Union of Concerned Scientists

FACT SHEET

Cover Crops

Public Investments Could Produce Big Payoffs

BEST PRACTICES FOR SUSTAINABLE, RESILIENT & DIVERSIFIED AGRICULTURE

On many farms in the United States, fields are left bare when crops are not growing—often for much of the year—creating a number of problems. Wind, rain, and snowmelt erode the bare soil, and nitrogen and phosphorus fertilizers leach into groundwater or run off into streams and rivers. This loss of soil and nutrients adds costs for farmers and causes severe—and expensive—environmental and public health problems in agricultural communities and beyond.[1]

Some farmers grow plants known as cover crops to protect and build their soil during the off-season, or for livestock grazing or forage. If adopted widely, this underutilized practice could help solve many environmental and health problems associated with bare soil. And because cover crops add organic matter to the soil, they can help farmers maintain the long-term productivity of their land.[2]

Studies suggest that cover crops prevent pollution by reducing nitrate leaching through soil by 40 to 70 percent compared to bare soil.

Despite these potential benefits, cover crops are currently planted on only a small fraction of U.S. farmland.[3] Why? Substantial economic and technical barriers—some embedded in government policies—discourage farmers from growing them.[4] New or modified policies that promote cover crop adoption, on the other hand, would enable farmers, taxpayers, and communities across the country to reap the benefits.

Regional—and Even Global—Impact

Cover crops help prevent pollution problems that many communities are forced to live with because the pollution is too difficult and costly to clean up. In particular, cover crops can:

- ***Reduce sediment in streams, rivers, and lakes.*** Erosion from bare farm fields carries sediment containing phosphorus into surface waters, degrading fisheries and habitats.[1,2] Cover crops help hold soil in the field, preventing erosion.
- ***Reduce nitrogen pollution.*** Nitrogen that leaches from farm fields makes its way downstream to coastal waters like the Gulf of Mexico or Chesapeake Bay, causing "dead zones" where fish and other marine organisms cannot live.[5]

  Nitrogen also contaminates drinking water: a recent survey found one of every four shallow groundwater wells in agricultural areas had nitrate levels above the U.S. Environmental Protection Agency's acceptable maximum.[6] Cover crops can reduce nitrate leaching between 40 and 70 percent compared with bare soil.[7]
- ***Reduce global warming emissions.*** Certain microbes convert excess nitrogen in soil into the gas nitrous oxide, which traps 300 times more heat in the atmosphere than carbon dioxide. Cover crops, by

Corn planted into a cover crop of oats and crimson clover
Source: http://plantcovercrops.com/photo-diary-corn-after-a-cover-crop/

keeping nitrogen tied up in plant tissue and soil organic matter, limit the creation of nitrous oxide in the field and downstream.[8] In some cases, cover crops can even increase carbon storage in soil, further reducing heat-trapping gases in the atmosphere.[2,9]

The Benefits for Farmers

Cover crops offer farmers potentially higher productivity and profits, especially in the long term.[10] For starters, cover crops can lower farmers' expenses by:

- ***Reducing the need for nitrogen fertilizers.*** Legume cover crops add between 50 and 200 pounds of nitrogen to each acre of soil per year—similar to synthetic fertilizers that can pollute our water. Cover crops also save farmers the money they would spend on synthetic fertilizers and the fuel used during application. Furthermore, this practice retrieves nitrogen left in the soil after cash crops are harvested, keeping it on the field and diminishing the need to purchase fertilizer.
- ***Reducing the need for pesticides.*** The thick mat of plant material left on the ground after cover crops die (or are cut) can limit weed growth while encouraging the growth of predatory insects that help control pests, minimizing both herbicide and insecticide purchases. Several cover crops can also kill harmful microbes, lessening the need for fungicides or nematicides.[2,11]

Cover crops can also improve productivity and contribute to sound ecological management of farm fields—making farms more resilient—by:

- ***Increasing soil fertility.*** Cover crops reduce soil loss and add organic matter to soil.[2] The aboveground part of the plant cushions the impact of heavy rains and slows water movement, while its roots bind the soil and form "pores" through which water drains, reducing runoff. And because cover crops are usually returned to the soil after they die, they replenish soil organic matter.
- ***Increasing soil's water-holding capacity.*** A cover crop allows more water to enter the soil than bare ground, and its roots create spaces that hold water, decreasing the need for irrigation and reducing susceptibility to drought. A mat of cover crop debris on the soil's surface—into which cash crops can often be planted—helps reduce evaporation during hot weather.
- ***Increasing cash crop yields.*** Cover crops' impact on yields can be difficult to quantify,[12] but some studies have shown an increase of more than 50 percent[13] due in large part to increased soil fertility and water-holding capacity.

What's Holding Farmers Back

Despite the clear benefits of cover crops, including potential improvements in cash crop productivity, adoption rates in many places are low. A survey of farmers in the Corn Belt found that 18 percent had used cover crops but only 8 percent had used them in the previous year.[3] The reason? At least initially, cover crops may not boost farmers' bottom line; they also carry certain costs and risks, some of which are not yet well understood.

Constraints on cover crop adoption include:

- ***Direct costs***. Farmers must usually account for the purchase of cover crop seed and the labor involved in planting and "terminating" (i.e., killing by various means) the crop, then possibly turning it into the soil—each of which may require specialized machinery. One study revealed that a 1 percent increase in the cost of cover crops can reduce their adoption by 14 percent.[14]
- ***Indirect costs.*** The ability to plant cash crops in a timely fashion may be limited if cover crop growth extends into the main growing season, as can happen during a wet spring. Under current federal policies, weather that delays the termination of a cover crop can render subsequent cash crops ineligible for insurance.
- ***Return on investment.*** Soil fertility, organic matter, and water-holding capacity increase slowly over time, so farmers may need to use cover crops for several years before the benefits become apparent. The immediate costs of running a farm may work against accurate valuation of these improvements.

- ***Land ownership.*** Because farmers often lease their land, they may be less inclined to make long-term investments like improvements to the soil's productive capacity if they are not certain they will be around to reap the benefits. Furthermore, improvements that increase the land's value also increase the cost incurred to lease it.
- ***Plant biology.*** If farmers overestimate the amount of nitrogen their cover crops will supply—a calculation based on several factors often influenced by weather, which is highly variable—cash crop production (and income) can suffer. In addition, cover crops need time to produce sufficient biomass, which can delay the planting of a cash crop and reduce its potential yield.[2]
- ***Region-specific considerations.*** When used without sufficient experience or knowledge, cover crops can have undesirable effects. In dry regions or during dry years, for example, cover crops (which typically remove water from the soil in late spring) may leave too little moisture for the cash crops that follow. In northern regions, cover crops may not have time to establish themselves after the cash crop has been harvested in the fall.
- ***Availability of information.*** Data on how different cover crops fit into specific cropping systems in a given region, or on managing risks and benefits, may be limited.

The Help Farmers Need

- The right mix of incentives and technical assistance can boost adoption of cover crops. In Maryland, for example, an aggressive incentive program has led 60 percent of farmers to use cover crops.[15] In the Corn Belt, many farmers indicated they would be more willing to adopt cover crops if modest cost-share assistance of $23 per acre were available.[13]
- Federal programs already exist to help farmers contend with yield losses due to bad weather or pests and ensure the long-term viability of their operations. Similar public investments are needed to advance strategies—including cover crops—that can solve the environmental and public health problems posed by agricultural pollution.
- Financial incentives can help farmers shoulder the direct costs of establishing cover crops, and can help

To Plant or Not to Plant: Variables in the Equation

A recent study estimated farmers' costs to grow several common cover crop varieties in Kansas. These costs—which include purchasing and planting seed, modifying the planting machinery, applying fertilizer where needed, terminating the crop, and possibly turning its residue into the soil—totaled between $62 and $107 per acre. But farmers must also consider such additional costs as foregone profits from a cash crop (which can be significant) and equipment purchases required for cover crop planting.

Farmers must therefore consider carefully whether the benefits of cover crops outweigh the costs. If the field is irrigated, cash crop prices are high, gains in cash crop yield caused by the cover crop are pronounced, and the risk of cash crop failure is low, the benefits to the farmer could be great. If some of these conditions are uncertain, farmers are unlikely to plant cover crops without additional financial incentive.

Costs Associated with Various Cover Crops in Kansas, 2008

	Hairy Vetch	Oats	Annual Ryegrass	Wheat	Cereal Rye	Crimson Clover
Seed ($/acre)	50	14	15	17	21	34
Planting ($/acre)	12	12	12	12	12	12
Fertilizer ($/acre)		57	57	57	57	57
Termination($/acre)*		4	4	4	4	4
Total Costs ($/acre)	**62**	**87**	**88**	**90**	**94**	**107**

Source: Bergtold, J., and L. Maddy. 2008. Cover crop economics: Costs, risks, and adoption. Department of Agricultural Economics. Manhattan, KS: Kansas State University.

compensate farmers for difficult-to-predict cash crop income losses stemming from cover crops.[3] Such investments would encourage higher adoption rates in the short term while also giving farmers, university extension agents, and researchers desperately needed experience with cover crops in different climates, soil types, and crop rotations—adding to our understanding of how they can be used consistently, successfully, and profitably.

Recommendations

The Union of Concerned Scientists supports policies and programs that can prevent pollution and improve long-term farm productivity by reducing the uncertainties and costs associated with cover crops and accelerating their adoption. Such programs should:

- Direct federal cost-share incentives to promote the use of cover crops through working-lands programs, namely the U.S. Department of Agriculture's (USDA's) Conservation Stewardship Program (CSP) and Environmental Quality Incentives Program (EQIP). More specifically, the USDA should 1) encourage broader farmer participation in CSP and expanded adoption of cover crops by increasing the minimum contract payment and the average per-acre payment; and 2) expand EQIP participation and create a level playing field for farmers by eliminating unnecessary payment caps for organic producers while reducing maximum payments for all producers.
- Ensure that federally subsidized crop and revenue insurance policies do not prohibit or discourage farmers from, or unduly penalize them for, using cover crops.
- Expand outreach and technical assistance to provide farmers with better information about the use and adoption of cover crops (including the varieties and mixes best suited to meet specific farm management objectives).
- Expand research into breeding and improving cover crops, using them in specific geographic regions, integrating them with various cash crops and farming systems, and maximizing their economic benefits. Research should also provide better estimates of nitrogen availability from cover crops, and consequent fertilizer savings for farmers.

Endnotes

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[4] Rodriguez, J.M., J.J. Molnar, R. Fazio, E. Sydnor, and M.J. Lowe. 2008. Barriers to adoption of sustainable agriculture practices: Change agent perspectives. *Renewable Agriculture and Food Systems* 24(01):60.

[5] Environmental Protection Agency. 2008. Hypoxia in the northern Gulf of Mexico: An update by the EPA science advisory board. EPA-SAB-08-003. Washington, DC.

[6] Environmental Protection Agency. 2011. Reactive nitrogen in the United States: An analysis of inputs, flows, consequences, and management options. EPA-SAB-11-013. Washington, DC.

[7] Tonitto, C., M.B. David, and L.E. Drinkwater. 2006. Replacing bare fallows with cover crops in fertilizer-intensive cropping systems: A metaanalysis of crop yield and N dynamics. *Agriculture, Ecosystems and Environment* 112:58–72.

[8] Parkin, T.B., T.C. Kaspar, and J.W. Singer. 2006. Cover crop effects on the fate of N following application of swine manure. *Plant and Soil* 289:141–152. Where cover crops lead to greater amounts of soil organic matter, they can increase the activity of microbes and hence the production of nitrous oxide, so the direct influence of cover crops on in-field nitrous oxide emissions is not clear. However, reduced loss of nitrogen from farm fields translates to lower nitrous oxide emissions downstream and to reduced requirements for synthetic fertilizer. Synthetic fertilizer production is an energy-intensive process, so less production means lower emissions of carbon dioxide.

[9] There are challenges with keeping stored carbon in the soil. If practices that sequester carbon are reversed, stored carbon can quickly re-enter the atmosphere. At some point, usually after several decades, the soil also reaches a limit that prevents additional net sequestration of carbon.

[10] Sustainable Agriculture Research & Education. 2007. *Managing cover crops profitably*. SARE Handbook 9. College Park, MD.

[11] Snapp, S., K.U. Date, W. Kirk, K. O'Neil, A. Kremen, and G. Bird. 2007. Root, shoot tissues of *Brassica juncea* and *Cereal secale* promote potato health. *Plant Soil* 294:55–72.

[12] Kornegay, J.L., R.R. Harwood, S.S. Batie, D. Bucks, C.B. Flora, J. Hanson, D. Jackson-Smith, W. Jury, D. Meyer, J.P. Reganold, J.A. Schumacher, H. Sehmsdorf, C. Shennan, L.A. Thrupp, and P. Willis. 2010. *Toward sustainable agricultural systems in the 21st century*. Washington, DC: National Research Council.

[13] For example, sorghum in the Great Plains, grown after vetch or red clover, had yield increases of 79 to 131 percent compared with continuous sorghum. Potatoes in Colorado grown after Sudangrass had 12 to 30 percent yield increases compared with after wet fallow (Kornegay et al. 2010).

[14] Lichtenberg, E., J.C. Hanson, A.M. Decker, and A.J. Clark. 1994. Profitability of legume cover crops in the Mid-Atlantic Region. *Journal of Soil and Water Conservation* 49(6):562–565.

[15] Estimate from the Maryland Department of Agriculture.