NRDC

ISSUE BRIEF

# CLIMATE-READY SOIL:
## HOW COVER CROPS CAN MAKE FARMS MORE RESILIENT TO EXTREME WEATHER RISKS

Farmers in central Texas were knee deep in water during the spring of 2015, wondering how they would ever be able to plant a crop in their flooded fields. May 2015 was the wettest month on record for the Lone Star State, something that many could hardly believe, given the bone-dry conditions during the previous four years.[1] From 2011 to 2014, Texas experienced record-setting drought and farmers lost more than $4 billion worth of crops due to hot, dry weather.[2] The same farmers who had been praying for rain were now wondering what they were going to do with all this water.

**Fact sheets on the use of cover crops in the top 10 agriculture states are available for download at www.nrdc.org/water/climate-ready-soil.asp**


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Texas wasn't the only state to experience a wet spring in 2015. Across the Corn Belt, in states like Nebraska, Iowa, and Kansas, farmers were struggling to plant crops in their fields due to wet conditions. Ultimately, many were forced to accept that they would not get a crop in the ground in 2015, and nearly 4.5 million corn and soybean acres are lying bare this year due to "prevented planting" caused by poor field conditions.[3]

Meanwhile, in California, farmers were wishing that some of that rain would head their way. In the midst of the worst drought in more than a thousand years, California farmers have seen wells and reservoirs run dry, threatening their crops and their livelihoods.[4] Over the past several years, groundwater levels in some parts of California's Central Valley have declined by more than 50 feet due to increasing irrigation demands and reduced recharge because of the dry weather.[5]

Sadly, droughts, heavy downpours, and floods are growing increasingly common in many parts of the country due to climate change.[6] Further, the economic threats to agriculture from these growing risks are greatest in the nation's leading farming states. The value of the agricultural sector in the top 10 states alone was more than $250 billion in 2014, which represents more than half of the entire U.S. total.[7] Climate change and extreme weather will likely have detrimental impacts on crop production, but farmers can use cover crops and other soil stewardship practices to make their farms more resilient to the climate change impacts already being felt and those likely to come in the years ahead. Such practices can also help to reduce and capture the greenhouse gas emissions that contribute to climate change.

NRDC examined the carbon capture and water-holding benefits of soil stewardship methods to increase soil organic matter in the 10 highest-value-producing agricultural states in the United States. This analysis estimates that using cover crops on just *half* of the acres devoted to the nation's two most ubiquitous crops—corn and soybeans—in those top 10 states could help capture more than 19 million metric tons of carbon each year and help soils retain an additional trillion gallons of water.

## GROWING RISKS OF EXTREME WEATHER

Over the past five years, farmers in the top 10 agricultural states lost more than $25 billion worth of crops due to drought, heat, hot wind, extreme rainfall, flooding, and other related impacts.[8] Table 1 shows the extent of these economic impacts in each of the top 10 agricultural states.

Scientists predict that climate change will result in higher numbers of consecutive dry days and hot nights, negatively affecting crop yields, especially in the western and southern parts of the country.[9] Higher temperatures in conjunction with longer dry periods will increase crop water requirements, likely exacerbating water shortages.[10] When it does rain, precipitation is expected to occur in heavier, more intense rainfall events, increasing the risk of soil erosion.[11] These extreme precipitation events are expected to become more frequent across the country as a whole, and three to five times more frequent across large areas of the West, Midwest, and Northeast (see Figure 1).[12] More carbon dioxide and other greenhouse gases like nitrous oxide ($N_2O$) in the atmosphere will likely stimulate weed growth, and changing precipitation and temperature patterns can mean new pressures from insect pests and pathogens.[13] Table 2 summarizes the effects of climate change on our nation's farms.

**Table 1. Annual average crop losses related to extreme weather (2010–2014) for the top 10 agricultural states[14]**

| Rank | State | 2014 Total Value of Agricultural Sector Production ($ billion) | 2010–2014 Annual Average Extreme Weather–related Crop Losses ($ million) |
|---|---|---|---|
| 1 | California | 56.2 | 110 |
| 2 | Iowa | 35.5 | 899 |
| 3 | Texas | 30 | 1,000 |
| 4 | Nebraska | 26.6 | 398 |
| 5 | Minnesota | 21.5 | 459 |
| 6 | Illinois | 21.2 | 802 |
| 7 | Kansas | 18.4 | 718 |
| 8 | Wisconsin | 14.7 | 197 |
| 9 | North Carolina | 14.6 | 156 |
| 10 | Indiana | 13.8 | 319 |

**FIGURE 1. PROJECTED CHANGE IN THE FREQUENCY OF HEAVY PRECIPITATION EVENTS BY THE END OF THE CENTURY UNDER A CONTINUED HIGH-EMISSIONS SCENARIO[15]**

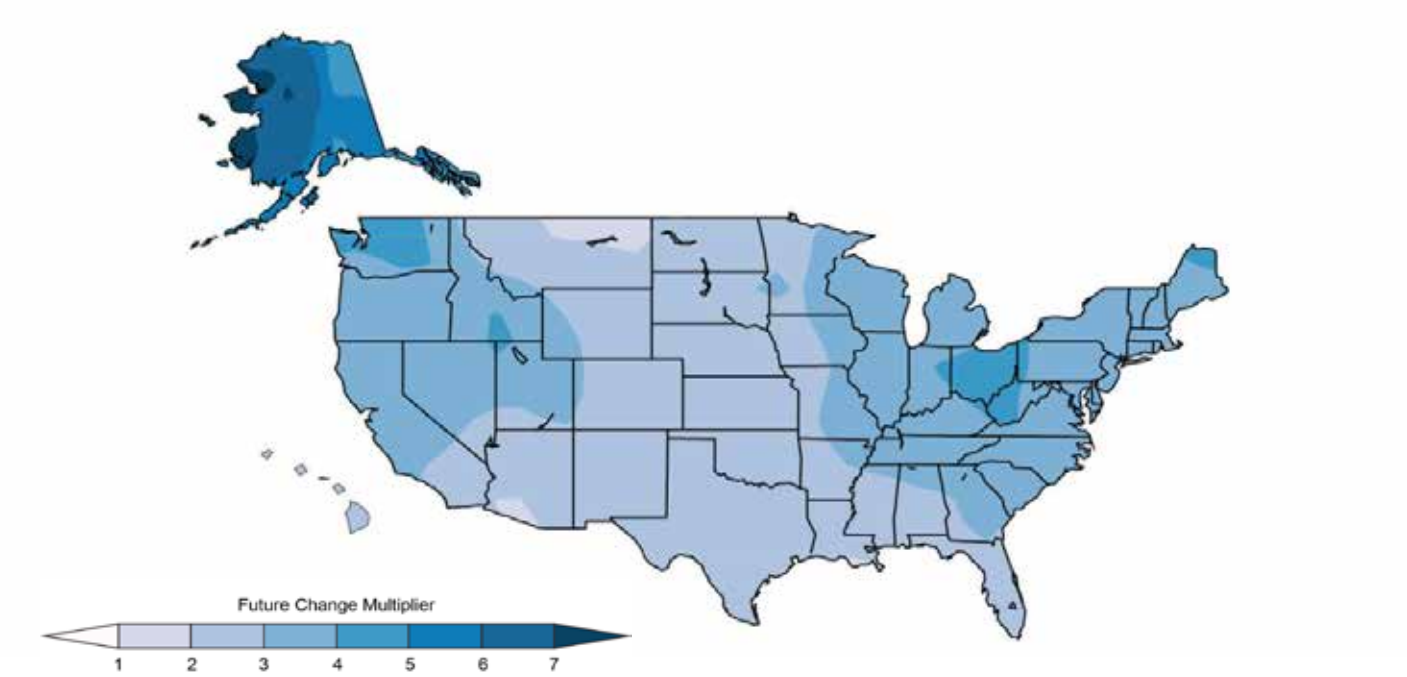


**Table 2. Major projected climate change effects, potential impacts on agriculture, and cover crop benefits[16]**

| Projected Change | Major Effects on Agricultural Crops | Cover Crop Benefits[17] |
|---|---|---|
| Higher levels of atmospheric $CO_2$ and other greenhouse gases | ■ May benefit growth and reduce water-use rates for some plants but decrease nutrient content in others<br>■ May negatively affect grain and fruit yield and quality<br>■ Stimulate growth of weed species and likely contribute to greater crop loss from weeds | ■ Increased storage of carbon in soil<br>■ Capture of soil nitrogen, reducing $N_2O$ emissions and nitrogen fertilizer needs<br>■ Suppression or control of weeds |
| Warmer temperatures | ■ Increase crop water demand, which is likely to raise the risk of crop loss, especially for crops grown in soils with limited water-holding capacity<br>■ During critical stages of plant growth cycles, can greatly reduce yields and increase risks of total crop failure<br>■ Reduce frequency of sufficiently cold temperatures needed for the winter chilling of perennial specialty crops (e.g., fruits and nuts), which will reduce yields<br>■ Allow for pests' overwintering (survival through winter) and increased reproductive rates | ■ Improved soil structure, tilth, and water-holding capacity<br>■ Increased soil water retention and plant-available water capacity (amount of water stored in soil that is available for use by plants)<br>■ Reduced incidence of some crop pests and diseases |
| Changing precipitation patterns | ■ Affect irrigation water availability, crop productivity, costs of water<br>■ Increase demand for irrigation if precipitation is reduced | ■ Increased soil organic matter, which improves soil tilth and productivity |
| More extreme weather events | ■ Increase soil erosion, which decreases productivity, if rainfall is more intense<br>■ Reduce yield, if drought occurs at sensitive stages of crop life cycles | ■ Reduced water runoff and soil erosion |

## BENEFITS OF SOIL STEWARDSHIP

Although farmers are feeling the brunt of the impacts of this new era of challenging weather, they also have an opportunity to be a part of the solution. Specifically, farmers can use cover crops—non-commodity crops that are planted typically in winter—to trap carbon in the soil and help reduce emissions of other greenhouse gases that contribute to climate change.[18] In fact, planting cover crops on just half of the corn and soybean acres in the top 10 agricultural states could sequester more than 19 million metric tons of carbon annually (see Table 3), equivalent to taking more than 4 million cars off the road.[19]

**Table 3. Carbon sequestration, greenhouse gas (GHG) emissions reductions, and water storage benefits if cover crops were planted on 50 percent of corn and soybean acres in the top 10 agricultural states[20]**

| 2014 Agricultural Sector Value Rank | State | Cover Crop Acres Planted (2012) | Half of Total Corn and Soybean Acres (2012) | Annual Carbon Sequestered And GHG Emissions Reductions (metric tons $CO_2$ equiv.) | Additional Water Stored (gallons) |
|---|---|---|---|---|---|
| 1 | California | 341,000 | 331,000* | 89,000** | 6.8 billion** |
| 2 | Iowa | 380,000 | 11,700,000 | 4,330,000 | 234 billion |
| 3 | Texas | 911,000 | 937,000 | 297,000 | 19 billion |
| 4 | Nebraska | 357,000 | 7,260,000 | 2,560,000 | 145 billion |
| 5 | Minnesota | 408,000 | 7,840,000 | 2,900,000 | 157 billion |
| 6 | Illinois | 319,000 | 10,700,000 | 3,950,000 | 214 billion |
| 7 | Kansas | 322,000 | 4,040,000 | 1,390,000 | 81 billion |
| 8 | Wisconsin | 553,000 | 2,980,000 | 1,100,000 | 60 billion |
| 9 | North Carolina | 393,000 | 1,200,000 | 442,000 | 24 billion |
| 10 | Indiana | 596,000 | 5,660,000 | 2,090,000 | 113 billion |
| Total | | | | 19.3 million | 1.06 trillion |

*California's existing cover crop acres already exceed 50 percent of the state's corn and soybean acreage (331,000) because these crops are not widely planted. California, however, has the potential to greatly expand cover crop adoption on farms planted with other field crops. We discuss these opportunities in greater detail in the California fact sheet.

** These values represent the amount of carbon/GHG emissions reductions and water stored by the soil currently planted with cover crops, which exceeds half of the state's corn and soybean acreage.

Cover crops not only help combat climate change but also improve soil health and help farmers become more resilient to the changes that are already happening. They increase water infiltration and storage and decrease the need for irrigation.[21] While cover crops do require water to grow, they increase the net water available for commodity crops when properly selected and managed due to their ability to increase infiltration and reduce evaporation.[22] Cover crops provide a variety of additional benefits including weed suppression, increased soil fertility, and reduced erosion.[23,24,25] They provide habitat for beneficial insects and reduce nutrient runoff and input requirements.[26,27]

Additionally, cover crops can increase short-term yields and increase yield potential and stability over time.[28] In fact, farmers who used cover crops experienced higher yields in the past three years (2013–2015) than did farmers who did not use cover crops during this period.[29]

Cover crops such as cereal rye, winter wheat, or hairy vetch are easily incorporated into the corn-soybean rotation.[30] Cover crops can also be readily incorporated into other crop production systems, such as vegetables, cotton, and cereals.[31]

Other practices to build soil health, such as no-till farming and compost application, can further help farms become more resilient to climate change. Using cover crops and other soil stewardship practices to increase organic matter in soil by 1 percent on half of the corn and soybean acres in the top 10 agriculture states could help the soil hold an additional trillion gallons of water (Table 3), which is enough water to meet the annual needs of nearly 33 million people.[32]

Despite the many benefits of cover crops, only 3 to 7 percent of farms in the United States use cover crops, and only 1 percent of total cropland nationally is planted with cover crops.[33] NRDC supports the expanded use of cover crops on U.S. farms and believes that farmers who use them should receive a discount on their crop insurance, just as safe drivers can get discounts on their car insurance.[34] NRDC is working on a proposal to offer actuarially sound crop insurance premium discounts to farmers who use cover crops to reduce their risk of crop loss. By investing in cover crops and healthy soil, we can help ensure a reliable food supply for the nation even in the face of more extreme weather and climate risks.

ENDNOTES

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