USB, NCGA and NPB. In fact, NPB's goal is to use regenerative agricultural practices to improve soil, land and biodiversity while restoring and protecting natural habitats to further decrease their land use footprint from a 2020 baseline. This is measured by the acres of land used for pork production per year and the acres of land under regenerative agricultural practices per year, as well as the acres protected or restored, including riparian areas.[7] USB intends to reduce land use impact among soybean farmers by 10%, measured by acres per bushel, by 2025[3] from a 2000 baseline.[4] NCGA's goal is to increase land use efficiency by 12% by 2030 from a 2020 baseline.[5]

INCREASE SOIL CONSERVATION

Healthy soils are the foundation of agricultural production. With a solid foundation, farmers can produce a strong, thriving crop. When the soil is healthy, its water- and nutrient-holding capacities improve, which often reduces the fertilizer needs of the crop. USB, NCGA and NPB all support soil conservation through their sustainability goals.

Corn and soybean farmers have already made progress in soil conservation. Soil erosion, measured in tons of soil loss per acre, decreased by 40% in corn production from 1980 to 2020 and by 35% in soybean production.[1] Farmers work to maintain and increase the health of the soil through practices such as conservation tillage and other soil conservation strategies. Practices like cover crops help sequester carbon and hold nutrients in the soil for the next cash crop and hold the soil in place to prevent it from running off into nearby waterways.[2]

Looking ahead to the next decade, both corn and soybean farmers will continue improving soil conservation. USB's goal is to reduce soil erosion by an additional 25%, measured in tons of soil loss per acre, by 2025[3] from a 2000 baseline[4] while NCGA aims to reduce soil erosion by 13% by 2030 from a 2020 baseline.[5]

The progress USB, NCGA and NPB have made toward improving these key indicators, along with the goals established for the next decade, has set a clear path forward to a more sustainable pork supply chain.

By adapting tried-and-true practices and adopting new methods and technology, corn and soybean farmers and pork producers seek to deliver a sustainable product for their customers and, ultimately, the consumer.

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SUSTAINABLE PRACTICES

Farmers have made significant progress in **reducing impacts** on land, water and air.

Recommended Improvements: Sustainable Agricultural Practices

U.S. corn and soybean farmers embrace sustainable agricultural practices, meeting today's needs for feedstuffs without compromising future needs. In a 2018 survey conducted by the United Soybean Board, nearly 60% of farmers said they have changed their production practices to increase the sustainability of their operations.[1] And according to the National Corn Growers Association and their Success in Stewardship Network, practices that protect the land and water and increase climate resilience are becoming the norm.[2] Through the adoption of sustainable agricultural practices that protect — and even benefit — the environment and natural resources, farmers have made significant progress in reducing impacts on land, water and air. These practices have also increased productivity over the past few decades.

At the same time, farmers recognize opportunities to improve. Corn and soybean production can continue to be more efficient and sustainable, in turn reducing the overall environmental footprint of feed for pork production.

The following pages of this blueprint describe many field-level practices currently implemented by U.S. corn and soybean farmers that demonstrate progress in terms of sustainable production. These sections also identify opportunities for continuous improvement to work toward sustainable outcomes in the following areas:

Cover Crops

Conservation Tillage (reduced tillage and no-till)

Nutrient Management

Pest Management

Water Management

Land Use

Wildlife Habitats

Equipment and Technology

Edge-of-Field Practices

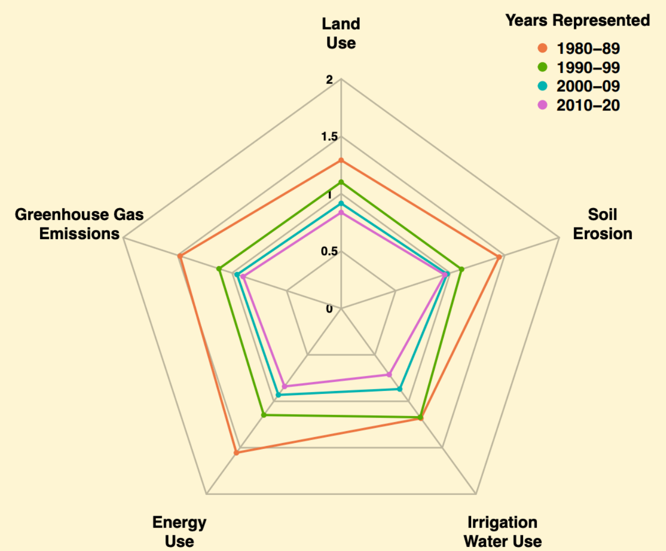
Renewable Fuels

Sustainable Agricultural Practices Data Sources

The latest U.S. Department of Agriculture Census of Agriculture, conducted every five years, provides insight on the change in adoption of major field-level practices. This blueprint highlights agriculture census data specific to the North American Industry Classification System category "oilseed and grain farming" unless stated otherwise. Percentages represent total cropland for that category. Production of corn for grain and soybeans, the primary feedstuffs for pork production, accounted for 74% of the acres in the oilseed and grain farming category in 2017.[3]

Figure 1.2.1. Summary chart of indicators for corn grain during 1980-2020

Data are presented in index form, where all indicators have been scaled by indicator averages for the period 1998-2002. A 0.1 point change is equal to a 10 percent difference. Index values allow for comparison of change across indicators with different units of measure. A smaller area represents improvement over time.



Indicators averages for corn grain for the period 1998-2002

Indicator	Value	Units
Land Use	0.00757	Planted Acres Per Bushel
Irrigation Water Use	0.254	Acre-inches Per Bushel
Soil Erosion	4.88	Tons Soil Loss Per Acre
Energy Use	48,700	BTU Per Bushel
Greenhouse Gas Emissions	12.8	Pounds of CO_2 Eq. Per Bushel

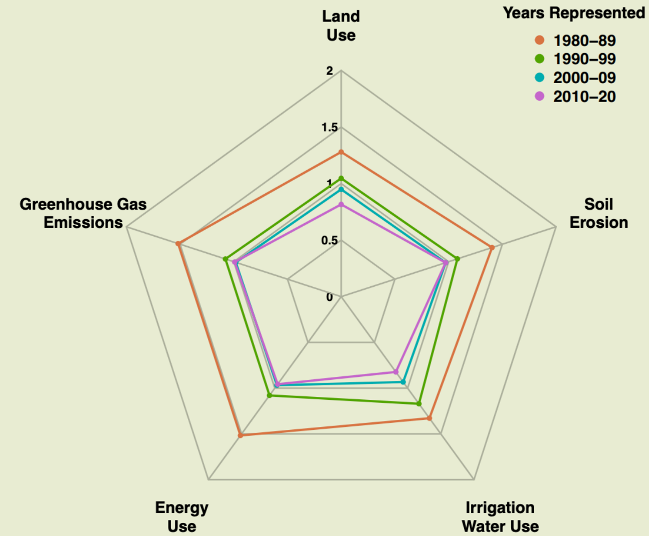
Source: Field to Market National Indicators Report, 2021.

Conservation Practices Physical Effects National Summary Tool FY2021

The USDA Natural Resources Conservation Service provides financial and technical assistance to farmers who voluntarily incorporate conservation practices to protect the environment while improving their operations. The Conservation Practices Physical Effects spreadsheet describes a variety of environmental impacts of specific practices on soil, water, air, plants, animals, energy and people.[4] This tool qualifies and explains the benefits of sustainable agricultural practices discussed in this blueprint.

Figure 1.9.1. Summary chart of indicators for soybeans during 1980-2020

Data are presented in index form, where all indicators have been scaled by indicator averages for the period 1998-2002. A 0.1 point change is equal to a 10 percent difference. Index values allow for comparison of change across indicators with different units of measure. A smaller area represents improvement over time.



Indicators averages for soybeans for the period 1998-2002

Indicator	Value	Units
Land Use	0.0267	Planted Acres Per Bushel
Irrigation Water Use	0.73	Acre-inches Per Bushel
Soil Erosion	4.78	Tons Soil Loss Per Acre
Energy Use	43,100	BTU Per Bushel
Greenhouse Gas Emissions	8.06	Pounds of CO_2 Eq. Per Bushel

Source: Field to Market National Indicators Report, 2021.

Field to Market National Indicators Report

Field to Market is an alliance of diverse partners working together to define, measure and advance the sustainability of food, fiber and fuel production.

The peer-reviewed 2021 National Indicators Report analyzes sustainability metrics for U.S. agriculture and provides science-based measurement of sustainability outcomes for commodity crop production.

It provides context for the progress of sustainable agricultural practices and identifies areas for improvement. Crop-specific data shared in this blueprint references production of corn for grain and soybeans.[5]

Source: Field to Market.

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COVER CROPS
Cover crops are planted primarily for long-term benefits to the soil.
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While farmers plant most crops, including corn and soybeans, to harvest and sell, cover crops are planted primarily for long-term benefits to the soil. Cover crops offer moderate to substantial improvement in soil erosion, greenhouse gas emissions and plant health, as well as slight to moderate improvements in soil health and water quality.[1]

In a corn-soybean production system, the most common practice for U.S. row crops, farmers typically plant cover crops in the fall following harvest of corn or soybeans, the cash crop. Cover crop seeds sprout and grow as long as the weather allows, go dormant for the winter and grow again in the spring until they are terminated to make way for the next cash crop.

Maintaining vegetative cover whenever possible supports soil health and prevents soil movement, allowing cover crops to provide many benefits to farmers. A wide variety of cover crop management practices allows farmers to adapt species to fit their climate, crop rotation and soil health needs. For example, mild winters in the southern U.S. allow cover crops a longer active growing season to produce more biomass. In the northern U.S., farmers can choose a cover crop mix that allows them to rely on winterkill for termination.

Cover crop adoption within corn and soybean production systems is in the early stages. In 2012, farmers planted 4.4 million acres of cover crops on their oilseed and grain farms, representing just 1.9% of the cash crop acres planted that year.[2] By 2017, cover crop adoption expanded to 7.9 million acres, or 3.3% of oilseed and grain cash crop acres.[3] That's roughly an 80% increase in cover crop acres in just five years, and anecdotal industry observations indicate that growth rate is continuing.

FARMER FEATURE

Incorporating Cover Crops into a Nutrient Management Strategy

For Iowa farmers Roger and son Wesley Zylstra, adopting cover crops while adjusting their nutrient management strategy helped them meet soil health, yield and economic goals. They raise pigs, so they use manure for soil nutrients. As they experimented with cover crop seeding practices and nutrient application timings, they found they could achieve higher corn yields while applying the same amount of nitrogen. Timing nutrient availability from manure and cover crop breakdown supported optimal cash crop growth. They have now started experimenting with planting corn and soybeans into green cover crops in the spring. Soil health testing suggests that microbial activity has increased. And they are seeing improvement in soil structure, with fewer equipment tracks and less ponding in the field after large rains.

Research and a growing body of experience show that cover crops provide many sustainability benefits, depending on management practices.

Cover crops can reduce erosion by keeping living roots in the soil and holding soil in place during the winter. This can improve water quality by reducing soil sediment and nutrients carried away by water.[4] Research shows that, on average, cover crops reduce sediment losses from erosion by 20.8 tons per acre on conventional-till fields, 6.5 tons per acre on reduced-till fields and 1.2 tons per acre on no-till fields.[5]

The organic matter cover crops produce both above and below ground as they grow improves soil structure and characteristics that can increase water storage and water infiltration. Soils that accept and store moisture better can reduce erosion and buffer the impacts of extreme weather events such as droughts and floods.[4] A wide range of studies found that non-legume cover crops like grasses increase water infiltration by 8% to 462%, while legume cover crops such as clovers increase infiltration by 39% to 528%.[6]

Cover crops help reduce nutrient loss and improve water quality by scavenging residual nutrients not used by the cash crop.[4] For example, cover crops led to reductions in the amount of nitrogen leaving fields at a median value of 48% across 10 studies, and phosphorus loads dropped between 15% and 92% in water samples from related studies.[7]

Maintaining living plants in fields encourages soil microbial activity, improving soil fertility and nutrient cycling in the soil. This activity can reduce the need for fertilizer inputs and enhance nutrient management.[4] Respiration, the amount of carbon dioxide released from soil and a gauge of microbial soil activity, is one of the key soil health indicators showing consistent positive changes due to cover crops.[8]

In multiyear cover crop research, soils with cover crops contained up to nearly .05 milligrams of carbon dioxide per gram more than soil from control strips — a sign of more microbial activity to break down residue and make nutrients more available to cash crops.[8] And in the 2019-20 National Cover Crop Survey, 49% of participants planting corn reported reduced fertilizer costs, as did 41% of participants planting soybeans.[9]

Some cover crops help suppress weeds, including herbicide-resistant weeds, which can reduce the need for herbicides.[4] In the short term, most fields require similar herbicide programs as cover crops are incorporated. However, as the practice increases the consistency of weed control, cover crops may support less intensive herbicide programs over the long term.[10] According to researchers, cover crops have the potential to reduce the density and size of weeds early in the growing season, improving herbicide effectiveness.[11]

Farmers measure reduction in herbicide use through cost savings. Although savings vary, 39% of National Cover Crop Survey participants planting corn reported herbicide cost savings in fields following cover crops compared to fields without them, and an additional 40% reported better weed control in corn for the same herbicide cost following cover crops. Similarly, 41% of those planting soybeans reported reduced herbicide costs following cover crops, and an additional 40% got better weed control at the same cost.[9]

Cover crops also add organic material to the soil, which holds the potential to store carbon in the soil.[4] Soil organic matter is the primary way carbon is stored, or sequestered, in soil.[12] According to the U.S. Department of Agriculture Sustainable Agriculture Research and Education program, a variety of research shows that cover crops increase soil organic matter levels anywhere from 8% to 114%, depending on species and management, and organic matter is comprised of about 58% carbon.[13]

FARMER FEATURE

Cover Crops a Key to Regenerative Agriculture

Since starting to incorporate cover crops in 2018, Kentucky farmers Brad and son Joel Reddick have seen benefits to their soil health and a reduction in input costs. With cover crops, they have observed their soil getting darker and retaining water better. They have found that planting cash crops into green cover crops and leaving residue on the soil keeps it cool during the height of summer. On their farm, they have found that cover crops suppress weed pressure, keep soil from touching leaves of emerging plants to reduce the risk of disease spread, and eliminate slug damage and the need for insecticides. Beneficial insects are thriving, further reducing pest damage to crops. They have reduced fuel costs and equipment wear because they make fewer trips through the field. With improved soil health, they have been able to decrease fertilizer application rates, reducing the risk of runoff and protecting water quality leaving their farm. In addition, their cover crops serve as a grazing option for their cattle.

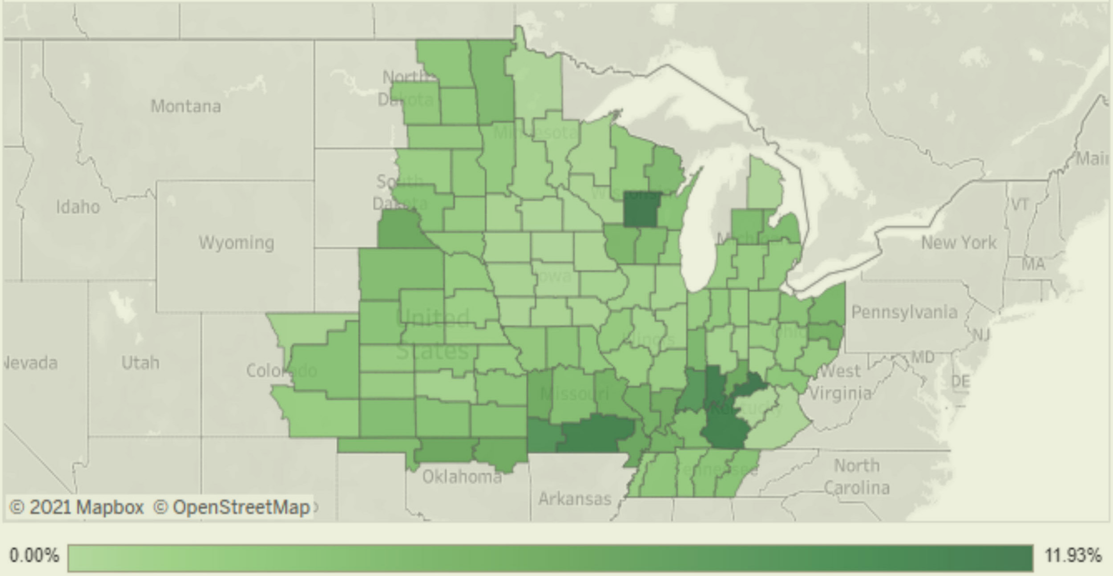
And cover crops seem to increase active carbon concentration more quickly than other affected soil health indicators.[8] An analysis of the impact of cover crops on carbon sequestration found that 20 million acres of cover crops have the potential to sequester about 60 million metric tons of CO_2-equivalent per year.[14]

Adoption of Cover Crops Gaining Traction

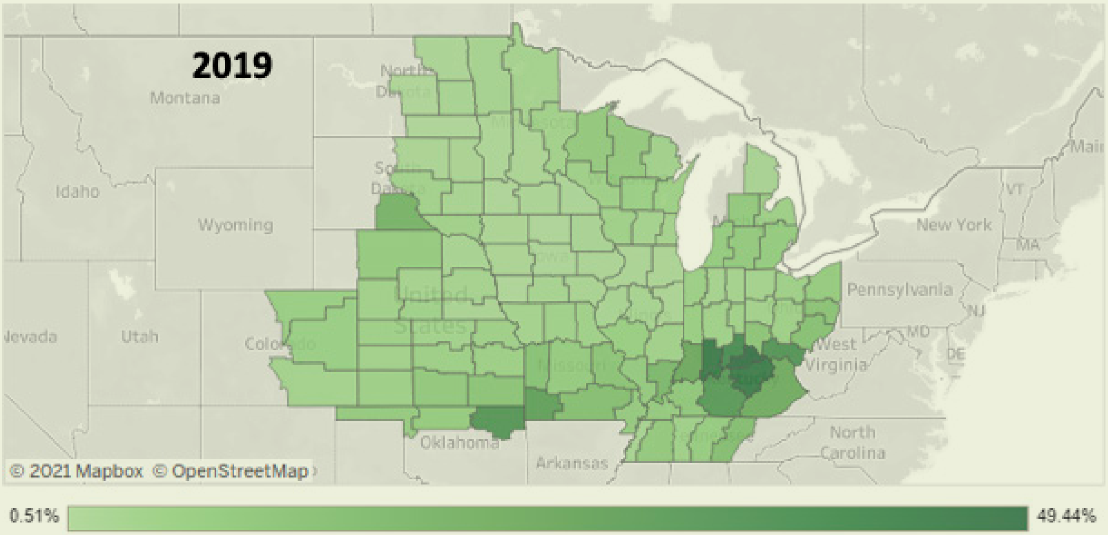
Interest in and adoption of cover crops is growing. The Midwest, which produces primarily corn and soybeans, has experienced the fastest increase in recent years. Overall, cover crop adoption increased by 79%, compared to the nearly 50% national average from 2012 to 2017.[15] In Iowa, use of cover crops increased 156% from 2012 to 2017, and Illinois, Ohio, Nebraska and Missouri also reported increases of 100% or more.[15]

According to Rob Myers, regional director of extension programs for the Sustainable Agriculture Research and Education program, acreage growth exceeds the increase in the number of farms using cover crops. This indicates that, right now, the increase in acreage is driven more by farmers with experience growing cover crops

Avg Pct Winter Crops Across Selected Years



Avg Pct Winter Cover Crops Across Selected Years



Source: Conservation Technology Information Center Operational Tillage Information System (OpTIS).

than farmers adopting the practice for the first time, a trend that fits with National Cover Crop Survey data.[15]

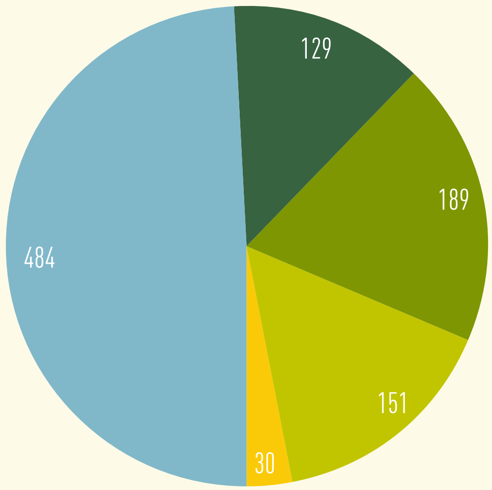
Such observations suggest that the process of cover crop adoption could mirror the adoption of conservation tillage practices. The concepts of different types of conservation tillage were introduced in the 1970s. The experiences of early adopters, who increased their own use of conservation tillage as they gained experience, coupled with programs to encourage these practices, contributed to the growth in their use throughout the next few decades. As the practice gained momentum, more farmers adopted conservation tillage practices that fit their farm, with widespread adoption during the 1990s. Now, 78% of oilseed and grain acres use some form of conservation tillage or no-till.[3]

Today, early adopters of cover crops are sharing their experiences, and numerous programs encourage use of cover crops, similar to the support for conservation tillage adoption during the 1980s and 1990s. The parallels offer promise for significant increases in the number of farmers incorporating cover crops into their production systems in the coming decade.

Financial incentives provided by federal and state programs and private organizations may be one driver of current increases in adoption of cover crops. In 2018, at least 22 states supported cover crop adoption programs, and farmers of about one-third of the cover crop acres received some type of financial assistance payment.[16]

Total funding for cover crops from federal conservation programs has been trending up. The level of financial support provided by one federal program in 2018, USDA's Environmental Quality Incentives Program, was about 20 times the level of support provided for cover crops by that program in 2005.[16]

What, if any, type of payment did you receive for planting cover crops in 2019?



- State government payment or through a local soil and water conservation district.
- USDA–NRCS Conservation Stewardship Program (CSP) payment
- USDA–NRCS Environmental Quality Incentives Program (EQIP) payment
- Payment from a private company to plant cover crops or use regenerative practices
- Did not receive any payment in 2019

Source: Conservation Technology Information Center 2019-2020 National Cover Crop Survey.

According to National Cover Crop Survey data, the number of participants receiving financial support for implementing cover crops is increasing over time. In 2014, 37% of survey participants planting cover crops reported receiving some type of financial support,[17] and similar responses increased to 41% in 2015.[18] When the question was asked again about 2019 cover crops, just over half of participants, or 52%, received financial support.[9]

Though cover crop adoption is increasing, widespread adoption is expected to take time. Implementing cover crops creates a different set of challenges than the implementation of conservation tillage practices. While conservation tillage practices often reduce on-farm costs immediately, cover crops often increase costs at least in the short term, due to seed purchases, additional trips through the field and other system adjustments.[16]

At the same time, the benefits of cover crops develop slowly, as the process of changing soil structure and health occurs over time.

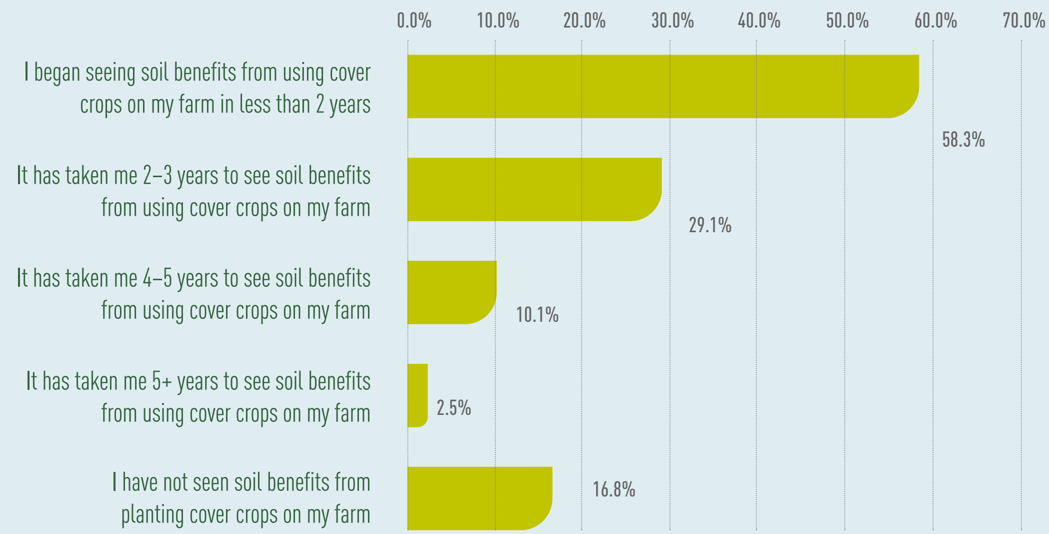
Although about 58% of participants in the most recent National Cover Crop Survey said they began seeing benefits of cover crops in less than two years, the rest said it took longer to experience the benefits of cover crops.[9]

FARMER FEATURE

Adapting Cover Crops to Conditions

A cover crop mix of barley, clover and radish helps Wisconsin farmer Dan Roehrborn improve soil health and take a conservation approach to managing nutrients. He varies practices based on the field, soil type and crops grown, relying on soil samples to understand nutrient needs. Since 2015, he has noticed an increase in soil organic matter and an improvement in capacity to hold nutrients. He acknowledges challenges of cover crops, such as too much ground cover causing excessive moisture, but he continues to try different methods to figure out what will benefit the farm most in the long term.

About how long did it take for you to begin seeing soil benefits on your farm from using cover crops?

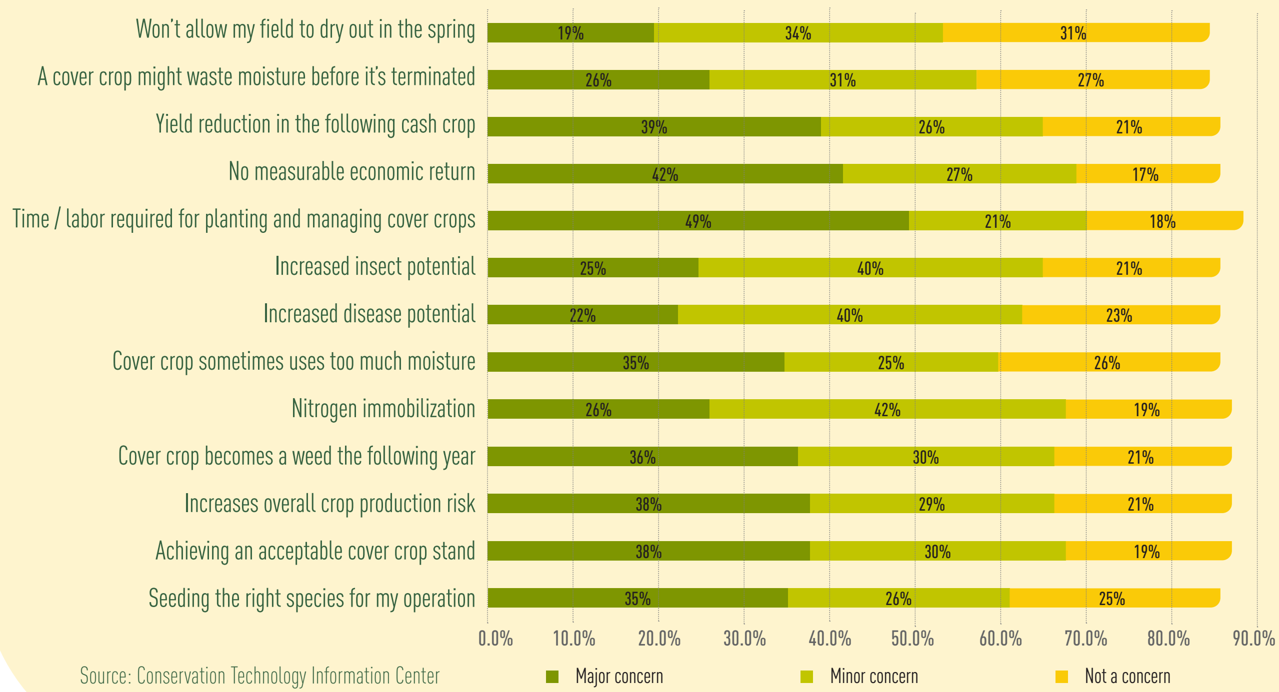


Source: Conservation Technology Information Center 2019-2020 National Cover Crop Survey.

The combination of increased costs and delay in seeing benefits are examples of adoption barriers. Survey participants who don't use cover crops expressed additional concerns and questions, such as the time and labor required to plant and manage them, uncertainty about the ability to measure economic return, potential crop yield reduction, impact on soil moisture, and future weed problems.[9]

The survey asked participants to rate their level of concern for a variety of common questions or barriers surrounding the usage of cover crops, as shown in the chart. Cultural barriers also exist, as fields with cover crops look noticeably different, and farmers hear what their neighbors think of their fields. Demonstrating positive outcomes, providing research data that addresses existing concerns, and providing education and support for new cover crop users will help overcome these perceived barriers.

Please rate the following concerns you have about using cover crops on your farm. (non-users)



Source: Conservation Technology Information Center 2019-2020 National Cover Crop Survey.

FARMER FEATURE

Protecting Highly Erodible Land with Cover Crops

A wheat cover crop helps manage highly erodible land while also serving as mulch that suppresses weeds and disrupts conditions for weed seed germination in the following crop on Mike Buis' farm in Indiana. This practice fits his operation's needs well, providing a large, flexible planting window and the ability to effectively terminate the crop with herbicide in the spring before it begins producing grain.

Research Builds Awareness, Improves Management Practices

Many agricultural and conservation organizations, including NCGA and USB, are investing in practical research to address the lack of knowledge and experience underlying many of the concerns limiting cover crop adoption. These efforts include exploration of management practices that help farmers address challenges created by growing season length, weather, residue and more.

Academic research lays a foundation of knowledge to help farmers understand how cover crops fit various corn and soybean production systems and their potential economic contributions, as well as management practices such as seeding cover crops early and planting cash crops into green cover crops. Other projects show how cover crops can play a role in managing pests such as weeds, insects and diseases. Researchers are investigating how to negate challenges like the impacts of residual herbicides on cover crop establishment. And other research focuses on benefits, including water quality in watersheds.

To build practical experience, organizations such as Precision Conservation Management and Practical Farmers of Iowa work directly with farmers to help them learn what cover crop practices fit their farms. Such programs share practical resources and tools and on-farm experiences with other farmers. Cover crops require investment, but farmers can build plans to offset those costs with support from conservation programs or practices such as grazing cover crops.

USB's Soybean Research & Information Network also provides practical cover crop resources and research from a wide variety of sources. This site promotes research and tools to help farmers find answers to their questions as they consider cover crops.

FARMER FEATURE

Cultivating Soil Health Through Cover Crops

Illinois farmer Jed Gerdes has invested in growing cover crops since the early 2000s. Over the years, he has seen his soil's organic matter increase, improving nutrient retention and availability. He has found that cover crops also reduce weed pressure and soil compaction. As he gained experience with cover crops, he transitioned to using multi-species cover crop mixes that include cereal rye and radishes. Together, these root structures help his soil act like a sponge, holding more water and nutrients for his corn and soybeans.

Photo and testimonial courtesy of Field to Market.

Many other NCGA and USB partnerships provide additional data, tools and practical support to help farmers adopt cover crops on their farms.

INfield Advantage is an Indiana-based program supported by Indiana Corn and the Indiana Soybean Alliance that provides high-quality assessments to farmers to measure their cover crop practices. The program provides farmers with personalized, on-farm data they can use to understand how field-specific cover crop use can affect other elements of the operation such as input use, soil health and, ultimately, yield increases or cost savings.[19]

The Conservation's Impact on the Farm Bottom Line report, a collaboration between EDF, the Soil Health Partnership and K-Coe Isom, took a deeper look into the sustainability practices farmers can implement without sacrificing their bottom line. The findings of this study showed that cover crops can be included as part of a profitable farming operation, especially as farmers' years of experience with the crops increase. Farmers in the study with more than five years of experience with cover crops had higher net returns than farmers with less than five years of experience with cover crops. The cost savings seen by the farmers with more cover crop experience were most often associated with seed expenses and cover crop and fertilizer applications.[20]

FARMER FEATURE

Cover Crops Protect Soil

Delaware farmer Cory Atkins works to plant cover crops in all his fields to protect soil during winter. He adjusts his cover crop mix to support the cash crop that will follow it. In his irrigated fields, he waters the cover crop in the fall to ensure a good stand to protect his soil. In the spring, he plants his corn, soybeans and vegetable crops directly into the green cover crops. He also grows barley and wheat, and some of those harvested crops become cover crop seed for the following fall. In addition to incorporating cover crops into his production system, Atkins encourages other area farmers to use them.

To reinforce the value cover crops can offer, other resources include information explaining how their benefits link to other agronomic issues. For example, the Take Action program, which focuses on integrated pest management strategies to fight pesticide resistance, includes resources such as fact sheets and videos that highlight the benefits of cover crops for weed suppression.

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CONSERVATION TILLAGE

Conservation or reduced tillage **disturbs the soil less** than intensive tillage, leaving varying amounts of crop residue on top of the soil.

Farmers work to preserve both the quantity and quality of their soils, a critical resource for corn and soybean production.

They want to continuously improve soil quality while protecting soil quantity — keeping the soil in their fields. Tillage moves the soil to create an environment where seeds can be easily inserted into it and plants can grow well while also reducing weed pressure. However, that disturbance leaves soil susceptible to being blown away by wind or washed away by precipitation. It also oxidizes organic matter and accelerates the loss of carbon.

Soil types vary dramatically depending on the texture and moisture content, from light sand to heavy clay and everything in between. The practices farmers use to protect and improve soils vary as well, depending on what best fits their soil types, topography and climate.

Intensive or conventional tillage completely turns soil over to bury past crop residue — the leaves, stems and other organic material left in the field from the previous crop harvest. Such tillage helps soil temperatures increase more quickly in the spring. It loosens heavy soils to create an environment for seeds to germinate, effectively push through the soil crust and grow. Conventional tillage also controls weeds and speeds up the decomposition of crop residue to make the nutrients in that residue available to the next crop. However, it also can make many soil types more susceptible to erosion.

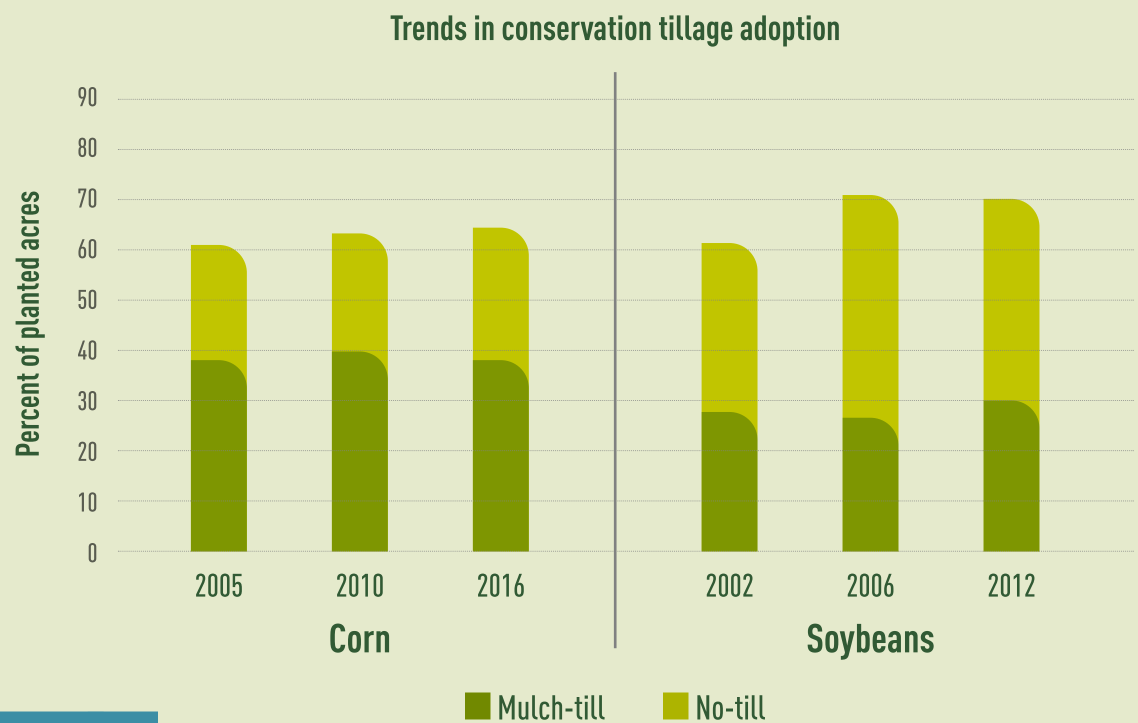
As agriculturists learned more about the mechanics of erosion and soil health, research and experience showed that not all soil types need to be completely turned over to create ideal seedbeds. The development of a broad range of herbicides provided weed control alternatives to tillage. Over time, farmers have moved away from conventional tillage where it isn't needed. The "2018 USDA Tillage Intensity and Conservation Cropping in the United States" report states as of 2012, conservation tillage practices were used in roughly 70% of soybeans, with 40% of total soybean acreage being no-till. In corn as of 2016, 65% of total acreage used conservation tillage practices, with 27% of total corn acreage being no-till.[1]

Conservation or reduced tillage disturbs the soil less than intensive tillage, leaving varying amounts of crop residue and organic matter on top of the soil. Conservation tillage practices range from strip-till, which moves soil just in the strip seed will be planted in, to vertical tillage, which focuses on dragging vertical blades through the soil with minimal disturbance to the surface. Types of conservation tillage in this discussion also include mulch-till, ridge-till, no-till and similar practices. Each type of tillage offers benefits that vary based on soil type, field topography and other practices in the production system. For example, strip-till can create an ideal seedbed for corn and allow precise fertilizer placement to encourage early crop emergence and growth, while allowing crop residue between rows to protect soil from erosion. Vertical tillage can break up layers of soil compaction to allow future crop roots to push deeper into the soil more easily, while also using organic matter on the surface to protect against erosion.

For decades, NCGA and USB have invested in research and education efforts to encourage farmers to adopt some type of conservation tillage that fits their environment. According to agricultural census data, adoption of these practices is increasing. In 2017, 77.2 million acres — about 33% of the total oilseed and grain farming acres, the category in which corn and soy production falls — used reduced tillage practices.[2] That was an increase of 14.9 million acres compared to 2012, when just 26% of these acres used a type of reduced tillage.[3]

No-till, one type of conservation tillage sometimes called out separately in statistics, completely eliminates all soil disturbance, aside from planting seeds. This practice protects against erosion and minimizes trips across the field, but it requires different crop management practices to manage pests. Only 3 million acres of no-till were reported in 1972,[4] representing the beginning of what has become a significant shift in tillage practices. By 2000, no-till acreage had increased to 51 million acres.[4]

Much of that shift occurred in oilseed and grain acres. According to the agricultural census, 34% of those acres were no-tilled in 2012.[5] By 2017, 85.2 million acres, or 36% of the total grain and oilseed acres, used no-till,[2] an increase of 4.4 million acres from 2012. Though that recent gain is modest, it represents a significant shift over the past few decades. The advent of herbicide-tolerant corn and soybean seeds aided the growth of this practice, because farmers could control weeds without tillage.



Note: Mulch-till is land with tillage and a Soil Tillage Intensity Rating less than 80
Source: USDA Economic Research Service, based on USDA Agricultural Resource Management Survey (ARMS) data for 2002–2017.

FARMER FEATURE

Tillage Transitions Take Time, Improve Soils

Maddy Rabenhorst and her husband raise corn and soybeans in southeast South Dakota. Rabenhorst grew up on her family's fourth-generation farm in Bristol.

As she and her husband began farming, they realized to achieve their goal to improve their land, they needed to adopt more sustainable practices. One change they decided to make to leave the land better than they found it is phasing their ground out of a conventional tillage system.

"Removing tillage from our management practices has been a longer process than we initially anticipated," Rabenhorst says. "After being tilled for many years, our ground expects to be tilled year after year, and requires a slow end to that practice."

That means the structure of the soil has adapted to tillage, so that tillage impacts how it manages moisture and supplies nutrients to the crop. Rabenhorst says getting out of the tillage cycle takes patience, planning and diligence. Over the past few years, they have transitioned to a minimum-till program, allowing the soil structure to adapt to less disturbance.

"We have also been experiencing high rainfall events the past couple of years, which has made it difficult to adopt new practices," she says.

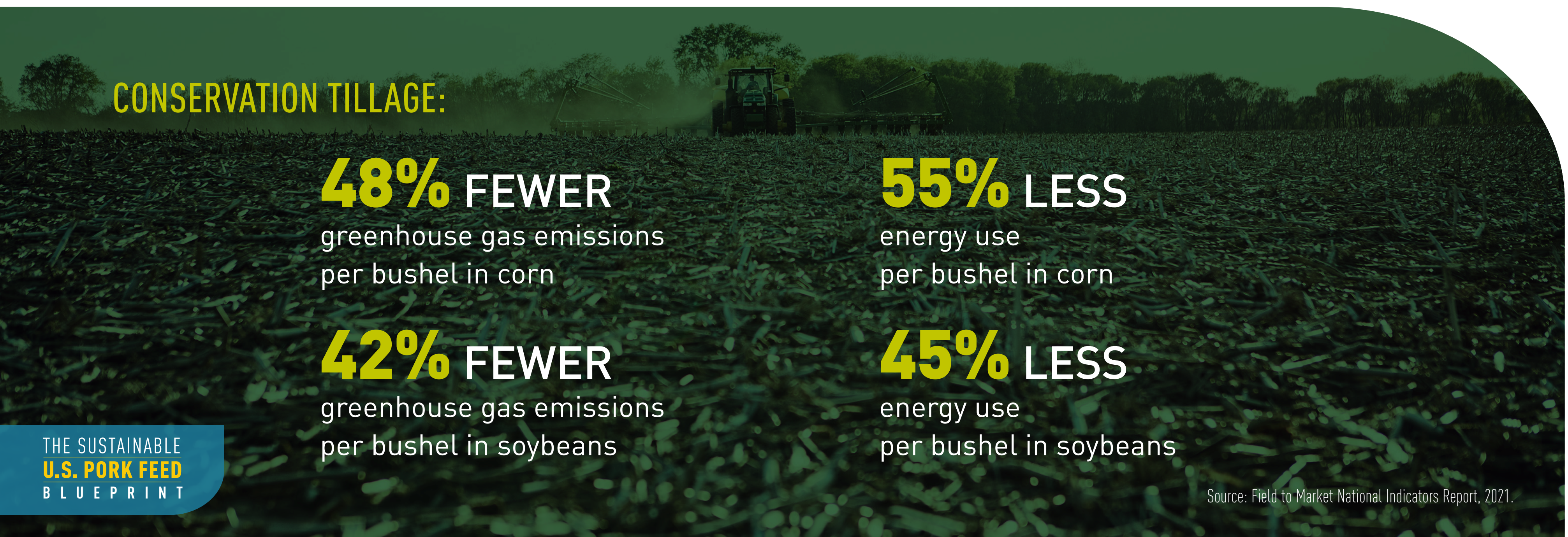
However, the Rabenhorsts are planning to switch to a 100% no-till system within the next decade and incorporate cover crops across their entire farm. Both she and her husband had to totally commit to become a no-till operation, as they must continually adjust their mindsets and how they manage their ground to make conservation tillage work for them.

> *Getting out of the tillage cycle takes patience, planning and diligence.*

U.S. corn and soybean production has realized many sustainability advances due to the decrease in tillage in recent decades. Altogether, 162.4 million oilseed and grain acres — 69% — used some form of conservation tillage practices, including reduced-till and no-till, by 2017.[2] These changes in tillage practices, tailored to fields and production environments, have made measurable impacts.

According to the National Resources Conservation Service, conservation tillage provides moderate to substantial improvement in soil erosion, as well as slight to moderate improvement in water quality.[5] Adoption of these practices correlates to a decrease in soil erosion. The 2021 National Indicators Report found that soil erosion, measured in tons of soil loss per acre, decreased by 40% per acre in corn and 35% per acre in soybeans from 1980 to 2020.[6]

These practices deliver moderate to substantial improvement in emissions of particulate matter and greenhouse gases, as well as energy efficiency.[5] Conservation tillage reduces fuel and equipment use. For example, Minnesota farmer Brian Ryberg stated that a strip-till and no-till system reduced his trips through his fields by 25%, and that led to a 60% decrease in fuel use.[7] Adoption of conservation tillage is a primary factor in the decrease in greenhouse gas emissions, measured in pounds of CO_2-equivalent gases per bushel. Emissions decreased by 48% in corn and 42% in soybeans from 1980 to 2020.[6] It is also one of the many factors contributing to the decrease in energy use, which is measured in BTUs, by 55% per bushel of corn and the 45% decrease per bushel of soybeans during the same period.[6]



CONSERVATION TILLAGE:

48% FEWER greenhouse gas emissions per bushel in corn

55% LESS energy use per bushel in corn

42% FEWER greenhouse gas emissions per bushel in soybeans

45% LESS energy use per bushel in soybeans

Source: Field to Market National Indicators Report, 2021.

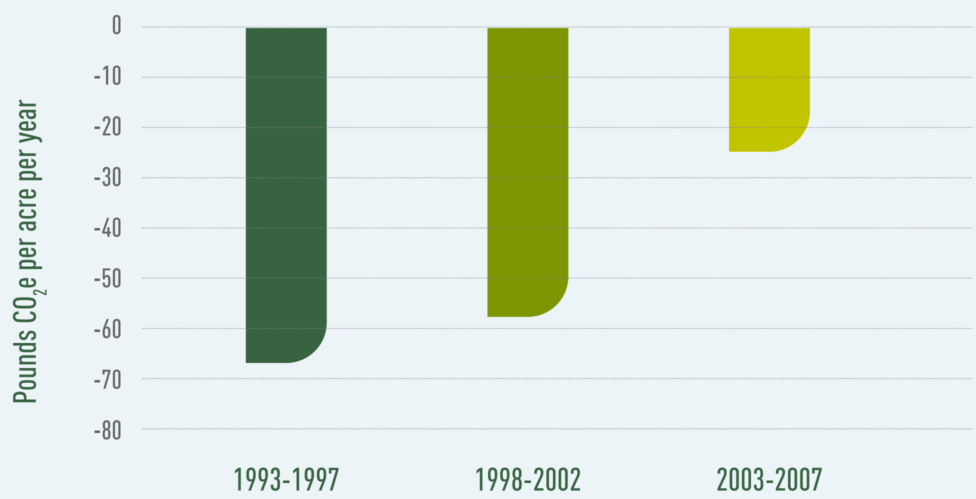
Conservation tillage also impacts soil health by maintaining or improving soil organic matter content and the habitat for soil organisms. Soil microbes break down soil organic matter, capturing carbon in the soil and offsetting greenhouse gas emissions. Increased soil microbial activity increases the ability of soil to sequester carbon.

The adoption rate of conservation tillage practices has slowed as more farmers determine the practices that work best in their fields. Conventional, or intensive, tillage still provides value in specific situations, such as controlling herbicide-resistant weeds, terminating cover crops and raising soil temperatures to support seed germination in cool, short-season climates.

However, conservation tillage has shown to have economic value for farming operations. In a time where the farm economy presents many challenges, farmers are looking for ways to improve profitability while still producing a viable crop. According to a study conducted by Soil Health Partnership, Environmental Defense Fund and K-Coe Isom, growers were able to reduce operating costs by reducing or eliminating tillage. Cost savings came primarily from fuel and oil, machinery, equipment and repair expenses.[8]

The amount of carbon lost from row crop production systems

A model used in the 2016 Field to Market National Indicators Report shows a decrease in the amount of carbon lost per acre over time in row crops, including corn and soybeans. The most noticeable decrease occurred from 2003 to 2007, perhaps a reflection of adoption of conservation tillage and residue management practices.[9]



Source: Field to Market National Report, 2016.

FARMER FEATURE

Experience Inspires No-Till Adoption

Growing up on his family farm in Otterbein, Indiana, Mike Conner noticed soil erosion.

"I remember seeing snow piled up in the roadside ditches, and it'd be black," Conner says, recalling tillage practices that would darken the snow with displaced soil. "I'd watch soil being blown away, and something about that always bothered me — like it was a part of me being blown away, too. I thought, 'There's got to be a better way.'"

After graduating from college, Conner taught science and coached basketball at an Indiana junior high school. Eventually, he felt the call to return to the family farm as a third-generation farmer. When he joined his dad, growing corn and soybeans on their 1,000-acre farm, Conner hadn't forgotten his childhood observations about soil displacement. He educated himself about no-till practices.

At first, his dad wasn't convinced. But little by little, Conner introduced the practices in their cornfields and began to see great results, gradually switching over their management techniques and experimenting with cover crops on more and more fields.

"After my dad passed away, it was time to do what I really wanted to do: no-till," he explains. "I've been 100% no-till for 25 years, and I wouldn't want to do it any other way."

I've been 100% no-till for 25 years, and I wouldn't want to do it any other way.

Photo and testimonial courtesy of Field to Market.

To further explore the potential for carbon sequestration and encourage additional adoption of conservation tillage where appropriate, NCGA and USB continue to invest in research and education through their participation in a variety of broad industry efforts and organizations.

- In 2022, the Ecosystem Services Market Consortium will launch a program to compensate farmers for quantifiable environmental improvements that generate soil carbon, reduce greenhouse gases, improve water quality and more. Pilot projects for this system are currently underway.

- Field to Market's Fieldprint® Platform uses the Soil Conditioning Index developed by NRCS to provide field-level guidance to farmers about how to increase soil carbon content, allowing them to monitor performance over time. Tillage practices influence this metric.

- The Conservation Technology Information Center leads projects that increase understanding of the value of conservation tillage. It also provides information on conservation practices and promotes their adoption.

- Efforts like Precision Conservation Management, supported in part by NCGA, and seasonal resources from USB provide information to farmers about the value of conservation tillage.

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NUTRIENT MANAGEMENT

While the soil and its ecosystem provide much of what corn and soybeans need, **adding nutrients** allows farmers to better feed their crops.

Like people and animals, plants need nutrients for healthy growth.

While the soil and its ecosystem provide much of what corn and soybeans need, adding nutrients allows farmers to better feed their crops. The most common nutrients added to corn and soybean production systems — and considered targets for improvements in sustainability — are nitrogen, phosphorus and potassium. However, many other nutrients and additives support soil health and plant nutrition.

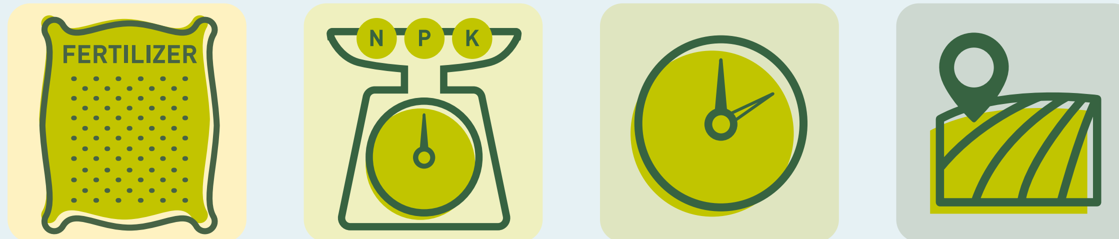
Farmers applied fertilizers to 173.8 million acres, or 74%, of oilseed and grain farms in 2017.[1] They customized timing, rates and method of fertilizer applications to fit their operations and support crop yield and quality.

The most common nutrients used are commercial, or synthetic, fertilizers. In 2017, 165.5 million acres, or 70%, received commercial fertilizer.[1] Another 7.1 million acres, or 3%, used livestock manure as fertilizer.[1] Use of manure is growing slowly, up from application on 6.8 million acres in 2012.[2] At the same time, commercial fertilizer use is slowly decreasing, as it was applied on 4.3 million acres less in 2017 than in 2012.[1] Crop rotation between corn and soybeans also serves as a fertilizer source, as soybeans replace vital nutrients in the soil by fixing, or adding, nitrogen to the soil that corn needs.[3]

'4Rs' Support Sustainability

Industry education encourages farmers to follow the "4Rs" of nutrient stewardship, applying the **right source** of fertilizer, at the **right rate**, at the **right time** and in the **right place**. The goal is to ensure the crop uses all available nutrients, minimizing the potential for excess nutrients to move out of fields and into surrounding environments, where they can disrupt ecosystems. Many practices support this goal.

What are the 4Rs?



Right Source
Matches fertilizer type to crop needs

Right Rate
Matches amount of fertilizer type to crop needs

Right Time
Matches nutrients available when crops need them

Right Place
Keeps nutrients where crops can use them

Source: The Fertilizer Institute

Choosing the **right source** requires ensuring fertilizer provides the nutrients crops actually need. Commercial fertilizers are sold based on their nutrient content. However, the nutrient content of manure varies based on livestock species and diet, so sampling manure for nutrient content reveals what it will provide to crops.

Soil tests determine the **right rate** for nutrient applications. Variable rate technology allows farmers to precisely tailor the type and amount of nutrients applied within a field.

The **right timing** is crucial, as crop needs vary at different growth stages. To address this, farmers can use split fertilizer applications, dividing the total fertilizer used into two or more treatments per year to enhance nutrient efficiency and protect the environment.[4]

Fertilizer application equipment puts nutrients in the **right place** to be accessible to plants. For example, forms of nitrogen in commercial fertilizer and manure can be injected into the soil for accessibility to plant roots. Fertilizer applied with the planter as seeds go into the ground is readily available to germinating seedlings.

Farmers gather data to determine management practices that allow them to effectively implement the 4Rs in each field, ensuring sound nutrient management. For example, Nebraska farmer and agronomist Andy Jobman (pictured right) relies on yearly zone and grid sampling to measure and benchmark soil health and nutrient levels in his fields and the fields of his clients. Split fertilizer applications deliver nutrients when his crops need them. And, Illinois farmer Dan Farney (pictured below) adds yield map data to soil information to develop his soil fertility plan. He relies on precision application and variable rate technology to implement that plan.

Photo courtesy of Field to Market.

Nutrient management focused on the 4Rs provides moderate to substantial improvement in plant health, as well as soil health, water quality and greenhouse gas emissions. Precise nutrient management also provides slight to moderate improvement in air quality.[5]

Adoption of practices to achieve the 4Rs has reduced the quantity of nutrients used on corn and soybean acres. The reduction in energy to produce and apply nutrients is among the many factors contributing to the 55% decrease in energy use per bushel of corn and the 45% decrease in energy use per bushel of soybeans – measured in BTUs per bushel – from 1980 to 2020.[6]

Investments Limit Nutrient Loss and Protect Water Quality

If not used by crops, excess nutrients from fertilizer applications can move from fields into surface water and groundwater. Although many complex environmental interactions influence water quality, agricultural nutrient runoff is one factor that has been linked directly to concerns such as high nitrogen and phosphorus levels in drinking water and hypoxia in aquatic ecosystems.[6] Corn and soybean farmers follow a combination of regulations and voluntary practices to provide the nutrients their crops need while minimizing nutrient runoff.

Most regulations are state-specific, and the industry invests in ensuring farmers understand those regulations. In regions like the Chesapeake Bay Watershed, regulations include nutrient management plan requirements for farmers, regardless of the nutrient source used. Every state regulates manure nutrient management. These regulations cover practices such as maintaining “setbacks,” which means keeping nutrient applications a specific distance away from streams and other water sources. Many regulations come with certification requirements that ensure farmers or others applying nutrients understand them.

However, the corn and soybean industries emphasize the value of voluntary adoption of strategies that fit specific soil types, field topography and surrounding ecosystems. Through industry organizations, farmers have been involved in developing nutrient loss reduction strategies, as encouraged by the Hypoxia Task Force of the Environmental Protection Agency. To date, 12 states with priority watersheds for the Mississippi River and the Gulf of Mexico have developed nutrient loss reduction strategies that actively promote research for and voluntary adoption of nutrient management practices.[7]

FARMER FEATURE

Nutrient Management Supports Soil Health

Illinois farmer Mike Wurmnest applies nutrients at variable rates based on soil tests. He analyzes the nutrients already in his soil to develop more efficient application strategies to ensure his soil stays healthy for the future and to save application costs. “We only want to put the nutrients where they’re economically needed — to save costs and nutrients,” he says. “When we get soil tests back, we can still see where my dad and grandpa spread manure.”

Photo and testimonial courtesy of Field to Market.

In addition to management strategies related to the 4Rs, practices including conservation tillage, cover crops and edge-of-field strategies provide nutrient management benefits. Corn and soybean farmers invest in research and awareness to improve nutrient management.

- Agronomic resources help farmers implement science-based nutrient management strategies on the farm that can help curb unwanted nutrient loss.
- To support progress toward the state's nutrient loss reduction strategies goals, the Minnesota Corn Growers Association invests in a variety of water quality research.
- The Louisiana Soybean and Grain Promotion Board is investing in research to develop biofertilizers that reduce nutrient loss.

Advanced 4Rs Practices Decrease Emissions

A family farm in the Western Lake Erie Basin found that adopting complex nutrient management practices measurably improved sustainability. Variable rate applications of nitrogen, phosphorus and potassium provided the right rate of nutrients in the right place. Switching some fertilizer applications from fall to injecting it alongside growing plants in the spring ensured nutrient availability at the right time. Replacing a dry nitrogen source used in the fall with a different type of in-season nitrogen delivered the right source of the nutrient. Making a change from basic to more advanced 4R practices improved efficiency, decreased the total cost per acre by $101.11 and decreased CO_2-equivalent greenhouse gas emissions by 19%.[8]

Photo and testimonial courtesy of The Fertilizer Institute.

Constructed Wetlands Show Promise in Managing Nutrients

Wetlands function as nature's kidneys, removing nutrients and sediment through natural processes in the vegetation and soils, as well as slowing down the flow of water before it reaches creeks, streams and rivers. A constructed wetland is a human-made wetland that acts as this treatment system. Illinois researchers are investigating how such wetlands might provide a tool to help farmers manage nutrients. The Franklin Farm project designed constructed wetlands to slow down and clean tile water from nearby crop fields. Research has found that constructed wetlands of various sizes reduce nitrogen 30% to 46% and phosphorus 45% to 91%.[9]

Photo and testimonial courtesy of The Nature Conservancy.

Several grower groups and supply chain companies are using the nitrogen (N) balance framework to measure and report improvements in nutrient management. This simple mass balance approach considers the amount of N that remains in the field after harvest and is at risk of loss to the environment.

With readily available data (N added to the field in the form of fertilizer or manure, and N removed from the field as grain or stover), the N balance score can then be translated to nitrous oxide emissions and nitrate leaching. Ideally, N balance scores will fall into a "safe zone"— experts suggest this is generally 25–75 lbs. N/acre. Within this N balance safe zone, a farmer is optimizing yields, using N additions efficiently, minimizing negative environmental impacts and protecting long-term soil health.

FARMER FEATURE

Nutrient Recycling Reduces Environmental Impact of Feed

Iowa farmer Lindsay Greiner raises corn, soybeans and pigs. Nutrient recycling is a critical aspect of reducing the environmental impact of his farm. All the manure from his pigs becomes fertilizer for his fields. "The pigs turn the corn and soybean meal in their diets into meat," he explains. "We use the leftover nutrients from that process to raise more corn and soybeans to feed more pigs next year." Like all farmers who use manure fertilizer, he develops and follows a nutrient management plan. The plan combines grid soil samples showing nutrients already in the soil with yield maps and the nutrient value of the manure. He uses best practices to get the full value out of nutrient recycling, such as waiting until soil temperatures are appropriate and incorporating manure into the soil.

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PEST MANAGEMENT

Farmers often serve **on the front lines** of managing invasive species.

Pests — weeds, insects and diseases — attack corn and soybean crops, decreasing quality and stealing yield. Contrary to common assumptions that crops are treated with an abundance of chemicals, farmers use many different tools to protect their corn and soybeans from these pests. They combine practices into integrated management strategies that fit their farms, including:

- Cultural controls that include crop rotation, row spacing and cover crops.
- Mechanical controls that incorporate practices such as tillage and cleaning equipment.
- Biotechnology that enhances seeds to make pest control more effective and reduces the need for chemical control. Currently, farmers plant seeds with herbicide-tolerant biotechnology on 89% of corn acres and 94% of soybean acres, according to the USDA Economic Research Service.[1]
- Chemical controls include natural and synthetic pesticides. They also include biologicals, which are based on natural pest enemies like pathogens. In 2017, 87% of oilseed and grain acres received treatment to control weeds, 31% were treated to control insects and 13% were treated to control diseases.[2] Improvement in chemical active ingredients and lower per-acre application rates, especially for herbicides, has resulted in a downward trend in the volume of chemicals used since it peaked in 1981, though acres treated has remained relatively consistent.[3]

Integrated pest management practices, which incorporate all these tools, allow farmers to improve crop production efficiency, producing more feedstuffs with fewer inputs. Such systems deliver substantial improvement to water quality because of the targeted use of chemical controls, while providing slight to moderate impacts on greenhouse gas emissions.[4] Consider biotechnology, which contributes to increases in conservation tillage and decreases trips across fields. In turn, it supports sustainable results such as reduced fuel use, fewer greenhouse gas emissions and less soil and water runoff.

Crop Protection Network

The multistate and international partnership of university and provincial Extension specialists, and public and private professionals, known as the Crop Protection Network (CPN), provides unbiased, researched-based information to farmers and agricultural personnel. The goal of this network, which is organized by faculty and staff at land-grant universities and provincial agencies, is to help farmers, researchers and others in the ag industry with relevant information to help them make decisions related to protecting a variety of crops, including corn and soybeans. CPN's library includes a variety of resources covering topics such as crop scouting and fungicide management. Resources such as publications, webinars, videos and images can be found at cropprotectionetwork.org.

CROP PROTECTION NETWORK
A Product of Land Grant Universities

At the same time, these practices support moderate improvement in biodiversity.[4] For example, integrated pest management for insects and diseases encourages the presence of beneficial insects to help control destructive insects that feed on crops or spread diseases. Some efforts, such as this New Jersey program, even release beneficial insects to protect crops.

Farmers often serve on the front lines of managing invasive species. These aggressive plants, insects or animals spread beyond their original habitat and dramatically upset the balance of native ecosystems. Because many farmers scout their corn and soybeans for pests throughout the year, they are among the first to identify invasive species, alert others to their presence and figure out how to manage them from their diverse toolbox. Management of field borders, ponds, streambanks, filters and buffers can also clear invasive species and replace them with native options.[4]

Technological advances and a deeper understanding of production systems have allowed farmers to control pests more efficiently and with fewer inputs. The energy use indicator in the 2021 National Indicators Report accounts for pest management tools, including chemical controls. Advances in pest management contribute a small part to the many factors supporting the 55% decrease in energy use per bushel of corn and the 45% decrease in energy use per bushel of soybeans – measured in BTUs per bushel – from 1980 to 2020.[5]

FARMER FEATURE

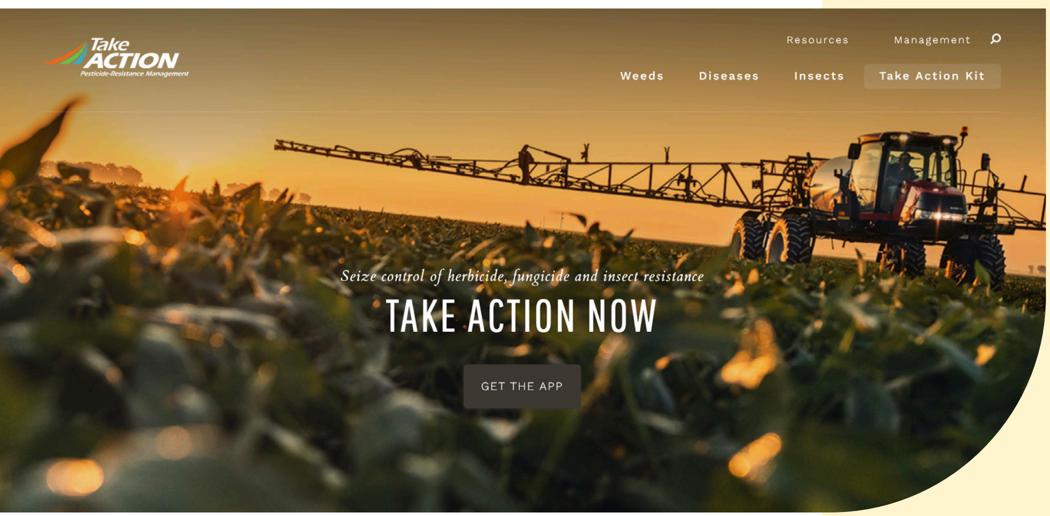
Scouting Directs Efficient Pest Management

Regular scouting for weeds, insects and diseases allows Maryland corn and soybean farmer and USB farmer-leader Belinda Burrier to protect crop yield and quality. When she notices a problem, she scouts more frequently. She makes it a point to know the treatment threshold for when pests cause economic damage, such as the number of insects or weeds within a certain area. She says on her family farm, they wait to treat until a problem reaches the threshold so they don't over-apply inputs. They also rotate herbicide types to manage resistant weeds. The Burriers constantly monitor potential pest problems and talk to neighbors and others about what they are seeing in their fields to stay ahead of pests and manage them effectively.

However, pests adapt as well. Weeds, insects and diseases can develop resistance to common management practices over time. For example, 266 weed species have evolved resistance to 21 of the 31 known herbicide sites of action, according to the International Herbicide-Resistant Weed Database.[6] Management to delay insect resistance is equally crucial, because modes of action available for insect control are much more limited. When a new chemical control method is introduced for insects, pests immediately begin to adapt, often developing resistance between two and 20 years later.[7]

Farmers will realize improvements in sustainability as they continue to adopt resistance management practices that incorporate a broader set of integrated control tools into their production systems. NCGA and USB provide details about specific practices to prevent the development of resistance for pest control at IWillTakeAction.com.

And the industry continues to invest in research to develop new tools, such as biological pesticides and advanced biotechnology options, and to refine management practices, like pesticide application timing, to fight resistance and reduce impacts of pest control on field ecosystems.



Take Action

University and industry experts provide resources, updates and recommendations for herbicide-, insect- and fungicide-resistance management at IWillTakeAction.com. Here, farmers find information and tools to develop resistance management strategies for challenging weeds, insects and diseases in their fields. The Take Action campaign is supported by NCGA, USB, the Agricultural Biotechnology Stewardship Technical Committee and the Herbicide Resistance Action Committee. The program relies on partnerships with land-grant universities, six major agro-chemical companies and cotton, sorghum and wheat commodity groups for research and technical support for the program.

Through the help of these partners, Take Action develops and distributes thousands of resources to farm advisers and their farmer customers each year. The most popular resources are the Take Action herbicide, fungicide and insecticide classification charts, which break down the modes of action for each, pairing them with their corresponding active ingredients and trade names so farmers can easily identify the modes and sites of action in their products and rotate between them. Additional resources and information can be found on the Take Action app.

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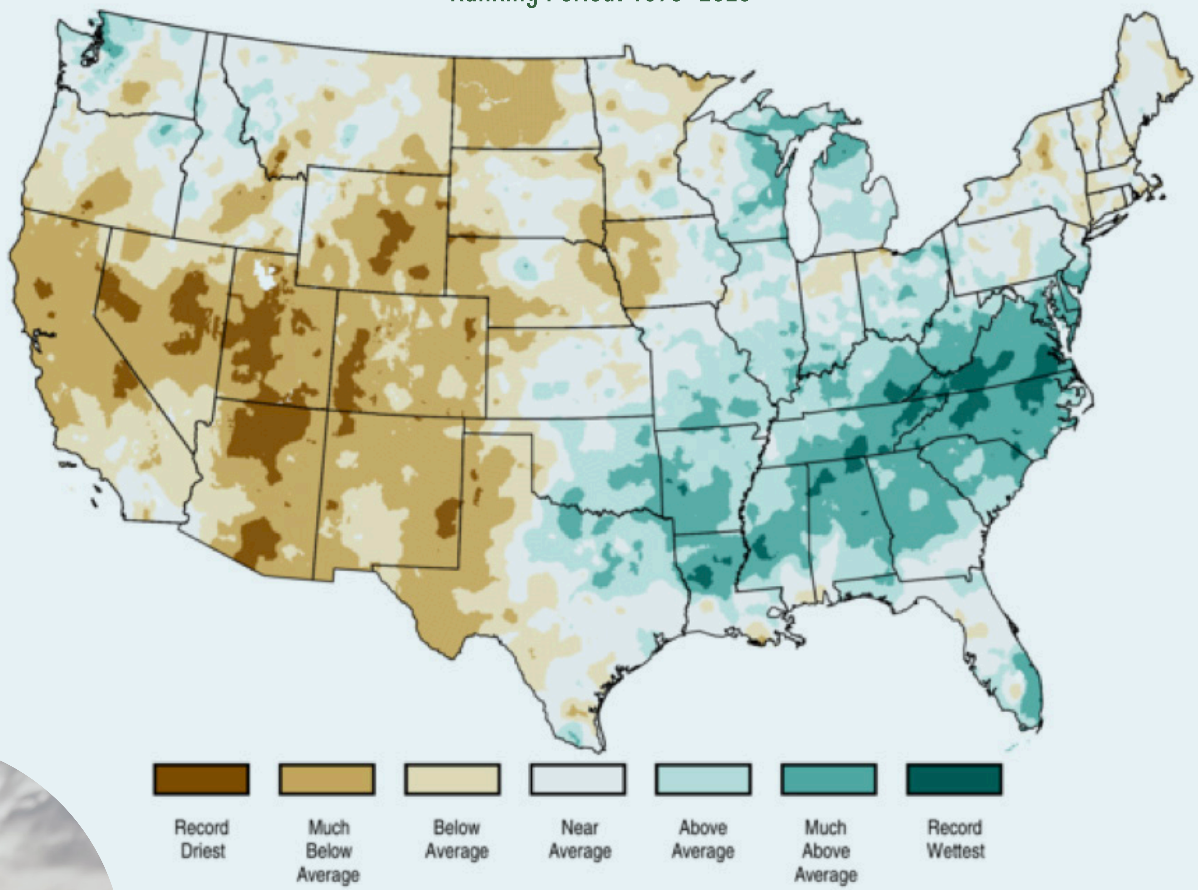
WATER MANAGEMENT

Crops need water,
but at the **right time**
and in the **right amount.**

Rain Makes Grain

"Rain makes grain" is a common proverb among farmers. Crops need water, but at the right time and in the right amount. In U.S. corn and soybean fields, water can be overly abundant, extremely scarce or poorly timed. Farmers work to maximize the value of the water they have and preserve water quality as it leaves their fields. How they manage water depends on their climate, topography and soil types.

Total Precipitation Percentiles
January–December 2020
Ranking Period: 1895–2020



Source: National Centers for Environmental Information Data Source: 5km Gridded Dataset (nClimGrid)

Irrigation Requires Efficient Water Use

Irrigation allows farmers to control when they water a crop to achieve stable yields and crop quality. They use many different systems, such as sprinklers on irrigation pivots, furrows and pipes along the ground. About 12.4% of U.S. grain corn and soybean acres are irrigated.[1] Irrigated oilseed and grain acreage decreased nearly 3.2 million acres between 2013 and 2018.[2]

Advances in technology and agronomics have allowed farmers to improve irrigation efficiency. The U.S. Department of Agriculture Natural Resources Conservation Service, which provides U.S. farmers with financial and technical assistance to implement conservation practices, recognizes a variety of irrigation practices that provide slight to substantial improvements in irrigation efficiency, including planned water application, ditches and reservoirs.[3] The Field to Market Irrigation Water Use Indicator measures efficiency based on the volume of water necessary to cover an acre 1 inch deep that is applied per unit of yield increase. Based on that indicator, irrigation efficiency improved by 56% in corn and 61% in soybeans from 1980 to 2020.[4]

The rate of improvement in efficiency slowed toward the end of this measurement period, due in part to extreme weather events like the severe drought of 2012, as well as the costs of adopting more advanced technology. NCGA and USB invest in opportunities to continue increasing irrigation efficiency. For example, ongoing advances support variable rate irrigation. Industry partnerships funded creation of the SmartIrrigation app for soybeans, with a corn app currently in development. And, education programs such as an irrigation school in Arkansas and the Central Nebraska Irrigation Project help farmers implement improvements.

Managing Excess Water Protects Water Quality

The majority of U.S. corn and soybean production relies on rainfall for water, which creates a different set of management challenges. Many soil types under rain-fed production experience both excess water and dryness. Farmers add drainage to fields to manage too much water from weather events such as heavy rains, extended rainy periods and wet winters.

Corn and soybean fields with grades or highly erodible land include grass waterways. Farmers plant these broad, shallow strips of land with perennial grasses and vegetation. These waterways typically follow the natural contour of the land to conduct surface water through cropland. The vegetation naturally filters water as it moves away from the farm, keeping soil and nutrients on the farm rather than being carried away by excess water.

Buffers of vegetation along streams or ditches fulfill the same purpose, protecting natural resources in fields and the quality of water leaving fields. These features provide moderate to substantial improvement of some types of erosion, as well as improvement to water quality.[3] In fact, when properly created and maintained, buffers can remove up to 50% of unused nutrients and pesticides, up to 60% of certain pathogens and up to 75% of soil sediment from water running off fields.[5]

About 44.8 million acres of U.S. oilseed and grain fields, or 19%, use tile drainage.[1] Tiling buries perforated tubes in the soil that help water to drain from the field, improving soil health by creating a better environment for soil microbial activity. According to NRCS, this subsurface drainage provides moderate to substantial improvements in ponding and flooding in fields, as well as slight to substantial improvements in soil erosion.[3] Fields with tiles increased by 7 million acres from 2012 to 2017,[1] and interest continues, due in part to heavy rains.

FARMER FEATURE

Irrigation Reservoir Recycles Water

A 100-acre reservoir, built on land taken out of production in the 1980s, allows Arkansas farmer Brad Doyle to conserve and recycle water. His heavy clay soils don't allow water to move through. Surface ditches and furrows in the field drain water into the reservoir when it rains, especially in the spring. Then, during hot, dry summers, water from the reservoir is pumped through a flexible poly-pipe irrigation system. Calculations of water pressure and field size determine where he pops holes in the pipe to fill the furrows for efficient irrigation.

Another 27.6 million oilseed and grain acres, nearly 12%, use surface drainage to manage excess water.[1] In fields with almost no slope and heavy soils, farmers use precision technology and equipment to create shallow ditches or furrows through fields to carry away excess water. They provide slight to moderate improvements in both soil erosion and water quality.[3]

Ongoing industry investments from NCGA and USB focus on further reducing the soil sediment and nutrients from surface and subsurface drainage, and then sharing learnings with others. Research projects evaluate differences between water management practices, develop tools to monitor water quality and much more. To help farmers understand how their field-specific practices impact water quality and identify opportunities to improve, Field to Market's Fieldprint® Platform uses the NRCS Water Quality Index.

Limits on time, labor and financial resources are the most common barriers to farmers adopting more advanced management practices to manage excess water and monitor water quality leaving their fields. However, as research demonstrates the business case for improvements, farmers will be more likely to invest toward continuous improvement in water management.

FARMER FEATURE

Water-Control Structures Manage Tile Water

Because her family farms in the Lake Erie Basin of Michigan, farmer Laurie Isley is very conscious of water quality. The farm participates in a research project that monitors the quality of water leaving the fields. In addition to no-till, strip-till, buffers, a saturated buffer, filter strips and cover crops, she is experimenting with using water-control structures to slow water drainage from field tiles. These structures include boards that block or slow the release of tile water, to better manage water from heavy rains. She hopes to discover if slowing tile drainage with these water-control structures will retain water in the tiles that could be available to her crops during dry weather.

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LAND USE

As the overall sustainability of corn and soybean production increases, **land use improves as a result,** as the crops are able to yield more on less land.

Responsible land use is a global issue for oilseed and grain production. According to the Food and Agriculture Organization, land conversion from natural ecosystems to agriculture is linked to increased greenhouse gas emissions and loss of carbon biomass above and below ground.[1] The land conversion process releases carbon stored by natural ecosystems in soils and plants, and crop production cycles typically store less carbon than those ecosystems. In fact, the process of converting land to agriculture has historically been the largest cause of greenhouse gas emissions.[1]

However, this is an area where the U.S. has potential to have a high impact. When U.S. Soy conducted research to map industry efforts to the United Nations Sustainable Development Goals, "land use" was one of the material assessment factors indicated as a point of impact for making progress toward the UN's SDG "Life on Land." For this study, land use is defined as "not expanding to marginal ground," meaning in order to show improvements in land use, acres used for soy production are not expanding outside of land previously used for crop production.[2]

While U.S. corn and soybean production continues to increase over time, the amount of land committed to these crops has been slowly declining. In 2017, about 235.1 million acres were dedicated to oilseeds and grains.[3] This total declined about 1.3% from the 238 million acres in oilseeds and grains in 2012.[4] While most of this land is permanent cropland, 7.3 million acres are woodlands, and nearly 5.5 million acres are enrolled in wetland and other conservation reserve programs.[3] Because they contain other ecosystems, they are considered marginal ground for crop production.

As the U.S. Grains Council explains, virtually all U.S. grain farms are family operations committed to protecting their resources. Increasing production while lowering inputs per unit of production and preserving natural resources demonstrates sustainability.

Farmers use cropland more efficiently as they take advantage of technology and continuously improve management practices. The measure of the efficiency of land use in acres per bushel of production has improved 44% for corn and 47% for soybeans from 1980 to 2020.[5] And farmers recognize opportunities for further improvement. By 2025, U.S. soybean farmers aim to reduce land use impact by 10%.[6] And, by 2030, U.S. corn farmers have committed to increasing land use efficiency by 12%.[7]

The U.S. Soybean Sustainability Assurance Protocol is based on a national system of sustainability and conservation laws and regulations, combined with the implementation of best management practices like those outlined here.[8] Although the SSAP verifies sustainable soybean production on a national scale, the laws, regulations and best management practices outlined apply to both corn and soybean production. Both crops are grown in the same fields.

Per an SSAP directive, soybeans — and, by extension, corn — are not produced on highly biodiverse grasslands, wetlands, continuously forested lands, peatlands or primary forests, or in designated protected areas.[8] Instead, farmers often use land like this to protect resources and enhance biodiversity.

Land use improves as farmers implement the other sustainability practices outlined in this blueprint. As the overall sustainability of corn and soybean production increases, land use improves as a result, as the crops are able to yield more on less land. Although there is always room for improvement, this is an area that is considered a strength for U.S. pork production.

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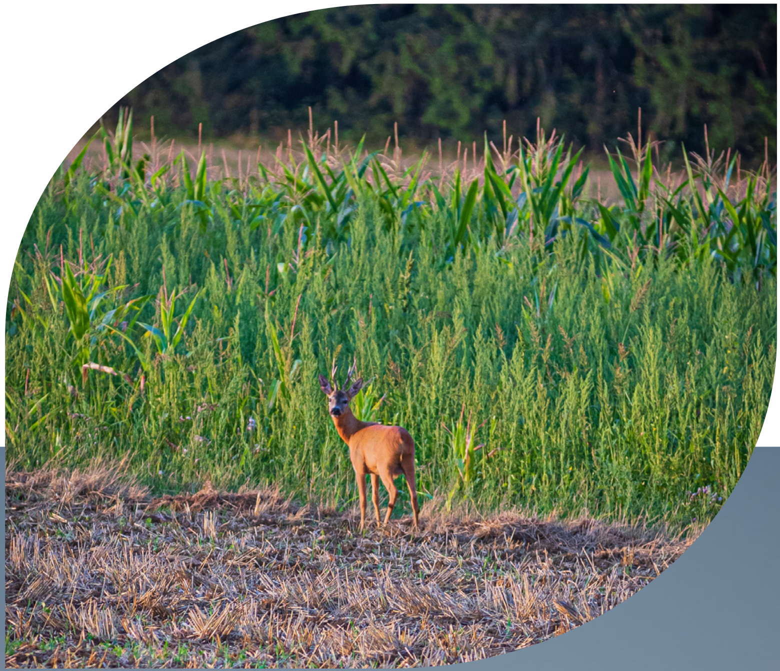
WILDLIFE HABITATS

Farmers are positioned to help by providing habitats and using pollinator-friendly practices.

Working land, including corn and soybean fields, provides much of the open space required for wildlife habitats. Farmers understand management practices in and around their fields influence wildlife of all kinds, including pollinators, fish, birds and animals in nearby woodlands, wetlands and other environments. In fact, oilseed and grain farms include 7.3 million acres of woodlands.[1]



Biodiversity is considered an indicator of ecosystem health. Field to Market developed a biodiversity metric called the Habitat Potential Index, which monitors habitat and landscape changes. Practices that preserve or restore buffers of native plants or target specific flora and fauna provide habitats that support biodiversity.[2] This metric lives in the Fieldprint® Platform, where farmers can measure the environmental impacts of crop production and identify opportunities for continuous improvement.

For decades, the NRCS at the state and federal levels has supported voluntary efforts of farmers to make wildlife-friendly improvements on their land with support from farm bill provisions.[3] Practices that enhance terrestrial and aquatic habitats include:

- Constructing and restoring wetlands.
- Managing forest stands.
- Developing and managing ponds.
- Planting wildlife habitat plants in buffer and filter strips.
- Building wildlife structures.[4]

More than 75,000 oilseed and grain farmers enrolled about 5.5 million acres in government conservation programs in 2017.[1]

Many current efforts focus on pollinators. Although corn and soybeans do not require pollinators, both crops serve as a food source and habitat for them. Additional evidence indicates bees can increase soybean yields as much as 18%.[5]

The general decline in pollinator populations has been widely documented and acknowledged.[6] Farmers are positioned to help by providing habitats and using pollinator-friendly practices. Their integrated pest management strategies are designed to protect beneficiaries like pollinators. An increasing number of farmers choose to plant buffer strips, field edges and other landscape features in and around corn and soybean fields to a variety of native species that support pollinators. And a handful of farmers keep beehives.

Ongoing NCGA and USB investment and collaboration continue to raise farmer awareness of opportunities to improve.

- NCGA and USB invested in developing comprehensive best management practices to protect pollinators in corn and soybeans in conjunction with the Honey Bee Health Coalition. The Bee Integrated Demonstration Project pairs local beekeepers and producers to apply and share best management practices.

- Farmers for Monarchs helps farmers identify and implement solutions on agricultural lands to achieve a sustainable monarch butterfly population. Many states, from Texas to Ohio, have pollinator conservation plans in place of which farmers are a key partner. Efforts focus on protecting, restoring and establishing native milkweed and other nectar plants.

- The Environmental Defense Fund Monarch Butterfly Habitat Exchange developed an advanced Habitat Quantification Tool that can accurately determine the value of habitat and enable incentives for habitat restoration and conservation. The Exchange opened in key states in March 2018.

- The Bee and Butterfly Habitat Fund identifies potential for pollinator habitat and designs a precision habitat mix to maximize pollinator support in that location.

- The Growing Matters BeSure! campaign continues to raise farmer awareness of opportunities to improve pesticide application practices to protect pollinators.

- USB encourages farmers to plant prairie strips — areas of land taken out of row crop production and replaced with perennial prairie grasses — that provide habitats to native wildlife, especially for pollinators. In addition, these strips can reduce soil sediment loss by up to 95% and nutrient loss by 70% to 77%.[7]

- The Iowa Conservation Reserve Enhancement Program is a federal, state, local and private partnership that incentivizes landowners who voluntarily establish wetlands for water quality improvement in the tile-drained regions of Iowa.[8] These wetlands provide a rich habitat for local wildlife.

Woodlands and Prairies Shelter Wildlife

Many farmers intentionally manage their land to create wildlife habitats.

FARMER FEATURE

Supporting Wildlife Through Woodland Maintenance.

Like many, Minnesota farmer Jamie Beyer has taken land out of farming production to create wildlife habitat. That wooded land supports a variety of animals — deer, pheasants, turkeys and ducks thrive on the crops they grow and the wildlife areas they maintain. Beyer also hosts beehives throughout the summer.

FARMER FEATURE

Protecting the Soil and Water — and Game Bird Populations.

Iowa farmer Tim Smith strategically places prairie strips in areas across the contour of his field to control runoff and prevent soil erosion into nearby streams. In these prairie strips, a multitude of native grasses and forbs create upland game bird habitat. Graduate students from Iowa State University are monitoring the nesting habitats of these prairie strips, studying the diversity of bird species and other wildlife. These studies show a positive correlation between plant and bird diversity, particularly for the ring-necked pheasant — a species on its way to recovery due to increased forage and habitat.

Photo and testimonial courtesy of Field to Market.

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EQUIPMENT & TECHNOLOGY

As technology increasingly integrates with tractors, combines and field implements, farmers are able to **improve their sustainability and environmental stewardship.**

Corn and soybean farmers rely on their equipment — and its technology — to successfully prepare, plant, fertilize, protect and harvest their fields. As technology increasingly integrates with tractors, combines and field implements, farmers are able to improve their sustainability and environmental stewardship. These improvements come through advances in both equipment production and the use of data.

Innovations Reduce Equipment Emissions

Much like consumer vehicle manufacturers, farm equipment manufacturers have been continuously working for years to improve power and fuel efficiency while decreasing emissions. In 1996, the EPA first set off-highway diesel emission standards and lowered them over time. Since then, farm equipment companies have used innovative engine technologies to meet increasingly higher standards. Some emissions were reduced by 90% from 1996 to 2014.[1]

For example, some tractor engines now automatically adjust to use only the power needed at the moment, improving fuel efficiency and reducing emissions. Using newer equipment and adjusting field operations to reduce emissions results in substantial improvement in particulate matter emissions, the variety of heavy particles associated with black smoke from diesel engines, and slight improvements in the emissions of greenhouse gases and ozone precursors.[2]

Precision Agriculture Improves Stewardship

Precision agriculture is the general term for a variety of technology tools used in field operation. Global Positioning System signals, sensors and other data-gathering information technology tools collect information that can steer machines, create maps that dictate exact input placement, minimize errors, ensure consistency, turn equipment on and off, decrease energy use and much more. This information helps farmers make more informed decisions and optimize care for crops and soil.

More simply, precision agriculture helps farmers use fewer inputs to grow more.

Specific precision agriculture capabilities include auto-steer, machine section control and precision irrigation. Variable rate technology allows farmers to change the rate of seeds planted or the amount of fertilizer or pesticides applied to fields while driving across them. Rates change based on prescriptive maps that dictate resource placement and rate to support soil health and crop productivity while using the least amount of inputs possible.

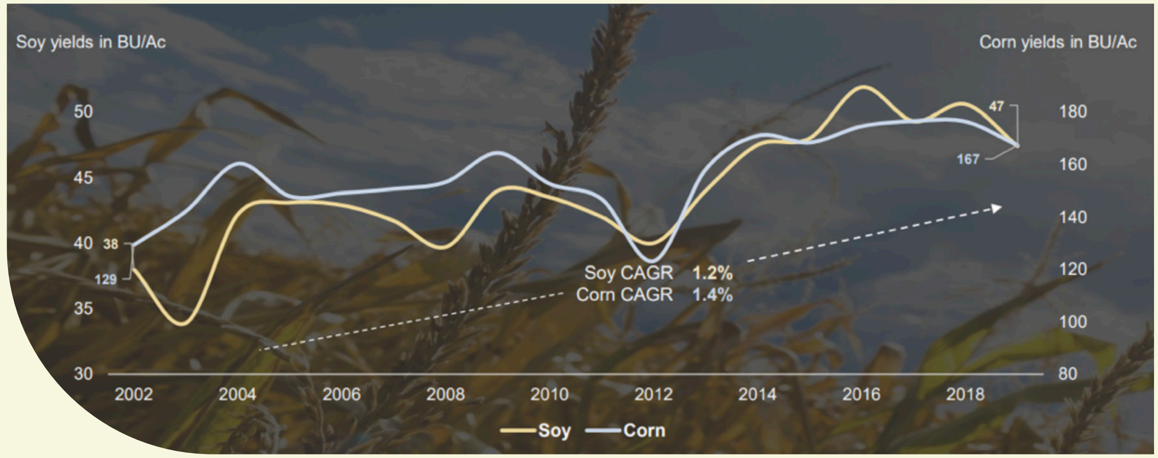
FARMER FEATURE

Investing in Sustainability with New Equipment

In Wisconsin, brothers David and Kevin Beske took a big step toward reducing their environmental impact by investing in precision agriculture. A GPS system helped them precisely target locations when tilling, planting and applying nutrients. This technology allowed them to see the bigger picture of their sustainability efficiency and make better decisions on inputs such as fertilizer and seed. They also invested in equipment, upgrading from an eight-row planter to a 24-row planter. This cut fuel needs for planting in half, and reduced time and trips through the fields by two-thirds. Together, equipment investments reduced their energy use and carbon footprint compared to their previous management practices.

Photo and testimonial courtesy of Field to Market.

Corn and Soy Yields from 2002-19



Source: The Environmental Benefits of Precision Agriculture in the United States. Association of Equipment Manufacturers with the American Soybean Association, National Corn Growers Association and CropLife America.

This technology helps corn and soybean farmers achieve several benefits, according to a study conducted by the Association of Equipment Manufacturers in partnership with NCGA, the American Soybean Association and CropLife America.

- Precision agriculture practices have increased farm productivity an estimated 4%.[3] Growth in corn and soybean yields has coincided with increasing adoption of precision technology since 2002. Broader adoption of these practices could increase productivity another 6%.[3] This helps keep marginal land out of production and makes it easier for farmers to maintain yields while using some land for filter strips, buffers and wildlife habitats.

- Technology has improved fertilizer placement efficiency by an estimated 7%.[3] Variable rate application, auto-steer and machine section control supports the 4Rs of nutrient management by placing the right rate of nutrients in the right place. More adoption of this technology could improve nutrient placement efficiency an additional 14%.[3]

- More accurate application has reduced herbicide use by an estimated 9%, and full adoption could reduce it by 15%.[3] Current technology adoption rates reduce herbicide use by an estimated 30 million pounds.[3]

- Automatic guidance systems and other technology have decreased fossil fuel use an estimated 6%, saving about 100 million gallons of fuel, with the potential to decrease another 16% with further adoption.[3]

- Precision irrigation, using soil moisture sensors and variable rate technology, has decreased water use an estimated 4%. Broader use of this technology could reduce water use another 21%.[3]

Use of precision agriculture technologies, including improved safety features, also has contributed to a decrease in injuries attributed to operator fatigue.[4]

Current adoption of many precision agriculture technologies for corn and soybean production varies by practice. The adoption rate of auto guidance is about 60%, while adoption of precision irrigation is at just 22%.[3] Adoption of variable rate application for nutrients is at 32%, and for herbicides, it is at 13%.[3]

Both improvements in engine technology and adoption of precision agriculture practices are factors that are contributing to overall decreases in greenhouse gas emissions, measured in pounds of CO_2-equivalent per acre — 48% in corn and 42% in soybeans — from 1980 to 2020.[4] They also factor into the 55% decrease in energy use per bushel of corn and the 45% decrease per bushel of soybeans over the same period, measured in BTUs per bushel.[4]

However, barriers to adoption of these technologies are significant. Farmers have limited capital to invest in new machinery with lower emissions and improved precision technology capabilities in the current economic climate. Some farmers have a limited understanding of the return on investment from these technologies, or how to implement them for maximum benefit. And, rural areas need improvements in the infrastructure that makes precision agriculture possible, such as broadband connectivity. For example, nearly 60% of U.S. farmers do not believe they have adequate internet connectivity to run their businesses, and that impacts their ability to rely on data and connectivity to improve their sustainability.[5]

Auto Guidance	Variable Rate Nutrient Application	Variable Rate Herbicide Application	Precision Irrigation
60%	32%	13%	22%

Source: The Environmental Benefits of Precision Agriculture in the United States. Association of Equipment Manufacturers with the American Soybean Association, National Corn Growers Association and CropLife America.

Both NCGA and USB are working with industry partners to address barriers to improving sustainability through equipment and technology adoption. NCGA helped fund The Environmental Benefits of Precision Agriculture study, and the Precision Conservation Management program from the Illinois Corn Growers Association, which assist farmers as they use data and precision technologies to improve their sustainability practices. USB funded the Rural Broadband and the American Farmer study detailing connectivity challenges and collaborated with broadband and data privacy experts to provide the infrastructure and tools farmers need.

USB partnered with The Yield Lab Institute to create the Soy Innovation Challenge, which challenged innovative leaders in the private sector to present their best ideas to disrupt and rethink the soybean value chain and increase profitability for farmers.[6] The seven finalists selected offered a wide range of specialized solutions for land stewardship, greenhouse gas monitoring, blockchain, traceability advancements and detailed nutritional information. The grand-prize winner, Regrow (formerly FluroSat) provides full crop-cycle analytics for sustainable and profitable agriculture. The goal of the challenge was to bridge the gap between production agriculture and technology companies that have farmer profitability top of mind.[7]

FARMER FEATURE

Variable Rate Technology Reduces Input Costs

Illinois farmer Lynn Rohrscheib found that technology has allowed her to use inputs more efficiently on her farm. Adjusting planting rates with variable rate technology, for example, allows her to account for different soil types in a field. Technology also has allowed her to reduce costs for inputs such as nutrients and pesticides.

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EDGE-OF-FIELD PRACTICES

Field borders provide opportunities to **protect natural resources** and **crop quality.**

Field borders provide opportunities to protect natural resources and crop quality. Features built into edges of crop fields reduce soil erosion, capture excess nutrients and sediment before they wash into waterways, and increase biodiversity.

These features can be as simple as ditches, filter strips and buffers that allow excess water to flow through permanent vegetation, reducing soil erosion and capturing sediment and nutrients in that runoff. This permanent vegetation, which often includes grasses and small native plants, also serves as a wildlife and pollinator habitat. Such field borders have been almost universally adopted by corn and soybean farmers where appropriate. These practices provide moderate to substantial improvement for some soil erosion and soil health aspects and slight improvement for biodiversity.[1]

Other edge-of-field practices involve stabilizing steeply graded ground, especially along streams or ditches. This can be done by moving or shaping ground, reseeding vegetation or adding structures designed to allow sediment to settle without running off into waterways.

Efforts to monitor water quality at field edges, especially in fragile watersheds, are increasing. NCGA and USB fund industry-supported advances in research and technology. These innovations have expanded recommendations for edge-of-field structures and practices that capture excess nutrients and soil sediment to further improve water quality as it leaves a field.

- An Indiana watershed research project installed a two-stage ditch along a streambank with known erosion issues. It was seeded with perennial plants to help enrich pollinator habitat. According to the participating farmer, taking out trees, reshaping the banks, adding a second level and reseeding it stopped streambank erosion completely. The project also showed others in the area the potential value of these efforts.[2]

- Saturated buffers use perforated drainage tiles to force excess water from a field to drain through the soil in a vegetated buffer strip. Soil microorganisms and plants absorb and break down excess nutrients, improving water quality. On average, saturated buffers can remove 50% of nitrates flowing under the soil surface.[2]

- Research looking into the effectiveness of prairie strips shows that by converting 10% of a crop field to diverse, native perennial vegetation, farmers can reduce sediment movement off their field by 95% and total phosphorus and nitrogen lost through runoff by 90% and 85%, respectively.[3]

Tile-drained water is routed to a woodchip filled trench located in a grassed buffer where the tile drainage leaves the field. Once the water enters the bioreactor, denitrification begins. Bacteria use the carbon from the woodchips as a food source and the incoming nitrate for their respiration process. Bioreactors can reduce nitrate levels by 15-60% in tile-drained water.

Source: Iowa Learning Farms.

There is also growing interest from conservation groups to advance the adoption of these practices among farmers. For example, the Nature Conservancy, the Soil and Water Conservation Society and the Meridian Institute brought together more than two dozen experts in agriculture, supply chain management, civil organizations and government officials to create a road map for edge-of-field practices that, when implemented together, accomplish a collective goal of conserving working lands. The goal of this road map is to establish a clear process for advancing adoption of these practices among farmers.[4]

Adoption of more complex edge-of-field practices is limited, primarily due to a lack of knowledge, proof of return on investment and funding. However, these practices represent opportunities for continuous improvement. They are slowly gaining traction, especially in sensitive watersheds and states with nutrient loss reduction strategies. As research refines implementation and demonstrates the value of these practices, adoption by corn and soybean farmers is expected to increase.

FARMER FEATURE

Leaving a Lasting Legacy of Stewardship by Protecting Soil and Water

Researchers are exploring ways to improve and adapt saturated buffers to address challenges farmers have encountered as they implement them. To find out if a different tile layout within saturated buffers more effectively removes nutrients from tile water, Illinois farmer Clint Robinson installed a new design on the edge of a field that drains into a large lake. He also has standard saturated buffers. Over time, researchers will monitor the water moving through both designs to understand their impact on water quality.

Photo and testimonial courtesy of Illinois Farmers Today.

Sources

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RENEWABLE FUELS

Biofuels, fuels derived from renewable sources of biomass, **support the sustainability of pork feed** production both directly and indirectly.

Biofuels, fuels derived from renewable sources of biomass, support the sustainability of pork feed production both directly and indirectly. The two most common biofuels used in the U.S. are ethanol, derived primarily from corn, and biodiesel, made mostly from soybean oil. These fuels burn cleaner than petroleum-based fuels. And they are coproducts of key ingredients in pig feed.

Direct Feed Ingredient Impact

Biodiesel and Soybean Meal

Biodiesel is made from a diverse mix of oil feedstocks. Soybean oil accounts for roughly half the oil used for biodiesel production,[1] but other sources include recycled cooking oil and animal fats. This renewable fuel is used in diesel engines and home heating applications in the northeastern region of the U.S.

The growing demand for biodiesel has increased overall soybean crush, increasing the supply of soybean meal. Although percentages vary by life stage, soybean meal makes up an average of 15.3% of pig rations.[2] Pigs consume about 7.5 million tons of soybean meal each year,[2] and use of soybean oil for biodiesel has lowered the price of soybean meal by as much as $48 per ton.[1]

Plus, use of animal fats and tallows for biodiesel production increases the value of these byproducts of pork production. For example, the value of choice white grease increased about 17% from 2009 to 2017 due to biodiesel production.[3] This supports economic sustainability of the pork supply chain. And the overall sustainability of pork production increases because these fats can become renewable, clean-burning diesel fuel.

Ethanol and Dried Distillers Grains

Nearly every gallon of gasoline in the U.S. contains a minimum of 10% ethanol derived from corn, according to NCGA.[4] About 30% of the field corn grown in the U.S. becomes ethanol.[4]

The ethanol production process also creates dried distillers grains with solubles, or DDGs, a valuable feed ingredient rich in protein, fat, vitamins and minerals. Research shows that DDGs can be easily incorporated into grow-finish diets for pigs as a cost-effective ingredient. Additionally, DDGs can be used at high diet inclusion rates of up to 30% in all phases of production to achieve optimal performance.[2]

As new technology is adopted by dry mills, the various components of corn can be further separated into its most valuable components to better meet nutritional needs of pigs at various growth stages.[5] As a result, more coproducts, such as high-protein DDGs, could become pig feed ingredients.

FARMER FEATURE

Variable Rate Technology Reduces Input Cost

Illinois farmer Elliott Uphoff sees being an environmentalist and a local energy supplier as part of his job as a farmer. As a trucker as well, he understands fuel needs. He sees his fields as literally full of energy, growing soybeans and corn very efficiently. And he believes using these crops for renewable fuel is a win for farmers, consumers and the environment. He drives a semi about 50,000 to 60,000 miles a year, and he fuels up with biofuel, usually a blend of 11% biodiesel, made from crops he grows. He notes that all fuels have a carbon footprint, but with renewable fuels, farmers are part of the full cycle. They use biofuels to create more energy by growing corn and soybeans.

Indirect Influence on Air Quality

In addition to producing feedstocks for renewable fuels, corn and soybean farmers also use them.

Because nearly every gallon of gasoline includes ethanol, it can be found in the fuel farmers use in their cars, trucks and gas-powered equipment. It is a high-octane, low-carbon fuel source.[4] A recently released study showed that corn ethanol reduces greenhouse gas emissions by 46%, compared to gasoline.[6]

NCGA is investing in research and awareness to move the fuel industry toward higher ethanol blends to improve air quality. Studies have shown that to optimize performance of future engines, high-octane fuel could use a blend of between 20% and 40% ethanol, compared to the standard 10% to 15% blends available today.[4] Additional ethanol demand would also increase the availability of DDGs for pig feed.

Farmers use diesel fuel for much of their farm equipment, including tractors and combines. Biodiesel made from soybean oil reduces lifecycle greenhouse gas emissions by up to 86%, compared to standard diesel fuel.[7] Most diesel equipment, including farm equipment, can run on blends of biodiesel. This fuel also lowers particulate matter by 47% and hydrocarbons emissions by 67%.[7] For every unit of fossil energy used to produce biodiesel, about 3.5 units of renewable energy are returned.[7]

Through USB, U.S. soybean farmers helped establish the biodiesel industry,[7] and they continue to support its growth. For example, USB is investing in research and awareness to encourage adoption of diesel fuel blends that include 20% biodiesel to improve air quality and maintain strong demand for soybean oil. Such an increase in demand for soybean oil would further improve the availability and cost-competitiveness of soybean meal for pig feed. Another recent study looked at the benefits to communities that use 100% biodiesel for transportation and home heating oil. Those benefits include decreased cancer risk and reduced asthma attacks due to lower particulate emissions, as well as fewer premature deaths and sick days.[8]

FARMER FEATURE

DDGs Meet Nutritional Needs of Pigs

Iowa pork and corn farmer Bob Hemesath uses DDGs at a 20% inclusion rate in grower and finishing diets for his pigs. He has gone up to as high as a 30% inclusion rate when economics allow. He says DDGs have been a great protein source.

Sources

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CONCLUSION

We've come a long way,

but we know we also have
a long way to go.

What's Next for Our Alliance

We — the organizations representing corn and soybean farmers and pork producers — hear you. We know customers of U.S. pork are ultimately customers of U.S. corn and soy as well through the feed supply chain. And we understand that our customers desire to increase sustainability through their supply chain, which includes us. That's why we created this blueprint — to demonstrate our united commitment to continuous improvement.

This blueprint aggregates a list of best management practices already used on farms today, but does not neglect the goals we set to continue moving toward a more sustainable tomorrow. This is what U.S. farmers have worked to develop through the evolution of farming, to protect the land, air and water that are the foundation of our planet for the current generation and generations to come.

We've come a long way, but we know we also have a long way to go. We agree that all commodity stakeholders must work together to support farmers as they scale up the use of conservation practices to create a sustainable energy and protein system fit for the current and future needs of customers.

In addition to our organizations' individual investments to help farmers improve on-farm sustainability, we are executing a collaborative plan to make significant progress toward achieving our sustainability goals by expanding cover crop acreage across the corn and soybean growing areas of the country.

It's a big goal, but it is only the first in our plan to make significant progress in "moving the needle" on environmental outcomes such as soil health and water quality. We look forward to reporting on our progress over time. Working together, we hope to continually reaffirm the U.S. corn and soybean value chain as a trusted leader in being environmentally sound, socially responsible and economically viable. We're proud to be making progress toward sustainability to be better stewards of the land and improve the sustainability of our customers' products.

The goal is to mitigate climate change, build farm productivity, and support resiliency by improving soil health through the implementation of 30 million acres of cover crops on corn and soybean acres in the U.S. by 2030.

Further progress through voluntary conservation efforts requires understanding and creating the enabling conditions that support widespread transition to sustainable practices, including providing farmers with financial incentives, technical assistance and peer learning opportunities.

- Field to Market National Indicators Report, 2021.