

Rotating Crops, Turning Profits

How Diversified Farming Systems Can Help Farmers While Protecting Soil and Preventing Pollution

HIGHLIGHTS

Replacing a fraction of current Midwest corn and soybean acres with a more diverse crop rotation system would produce higher yields and maintain farmers' profits while protecting their soil, cutting fertilizer and pesticide use and the associated costs, and reducing water pollution and global warming emissions. Our economic analysis of Iowa data shows that this more sustainable way of farming can be feasibly scaled up to as much as 40 percent of the state's farmland, with significant benefits to farmers, taxpayers, and rural communities. Federal policy changes are needed to support farmers in adoption of such systems, especially regarding up-front costs and farmers' need for practical, technical information.

Today's dominant Midwest farming system produces two commodities—corn and soybeans—in abundance; however, this system has grown steadily less beneficial for farmers over time. US corn and soybean growers achieved record-high harvests in 2016. But due to oversupply, prices farmers receive for these crops have plummeted, and US farm incomes were expected to drop to their lowest levels since 2002.

The dominant two-crop farming system also has negative consequences for our environment and farmers' long-term sustainability. It typically leaves fields bare for much of the year and employs tillage (plowing) practices that result in levels of erosion that cannot be sustained over time. The two-crop system relies on heavy fertilizer use, which allows the escape of excess nitrogen into the air and water; nitrogen pollution from agriculture costs the nation an estimated \$157 billion per year in human health and environmental damages. Rural communities suffer many of the consequences. Iowa, for example, ranks high among states in surface water pollution from fertilizers, pesticides, and eroded soil. And the negative effects extend far beyond the Midwest. Corn Belt watersheds are major contributors to the annual "dead zone" in the Gulf of Mexico, and nitrous oxide emissions from agricultural soil management comprise 5 percent of the United States' share of heat-trapping gases responsible for climate change.

Diverse Crop Rotations in Iowa Maintain Farmers' Profits While Delivering Additional Benefits

There is an urgent need for solutions that maintain farmers' productivity and profitability, protect the soil, and prevent air and water pollution. Long-term



Courtesy of Practical Farmers of Iowa

Research reveals a range of benefits from adding oats (pictured here) and alfalfa to typical Corn Belt crop rotations, and our analysis shows that these benefits for farmers and the environment hold up at scale. Public policy changes could increase adoption of more diverse rotations.

research at Iowa State University has shown that modified cropping systems can provide these solutions. The university's 15-year, 22-acre experiment has demonstrated that transitioning Iowa farm acres from today's dominant two-crop system to a more diverse rotation involving three or four crops grown throughout the year can increase crop yields and maintain similar per-acre profits. The Union of Concerned Scientists (UCS) performed additional analysis that indicates this system can provide additional benefits: reduced soil erosion, decreased runoff of pollutants that threaten the region's waterways and drinking water supplies in downstream communities, and lower emissions of heat-trapping gases to the atmosphere.

Since 2003, Iowa State researchers have compared three rotation systems: the two-year corn-soybean system that is typical in the region today, a three-year system that adds a cool-season small grain (such as oats) with a cover crop of red clover that acts as a "green manure," and a four-year system that includes a small grain (again, oats) with a green manure of alfalfa, followed by a second year of alfalfa for harvest. They have found that the longer rotations served to enhance yields and profits while reducing pesticide use and pollution. Average corn yields were 2 to 4 percent higher and average soybean yields 10 to 17 percent higher compared with the two-crop system, and the longer rotations were just as profitable as corn-soy alone. These more diverse rotations also cut herbicide use by 25 to 51 percent, reduced herbicide runoff in water by 81 to 96 percent, and reduced total nitrogen fertilizer application rates by 43 to 57 percent compared with corn-soy.

Diverse Crop Rotation Systems Could Dramatically Reduce Erosion and Water Pollution in Iowa

The crop rotation systems tested at Iowa State offer a range of benefits for farmers, rural communities, and the nation at large. We analyzed the extent to which expanding these systems would be sustainable over time and where, specifically, these systems could be expanded to maximize benefits. According to our modeling, adoption of diverse rotations grown without tillage (plowing) in the 25 Iowa counties with the

most erodible soils—representing 15 percent of the state's cropland—would achieve dramatic results:

- **Reducing soil erosion by 91 percent** compared with tilled corn-soy
- **Saving taxpayers and downstream communities \$196 million to \$198 million annually** in surface water cleanup costs
- **Achieving net reductions in heat-trapping gases valued at \$74 million to \$78 million annually** (from the combination of reduced fertilizer use and increased carbon storage in soil)

Rotation Systems Could Be Expanded to Millions of Acres over Time

We also analyzed the extent to which Iowa's farmers could scale up this system across the state, beyond the highly erodible acres described above. We used economic modeling to predict how changing supply and demand for various crops would drive farmers' decisions and found that:



Fields left bare between crops lose topsoil and wash fertilizers and other pollutants into streams when heavy rains occur. Here, erosion is seen on an Iowa field after a spring rain, before young corn plants are established.

Lynn Betts/USDA

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- **Diverse crop rotations could be adopted over time on 20 to 40 percent of Iowa’s farmland**—5 million to 11 million acres—without changes in crop prices driving farmers back to predominantly corn-soy.
- **Soil erosion would be reduced by 88 percent** compared with tilled corn-soy, to a sustainable level given natural soil replacement rates.
- Taxpayers would achieve total annual savings of \$124 million to \$272 million from reduced surface water cleanup costs and net reductions in heat-trapping gases valued at \$111 million to \$233 million annually, for a total of **\$235 million to \$505 million in environmental benefits every year.**

We focused our analysis on Iowa; however, our results can be generalized throughout the Corn Belt.

Farmers Face Numerous Obstacles to Adoption of These Systems

So why aren’t farmers already adopting these economically and environmentally beneficial systems? As business people often operating on slim margins, farmers face numerous barriers when it comes to adopting new or unfamiliar practices such as modified crop rotations. These include:

Market barriers. Markets for oats and other small grains today are not as well developed as markets for corn and soybeans, demand for these commodities is lower, and infrastructure such as seed suppliers and grain storage facilities is less ubiquitous. We assume that new markets for these crops (and the infrastructure to serve them) will emerge to meet supply over time, but farmers may initially be daunted.

Financial barriers. Adding new crops to their usual rotations may require farmers to make significant up-front investments—for example, in new equipment—and incur higher costs in the short term. And for the majority of US farmers who rent farmland from others, typical short-term leases do not allow for long-term planning or provide incentives for soil and water quality improvements.

Crop insurance and credit constraints. Until recently, provisions of federal crop insurance programs have discouraged complex rotations by insuring just a few crops and encouraging farmers to plant them exclusively; in past years farmers could lose benefits for acres not planted to those crops. Congress addressed this in 2014, extending coverage to diversified farmers with a new Whole Farm Revenue Protection program. But many county insurance agents lack training on this new program and may neglect to recommend the program to those



The USDA’s Natural Resources Conservation Service could increase the adoption rate of diverse crop rotation systems by developing a multi-state pilot project that provides farmers with firsthand knowledge of the benefits.

who could benefit from it. Further, lenders unfamiliar with the profitability potential of longer rotation systems may be unwilling to make loans needed to help farmers adopt them.

Technical and information barriers. Farmers need evidence that new practices are feasible, can be implemented successfully in their locations, and will benefit their bottom lines. Publicly funded research programs are critical; however, research on crop rotations and other agroecological farm practices at the USDA and at public universities are severely underfunded. Farmers also need publicly funded technical guidance, yet the number of county-level agricultural extension agents tasked with advising them has declined in recent decades.

Policy Recommendations

Federal farm policies—created and funded by Congress and implemented by the USDA—have played a major role in creating the dominant corn-and-soybean cropping system in the Midwest. Changes to these policies and investments are now needed to shift this system. Policymakers should:

- **Expand incentives and strengthen up-front financial support for farmers to shift to diverse rotations.** Specific recommended changes include:
 - Stronger support in the **Conservation Stewardship Program (CSP)** for diverse crop rotations,

specifically those involving a year-round mix of crops.

- Increased support for rotations in the **Environmental Quality Incentives Program (EQIP)**, in particular, a boost in per-acre payments to farmers for implementing diverse crop rotations.
- Additional funding for **USDA Farm Service Agency loans**. The agency's Direct and Guaranteed Operating Loans program and its microloans program require increased funding in the coming years to meet the high—and growing—demand.
- **Strengthen crop insurance coverage for diversified farms through improved promotion of the Whole Farm Revenue Protection Program.** The USDA must do more to promote this new and unfamiliar program to farmers and insurance agents. Agents, in particular, need to better understand its benefits so they can accurately recommend the program to those who could benefit from it.
- **Increase public support for research, technical assistance, and demonstration projects on diverse rotations.** A greater understanding of the optimal diversified farming systems in regions throughout the country will increase practical understanding and adoption of crop rotations. Additionally, more research needs to be devoted to how livestock producers can best incorporate different crops into their livestock feed. This requires:
 - Full funding for the **USDA's Agricultural Food and Research Initiative (AFRI)**, and increased emphasis on agricultural diversification. This federal program funds public agricultural research at institutions throughout the country, but allocates a relatively small portion of its funding toward increasing seed varieties and ecosystems knowledge. Congress should fully fund AFRI, and AFRI should increase its focus on research related to agricultural diversification.
 - **Funding more long-term research.** Beyond AFRI, there is a need for the USDA to fund long-term research projects focusing on farming system comparisons. The typical three- to five-year USDA competitive grant is too short to adequately capture the effects of diverse crop rotations on soil quality, for example.
 - Developing a **new farm pilot program to increase practical understanding of diverse crop rotations and their potential benefits for farmers and livestock producers.** Farmers and livestock producers in various regions of the country need tangible examples of successful diverse crop rotations and ways that these crops can be incorporated as feed into a livestock operation. To this end, the USDA's Natural Resources Conservation Service, in partnership with state and local farmer organizations, should develop a multi-state farm pilot program designed to provide farmers with this practical, firsthand knowledge.

Conclusion

Agriculture can be productive and profitable without the damaging effects on the nation's soil, water, and air caused by today's widespread use of two-crop systems. Farmers can maintain high yields and sustained profits through an updated approach, one involving a more diverse set of crops and a modified strategy for protecting the soil. Supported by a set of policy changes that increase technical assistance and assist with up-front costs, US farmers can make the transition to a farming system that supports their livelihood, protects the natural resources on which it depends, and reduces the cleanup burden on taxpayers—all at once.

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Union of **Concerned Scientists**

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