



# Crop Advantage



**Series Proceedings | 2018**

**IOWA STATE UNIVERSITY**  
Extension and Outreach

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Extension and Outreach

# 2018-2019 crop market outlook

## Objectives

- Explore the factors currently shaping crop markets.
- Investigate projected crop prices for the 2018 marketing year.
- Discuss potential profitability and marketing opportunities.

U.S. crop agriculture continues on an amazing productivity run. The last 5 corn crops are the 5 largest ever produced. The last 4 soybean crops are the 4 largest ever. This run is the result of a combination of improved seed genetics and mostly favorable weather conditions. And the question going forward for the crop markets is “Will this streak continue next year?” USDA has provided its first outlook for the 2018/19 crop year and the answer seems to be “Yes.”

The early estimate for corn acreage shows a slight increase in 2018, moving up to 91 million acres. With the national trendline yield set at 173.5 bushels per acre, that translates to corn production remaining above 14.5 billion bushels. Corn usage is projected to remain strong as well, but it is still just below expected production. Feed and residual use is expected to decline slightly, which is probably more about residual usage than feed demand as livestock production is on the increase. Corn usage for ethanol is set to reach another record next year. Domestic use of E-15 is rising and ethanol exports have been robust. Food, seed, and other uses continue to rise. The weakest demand sector is export. With global supplies of not only corn, but also other feed grains, at extremely high levels, U.S. corn is facing a lot of competition in the international marketplace. With total usage projected at nearly 14.5 billion bushels, corn demand is doing what it can to lift prices. But ending stocks are expected to rise slightly, reaching 2.6 billion bushels, and corn prices are projected to stay lower. The initial estimate for the 2018/19 season-average price is \$3.30 per bushel.

The projections for soybeans show that this year's run to beans was no one-year phenomena. USDA projects 91 million acres will be planted to soybeans in 2018, essentially tying with corn for the most acreage. The 2018 trend yield is 48.4 bushels per acre, which would result in 4.36 billion bushels of soybeans. Soybean use has been trending higher the last several years, with records being set each succeeding year. The estimates for 2018 continue that run. Domestic crush is set 1.97 billion bushels, up 30 million from this year. This is being driven by soybean meal demand by livestock and soybean oil use in the biodiesel industry. The increase in acreage implies additional seed use, so seed and residual usage is raised slightly. But the big story remains

exports. It's another year, another record as USDA estimates 2.325 billion bushels will leave the country. China remains the major destination. And unlike the past couple of years, projected use is a bit higher than production. So 2018/19 ending stocks are expected to be nearly 50 million bushels lower. But the reduction is not seen as having a significant influence on prices as the 2018/19 season-average price is roughly in line with current prices.

Current futures prices for the 2018 crops are offering a somewhat better outlook. Current corn futures would normally translate to a 2018/19 season-average price around \$3.80 per bushel. Current soybean futures point to season-average prices in just under \$10 per bushel. Figure 1 shows projected 2018/19 crop margins, based on trend yields, average basis levels, and production costs staying at 2017 levels. Right now, futures have both crops projected in positive territory.



Figure 1. Projected 2018/19 crop margins.

But those projections are likely misleading as the cash markets will maintain wider than normal basis levels. The larger stock levels are hampering basis improvement, which will not occur until some of the supplies are cleared from the market. Given current basis levels, projections for the 2018/19 crop margins would be slightly below breakeven for both crops. And that would continue another streak that is not as pleasant as the record production run. It is often said that the cure for low prices is low prices. But that cure has not taken affect yet and the USDA projections indicate that will at least be another year before it kicks in.

## Resources

### Ag Decision Maker

[www.extension.iastate.edu/agdm](http://www.extension.iastate.edu/agdm)

### Iowa Farm Outlook

[www2.econ.iastate.edu/ifo](http://www2.econ.iastate.edu/ifo)

USDA's World Ag Supply & Demand Estimates report [www.usda.gov/oce/commodity/wasde](http://www.usda.gov/oce/commodity/wasde)



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# 2017 growing season review: Yield, soil water, and root growth

## Objectives

- Understand how weather conditions affect crop growth.
- Quantify the role of groundwater and root growth on diminishing drought effects on yield potential.
- Examine the long-term credit or penalty of groundwater supplies on Iowa crop yields.

The 2017 growing season was marked with a distinct weather condition: full soil moisture profile entering the growing season; good temperatures in mid-April; rainy and cooler weather during planting period, from late April through May; dry and warm June and July; cooler August; and a rainy and cool September and October. What does all this mean? Planting season was on time to slightly delayed however with the warmer weather in June and early July vegetative growth was faster with corn silking occurring approximately one week earlier than normal in central and southern Iowa. The cool down in August and September was ideal to slow corn development and extend the grain filling period. Soybean maturity was also delayed while flowering was

on schedule.

From a rainfall perspective, starting the growing season out with a full soil moisture profile is beneficial to buffer lack of rain later in the growing season. Fast root growth in June (about 1 inch per day) and water uptake as well as the high atmospheric evaporation demand quickly decreases the groundwater table levels to around 6 feet by the end of July. This allows crops to develop deep root systems exploring a 5-6 feet depth of soil profile. At the bottom depths of root expansion there was moisture to support water uptake and sustain high crop growth rates.

A combination of good early vegetative growth, root growth extending deeply to obtain soil moisture, and an extended grain filling period all attribute to greater than expected corn and soybean yields in 2017.

## Resources

Forecast and Assessment of Cropping systems  
[crops.extension.iastate.edu/facts](http://crops.extension.iastate.edu/facts)

Twitter  
@IowaState\_FACTS

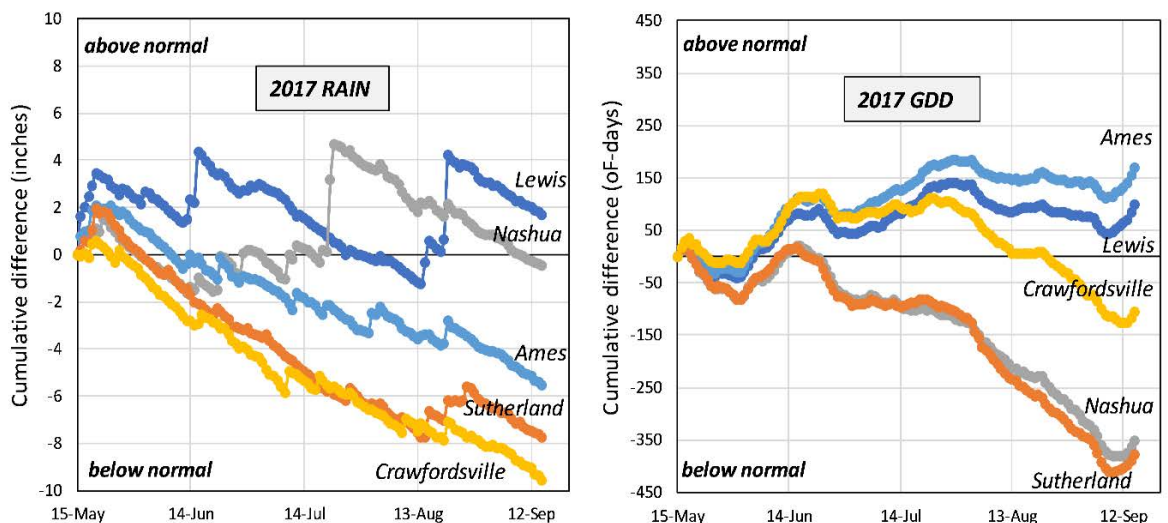
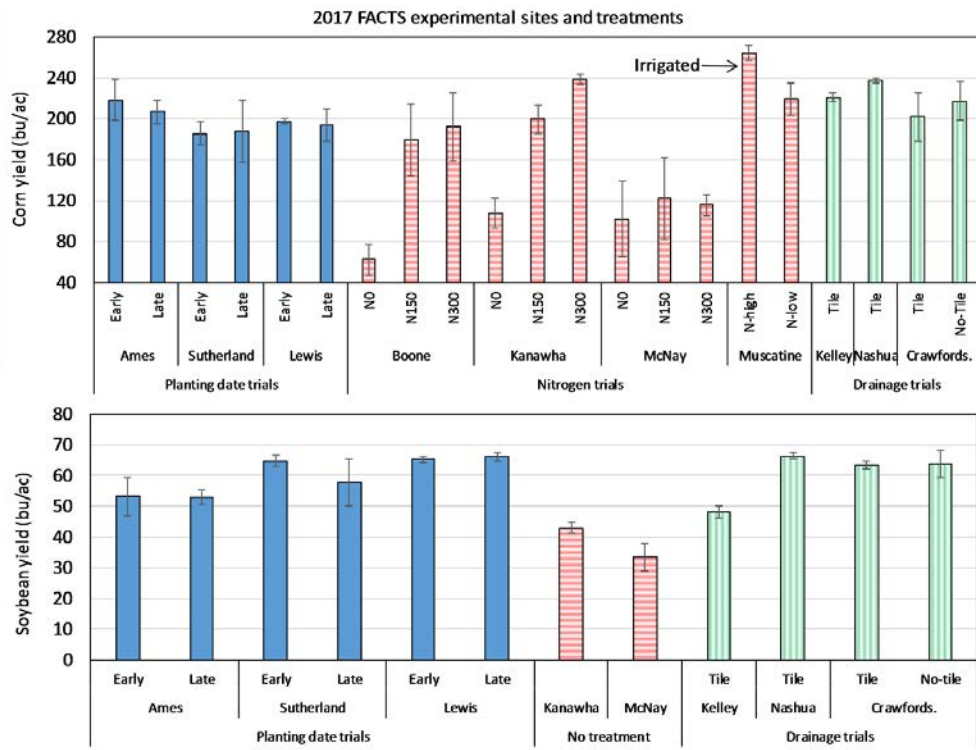
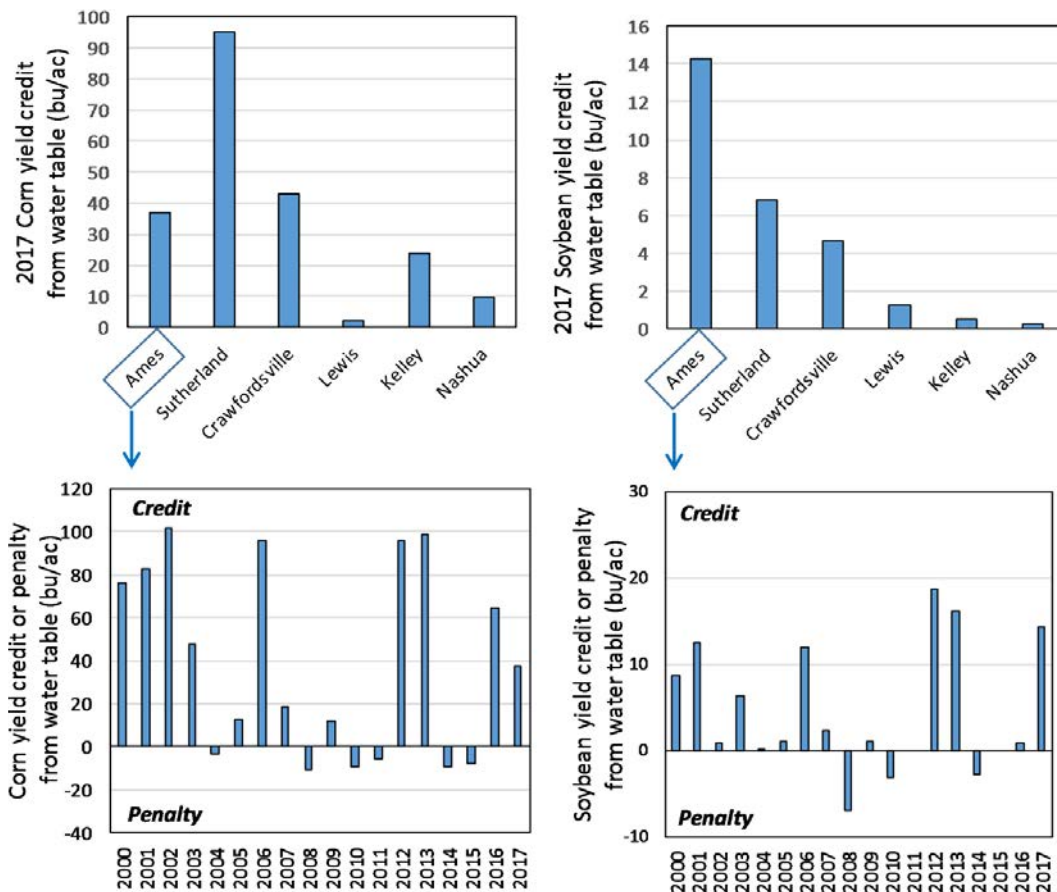


Figure 1. Cumulative difference between 2017 rain and GDD from long-term average climatology (35-year average).



**Figure 2.** Combine harvested crop yields at FACTS experimental sites. NO, N150 and N300 indicate 0, 150 and 350 lbs N/ac treatments. N-high and N-low indicate low and high N inputs (no zero due to irrigation). All other locations received the ISU recommended N rate (cnrc.agron.iastate.edu).



**Figure 3.** Model analysis of groundwater table yield credit and penalty in 2017 across six location (top panel) and long term impacts scenario analysis for Ames (bottom panels).



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# Factors for high yielding soybeans

## Objectives

- Determine achievable soybean yield potential geographically by soil and climate factors.
- Identify climate and soil influence of management practice effect on soybean yield.
- Discuss management practices for Iowa that are indicators of high yields.

Farmer fields from the soybean benchmarking survey were clusters using technology extrapolation domains (TEDs). The TEDs are based on four attributes that govern crop yield and inter-annual variability: total annual growing degree-days, aridity index, annual temperature seasonality, and plant available water holding capacity within the root zone.

There were enough survey respondents in 2014 and 2015 to cluster fields together in 5 TEDs with geographic coverage in Iowa (Figure 1).

There was an average 23.4% yield gap from estimated yield potential to farmer realized yields (Figure 2). The average farmer respondent had a yield potential of 58 bu/ac whereas the USDA NASS 2-year state average was 54 bu/ac and the average estimated yield potential was 75 bu/ac.

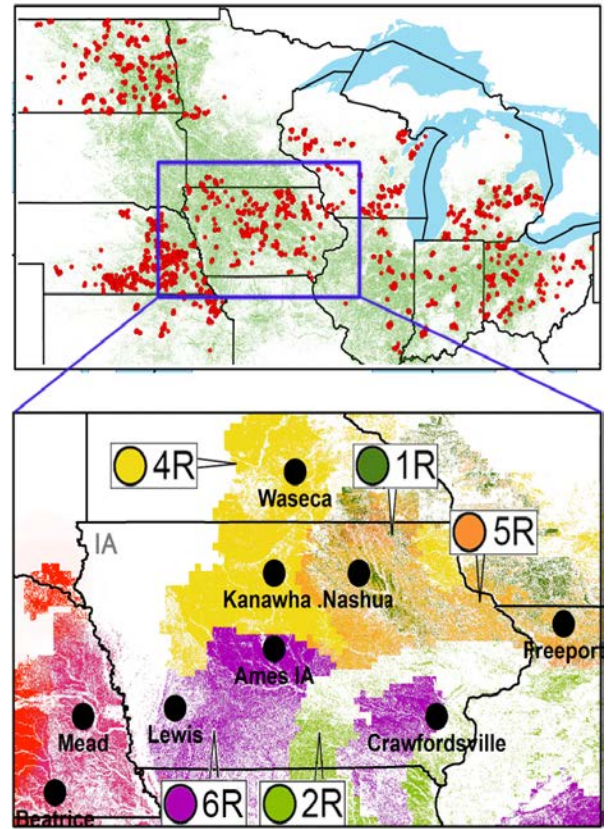
An early planting date was a strong indicator of high yield potential, especially in the 1R, 4R, and 5R TEDs in northern Iowa where the yield decline was greater than 0.4 bu/ac/day. In the southern TEDs (2R and 6R) there was only a 0.15 – 0.20 bu/ac/day yield decline (Figure 3).

Overall, in 7 of 10 TEDs there was a significant management affect associated with foliar fungicide/ insecticide use whereas there was only a significant tillage or artificial drainage management effect in only 4 of 10 and 2 of 7 TEDs, respectively (Figure 4).

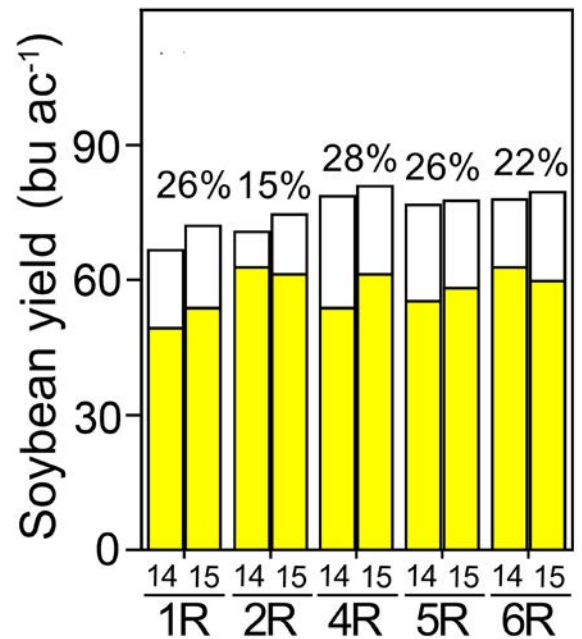
## Resources

Key management practices that explain soybean yield gaps across the North Central US

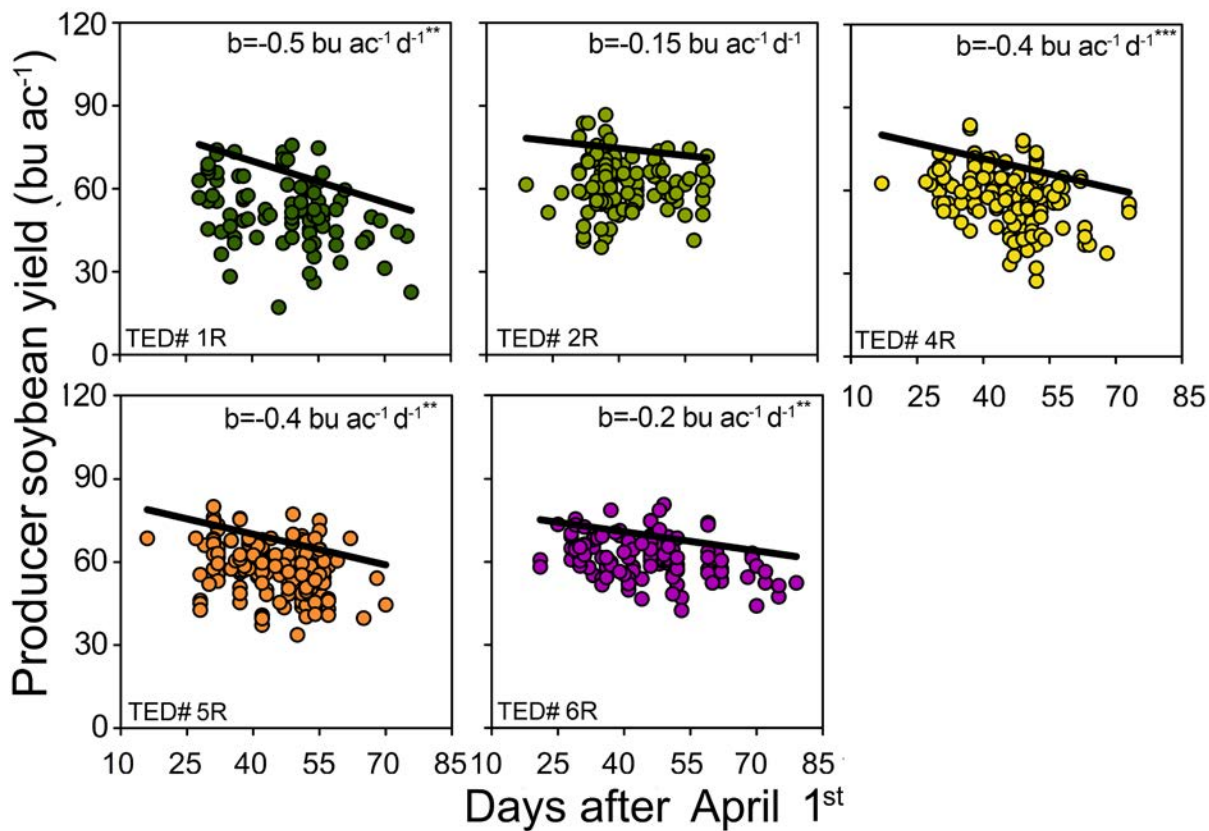
[www.coolbean.info/library/documents/2017\\_SoybeanYield\\_Final.pdf](http://www.coolbean.info/library/documents/2017_SoybeanYield_Final.pdf)



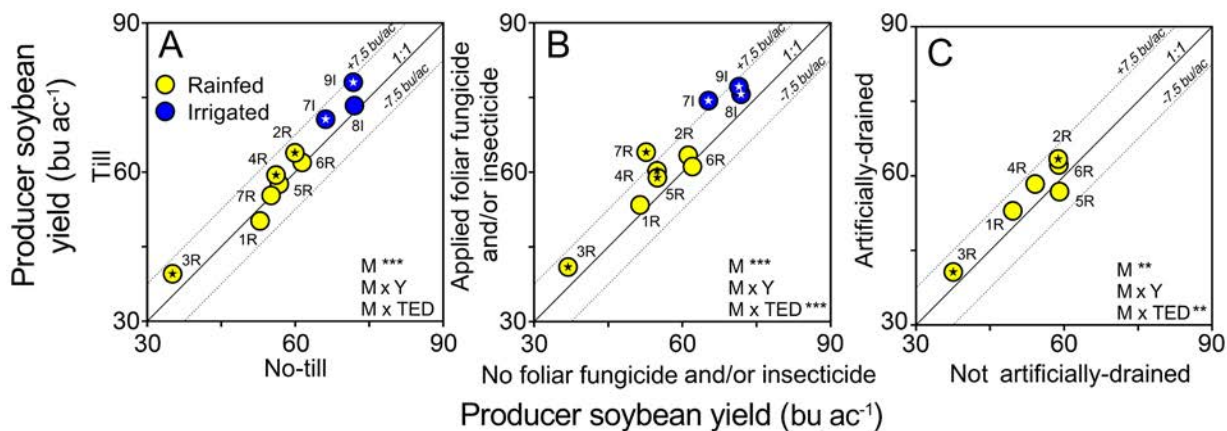
**Figure 1.** Map of Iowa showing five technology extrapolation domains (TEDs) with a critical number of survey respondents.



**Figure 2.** Yield potential for identified TEDs in Iowa in 2014 and 2015. Solid bars represent the average farmer reported soybean yield and open bars represent the estimated yield potential. The percentage values is the 2-year average yield gap for the individual TED.



**Figure 3.** Farmer reported soybean yields plotted against the planting date. The solid line is the fitted boundary function using the 90th percentile.



**Figure 4.** Comparison of farmer reported soybean yield between management groups (left, tillage vs no-tillage; center, fungicide/insecticide vs no fungicide/insecticide; and right, drainage vs no drainage). The TEDs with stars indicate significance of the impact on yield with respect to the specified management factor.



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# Inversions and impact of growing degree pattern on crop yield

## Objectives

- Understand the nature of an atmospheric inversion.
- Understand the impact of cool nights on corn yield per acre.
- Use the Iowa Mesonet as a resource in management of risk associated with crop yield.
- Use ISU decision aids to evaluate USDA estimates for US corn yield per acre.

The temperature of the air typically decreases with height above the ground. The temperature at the top of a 1,000 ft high hill is usually 5 degrees (F) cooler than at the base of the hill. When the temperature of the air is warmer with increased altitude an “inversion” condition exists. Inversions are a cause of serious air pollution in many cities and likewise can be a serious cause of “misapplication” of materials intended to application to a crop by spraying.

Inversions often form at sunset when winds are light or absent. If the wind is 5mph or above an inversion is not likely between the ground and 100 feet above ground. When the air is still evening to morning inversions are most common.

Growing degree days calculated from the low and high temperature recorded for 24-hr periods are commonly used to anticipate the development of crops, weeds, and insects. In early stages of development, the corn plant is very sensitive to the accumulation of growing degree days. The yield of corn is very sensitive to

the time between silking and denting of the crop. If growing degree days are accumulated slowly after silking the yield of corn is impacted. The impact on yield is a positive one if the over-night temperature is below usual (but not so cold as to injure the plant). When the overnight temperature is warmer than usual the plant reaches physiological maturity earlier than may be desirable for full dry weight accumulation.

The USDA crop yield estimate delivered during the first 10-days or so of each month after silking has historically impacted the DEC price of corn. However, the USDA estimate has not (in the past) considered the effectiveness of night time temperatures on expanding or contracting the days from pollination to maturity and the resulting impact on yield per acre.

A simple inspection of the deviation of over-night temperature from normal is useful in anticipation of an increasing or decreasing of the deviation of the yield per acre from the trend (or expected yield). The Iowa State University Mesonet ([mesonet.agron.iastate.edu](http://mesonet.agron.iastate.edu)) provides a tool to evaluate the occurrence of “cold” or of warmer than usual nights for numerous locations throughout the US Corn Belt.

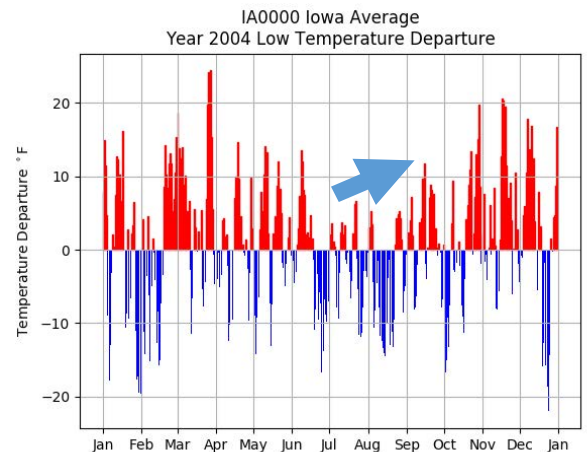
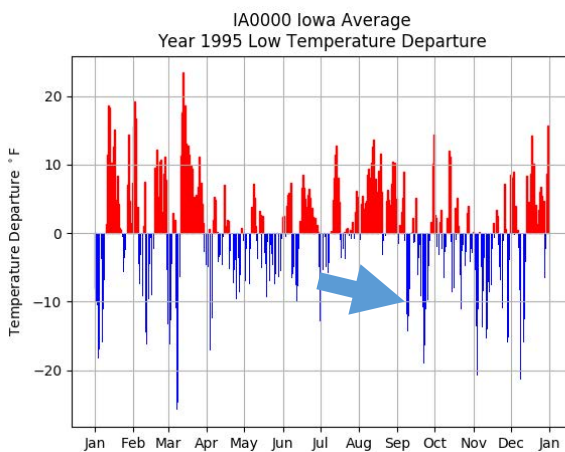
The method should be utilized for several corn-belt states and for several years of known above trend and below trend crop harvested years. The utility used in this analysis is:

<http://mesonet.agron.iastate.edu/plotting/auto/?q=32>

The user may choose the state and location within the state (or select the “Iowa Average” as was done in the example). In each case the “Low” temperature departure option is used.

## Resources

Iowa Environmental Mesonet  
[mesonet.agron.iastate.edu](http://mesonet.agron.iastate.edu)



**Figure 1.** The very low yield as compared to anticipated in 1995 and the very high yield as compared to anticipated in 2004 in the state of Iowa was apparent in the warmer than usual night-time temperatures in 1995 and the some-what cooler than usual night-time temperatures of 2004 as compared to long-term average temperatures for the dates. The period of 1 July to the end of August are highlighted and approximate the pollination to dent stage for the crop during the years depicted.



# Farm transitioning and working with new and beginning farmers

## Objectives

- Understand what it takes to retire from farming.
- Understand the importance of communication.
- Understand what it takes to get started in transferring.
- Understand how to start the process.

Transitioning the farm business to another generation requires an understanding of what is required to retired as far as living expenses and an understanding of how the assets will generate income in retirement.

The retiring parties are often interested in preserving wealth and are reluctant to take on more debt to expand the business while beginning farmers may have little equity and are eager to acquire new assets through additional debt. The retiring spouses need to agree on what retirement will look like and how it starts.

Communication is critical in making transfers work. Often the transition involves family members and it may be challenging to separate the business relationship from the family relationship. Good communication is key to problem solving and implementing a transition plan.

The transfer plan may include the transfer of labor, machinery, management and land. It seems that transferring the labor is the easiest! Transferring machinery is relatively easy as well. Transferring management is often a challenge but it can be accomplished in steps. There are several different strategies to use in transferring the business.

Transferring assets can be done by gifting, selling, or dying or a combination of these methods. There are advantages and disadvantages to each strategy. The strategy should be realistic and based on the goals of the parties involved.

## Resources

### Ag Decision Maker – Whole Farm Transition and Estate Planning

[www.extension.iastate.edu/agdm/wdbusiness.html](http://www.extension.iastate.edu/agdm/wdbusiness.html)

### Ag Decision Maker – Whole Farm Financial Resources

[www.extension.iastate.edu/agdm/wdfinancial.html](http://www.extension.iastate.edu/agdm/wdfinancial.html)

### Social Security – Benefit Calculation Examples For Workers Retiring In 2018

[www.ssa.gov/OACT/ProgData/retirebenefit2.html](http://www.ssa.gov/OACT/ProgData/retirebenefit2.html)

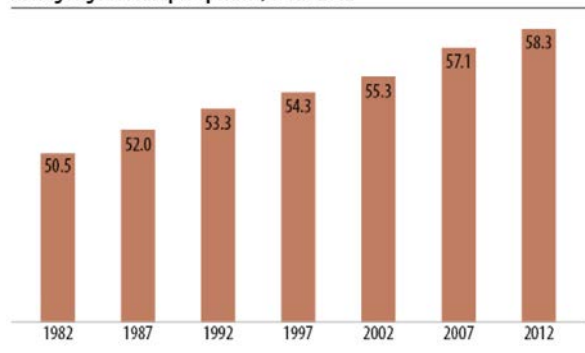


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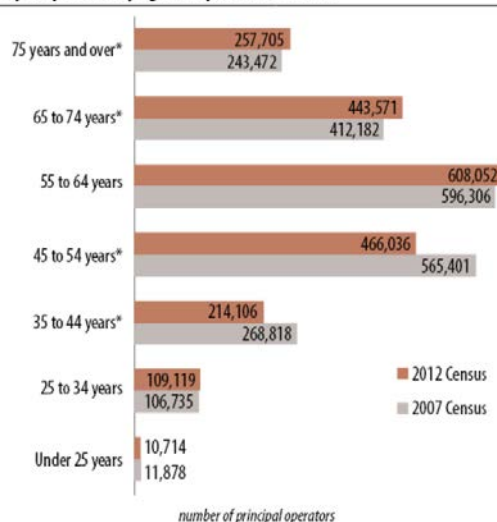
[kleibold@iastate.edu](mailto:kleibold@iastate.edu)

Average Age of Principal Operator, 1982 - 2012



Source: USDA NASS, 2012 Census of Agriculture.

Principal Operators by Age Group, 2007 and 2012



Source: USDA NASS, 2012 Census of Agriculture.

\*Statistically significant change.



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# Corn silage storage and handling

## Objectives

- Understand the nutritional value of corn silage and how it benefits the animal.
- Understand how different factors can affect corn silage quality.
- Review animal responses to improved forage quality.

Corn silage is a very valuable feed resource for dairy and beef cattle because it combines the nutritional characteristics of grain and forage in a single feedstuff. As seen in Figure 1, this forage is the base of almost all nutrition programs for dairy cows and dairy producers rely heavily on this forage. In fact, 100% of the surveyed producers include this feed in lactating cow rations.

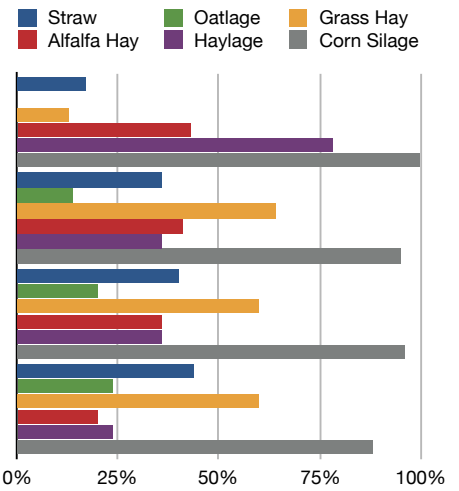
Growing forages should be considered as a whole program within a livestock enterprise. As such, the forage program can be divided into specific areas or processes that are interconnected and will ultimately impact forage quality and animal performance.

A forage program should consider the following guidelines:

1. Grow forages to optimize yield
2. Harvest nutrients at an optimal stage for digestion
3. Promote efficient utilization of the harvested nutrients

The forage program starts with hybrid selection, followed by planting and proper management during the growing season. Harvesting is next, and it is one of the most critical processes that impact the quality of the forage. Proper moisture content and chop length are critical for producing high quality silage. Below are the recommended harvesting practices:

- Moisture content: target 65%, acceptable range is 60 – 70%
- Maturity (milk line): not as reliable as moisture but it is practical, recommended milk line stage at harvest is 2/3 to 3/4
- Chop length: 3/8 to 1/2 inch for non-processed corn silage, 3/4 inch for processed silage
- Roller gap (if used): 1 to 2 mm



**Figure 1.** Survey of forages fed to transition dairy cows in Iowa. Source: Iowa State Extension and Outreach – Dairy Team Producer Survey (2015)

As stated before, the forage program should consider efficient utilization of the nutrients contained in the harvested forage. After harvesting, the forage needs to be stored; this phase includes packing and covering. These practices are needed in order to preserve nutrient content and reduce dry matter losses. Dry matter losses are the result of forage oxidation, in other words, the forage undergoes degradation due to the presence of oxygen. Packing has the goal of excluding as much air or oxygen as possible to prevent degradation of the forage; whereas covering with a plastic film prevents re-entry of oxygen, thus preventing further degradation of the harvested material. The forage program continues long after harvest because it also includes the feed out phase. Producers invest a great deal of time, money and effort into growing and harvesting corn for silage; these efforts need to be preserved by proper management of the silage. Improper management not only undermines the work that was put in to grow and harvest the forage but can also have negative effects on animal performance.

Since corn silage is harvested only once a year in our region, it is very important to do our best effort to produce nutritious feed that will last until next year's harvest season. Therefore, proper storage and handling are essential to ensure that producers have the opportunity to extend their forage supply and provide adequate nutrition to their livestock.

## Resources

ISU Extension and Outreach Dairy Team  
[www.extension.iastate.edu/dairyteam](http://www.extension.iastate.edu/dairyteam)

Twitter  
@ISUDairyTeam



**Figure 2.** Phases of a silage production program for livestock

# Grazing cover crops: Lessons learned

## Objectives

- Identify management considerations to better integrate row crop and cattle enterprises.
- Know what resources exist to look up pesticide restrictions when it comes to using cover crops as a forage source.
- Analyze how you might integrate cover crops and livestock for your farming operation.

**Grazing restrictions.** It is important for livestock producers to consider restrictions on labels of herbicides or other pesticides used earlier in the growing season if they intend to graze or harvest the cover crop as a forage source. This includes looking at the crop rotation restriction intervals and if the labels prohibits grazing previous crop residue. The label is the law, and failing to follow the restrictions is a violation and therefore a punishable offense.

**Moisture.** Cover crop forages are relatively high in moisture compared to even our vegetative pastures, especially very early on in the cover crop growing stage. The moisture content has a big impact on how much an animal can physically eat and ultimately, the rate of passage and the amount of nutrients absorbed. Consider feeding a dry roughage source or supplementing cattle while grazing cover crops to optimize forage utilization and cattle performance.

**Nitrate Toxicity.** Fields that have been heavily fertilized by chemical application and/or livestock manure may be at risk for toxic levels of nitrates, especially if the cash crop was hailed out or if seeded into preventative planting acres. While the risk is probably greater with fall grazing, nitrate toxicity could still be a concern in the spring. The only way to be sure that toxic levels are not present is to test the forage. Providing additional feed resources such as hay and slowly adapting cattle to the cover crop are ways to mitigate the risk.

**Sulfur Toxicity.** Brassicas (radishes and turnips) are well accepted for their ability to compact soil compact; however, brassicas are naturally high in sulfur and low in fiber so should be seeded with a small grain forage. Limit additional sulfur consumption from water sources and supplemental feeds associated with higher sulfur levels such as distillers grains or corn gluten feed.

**Termination.** Solely grazing cover crops or mechanically harvesting the forage is not an effective method of termination. Likewise, adequate leaf area needs to be available for herbicide absorption to effectively kill the plant. ISU researchers generally recommend terminating a cover crop 10 to 14 days prior to planting corn to protect yield; however, that time frame is less critical for soybeans. Check with your

crop insurance agent for their cover crop termination requirements prior to planting corn or soybeans.

**Soil Compaction.** Wet conditions are less than ideal for grazing crop residue during the spring. To minimize compaction risk, consider removing cattle during periods of excess moisture and altering the locations of feeding areas and mineral supply to avoid excessive congregation in a given area. Proper management to reduce high-traffic areas will result in minimizing the amount of tillage required, and ultimately, still allow producers to reap the soil health benefits of utilizing cover crops.



**Figure 1.** Yearling heifers grazing a cereal rye cover crop in the spring of 2016 at the ISU McNay Research Farm.

## Resources

**Herbicide use may restrict grazing options for cover crops**  
[store.extension.iastate.edu/product/14454](http://store.extension.iastate.edu/product/14454)

**Corn Herbicides: Restrictions When Planting, Grazing or Feeding Cover Crops**  
[practicalfarmers.org/app/uploads/2017/01/PFI-Corn-Herbicides.pdf](http://practicalfarmers.org/app/uploads/2017/01/PFI-Corn-Herbicides.pdf)

**Soybean Herbicides: Restrictions When Planting, Grazing or Feeding Cover Crops**  
[practicalfarmers.org/app/uploads/2017/01/PFI-Soybean-Herbicides.pdf](http://practicalfarmers.org/app/uploads/2017/01/PFI-Soybean-Herbicides.pdf)

**Twitter**  
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Iowa Beef Center – @iowabeefcenter

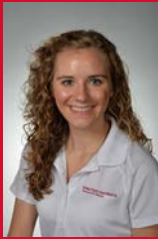
**CDMS Pesticide Label Database**  
[www.cdms.net/Label-Database](http://www.cdms.net/Label-Database)

**Cover Crops Provide Grazing Opportunities**  
<https://goo.gl/BVfYHn>

**Iowa Beef Center**  
[www.iowabeefcenter.org](http://www.iowabeefcenter.org)



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# Agriculture and the Clean Water Act: A legal update

## Objectives

- Understand the basic impact of the Clean Water Act on agriculture.
- Understand why the Des Moines Water Works lawsuit was dismissed.
- Learn the current status of the Clean Water Rule.

On March 16, 2015, the Des Moines Board of Water Works Trustees (DMWW) filed a federal Clean Water Act (CWA) lawsuit against the supervisors and drainage districts of three Iowa counties (Sac, Buena Vista, and Calhoun). The lawsuit, which was filed in the United States District Court for the Northern District of Iowa, asked the federal court to order the drainage districts to cease "all discharges of nitrate that are not authorized by an NPDES or state operating permit."

DMWW alleged that the concentration of nitrate in the Raccoon River, which is a primary source for DMWW's raw water supply, has steadily increased since the 1970s. The lawsuit alleged that the nitrate removal system cost DMWW up to \$7,000 per day to operate.

The complaint set forth nine causes of action, each of which is summarized briefly:

### Federal and state water quality laws

The primary claim by DMWW was that discharges from drainage districts are "point sources" of nitrate pollution. As such, DMWW alleged that the drainage districts must comply with the federal CWA and the National Pollutant Discharge Elimination System (NPDES) permit program, which is administered by the Iowa Department of Natural Resources. The complaint asked the federal court to declare that the drainage districts had violated federal and state law and to enjoin them from all discharges of nitrate not authorized by an NPDES or state operating permit. DMWW sought civil penalties for each continuing day of violation.

### Tort claims

The complaint also asserted a number of tort claims, including those for nuisance, trespass, and negligence. The drainage districts, the suit contended, created a substantial and unreasonable interference with DMWW's property right to withdraw high quality water from the Raccoon River. DMWW asked the court to order the districts to take all actions necessary to abate the nitrate pollution and to award DMWW damages.

### Constitutional claims

In addition to its tort claims, DMWW asserted several constitutional claims, arguing that DMWW would be deprived of due process and equal protection under the United States Constitution if the court were to enforce Iowa law declaring that drainage districts cannot be sued for money damages. DMWW sought a declaration that the districts are subject to a suit at law for damages in tort and other relief.

### Injunctive relief

The complaint asked the court to order the drainage districts to "take all steps reasonably necessary within a reasonable period of time to reduce the discharge of nitrate to the Raccoon River."

### Case resolution

Two years and one day after DMWW filed its controversial lawsuit, the federal court dismissed the action in its entirety. The merits of the case were never considered. The court dismissed the lawsuit after finding that—even if DMWW was able to prove an injury—the drainage districts would have no ability to redress (or remedy) that injury. In other words, the drainage districts were not the proper defendants for this Clean Water Act lawsuit.

The Supreme Court of Iowa had long held that a drainage district is "merely an area of land, not an entity subject to a judgment for tort damages." Iowa courts have allowed lawsuits against drainage districts only where the claims implicate a specific statutorily granted power or duty granted to the district. In other words, a court can compel a drainage district to fix damaged drainage tile.

DMWW acknowledged Iowa law, but argued that it was outdated and inapplicable to the facts at hand. DMWW asserted that this was a "new day" and that the court should have applied a "new rule of liability and responsibility for drainage districts concerning pollution." DMWW urged that "implied immunity has survived through repetition rather than critical analysis."

But the Iowa Supreme Court disagreed, ruling in response to a certified question addressed to it by the federal court, that Iowa drainage districts are immune from claims for damages or injunctive relief. The Court affirmed that such districts have a "limited, targeted role—to facilitate the drainage of farmland in order to make it more productive." The Court declared that it is for the Iowa Legislature, not the courts, to change that result.

The federal court found that this ruling applied equally to DMWW's tort claims and Clean Water Act claims. In other words, the court found that even if DMWW were to prevail in its Clean Water Act claims against the districts, drainage districts would have no legal ability to redress DMWW's alleged injuries. If a claim is not redressable, meaning that the party against whom the suit is brought cannot provide a remedy, a federal court has no jurisdiction to hear it. Consequently, the federal

court dismissed the lawsuit for lack of standing.

The federal court also found no merit to DMWW's claims that its constitutional rights were violated. The court ruled that the immunity Iowa law affords to drainage districts does not violate the Equal Protection Clause or the Due Process Clause of the United States Constitution. The court noted that DMWW's policy arguments are best directed to the Iowa Legislature. Finally, the court fully agreed with the Iowa Supreme Court's analysis of DMWW's takings claim. "A public entity such as DMWW cannot assert a Fifth Amendment takings claim against another political subdivision of the state."

DMWW did not appeal the order. The lawsuit, although dismissed, brought increased attention to Iowa's water quality issues. The Water Quality Initiative,

implementing the Iowa Nutrient Reduction Strategy, began in 2013. State legislators have not yet created a comprehensive framework for funding water quality projects. Legislation proposed in 2016 and 2017 failed, largely due to budget constraints.

## Resources

Center for Agricultural Law and Taxation  
[www.calt.iastate.edu](http://www.calt.iastate.edu)

Twitter  
@CALT\_IowaState

Des Moines Water Works Litigation Resources  
[www.calt.iastate.edu/article/des-moines-water-works-litigation-resources](http://www.calt.iastate.edu/article/des-moines-water-works-litigation-resources)

## Pest resistance: A threat to Iowa crop production

### Objectives

- Attendees will be able to define pesticide resistance.
- Attendees will be able to describe how pesticide resistance occurs.
- Attendees will be able to identify strategies to delay pesticide resistance.

The goal of this presentation is to provide overall concepts to define pesticide resistance, recognize the importance of pesticide resistance to crop producers, recognize the importance of pesticide resistance and effective pesticides to crop production, describe how pesticide resistance occurs, give specific examples pertinent to Iowa crop production and to identify strategies to delay pesticide resistance.

Specific pests can cause billions of dollars in crop loss. And, because pesticides are in limited supply, we have to be good stewards of these resources to ensure their continued and future use to protect crops. Using specific examples of herbicide resistance development, we will look at the causes that led to herbicide resistance and learn to apply those principles to other pests of primary concern in Iowa, specifically corn rootworm and soybean aphid.

Finally, this talk will identify strategies to delay pesticide resistance. Key to these strategies is the effective knowledge of crop scouting and treatment thresholds and how you might adopt those strategies in your farming operation.

## Resources

About the Iowa Pest Resistance Management Plan (IPRMP)  
[www.ipm.iastate.edu/about-the-iprmp](http://www.ipm.iastate.edu/about-the-iprmp)



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## Plan ahead.

Dealing with herbicide resistance can be expensive. Developing *long-term management plans* that reduce the chances of resistance developing will minimize that cost. It's a team effort – *farmer, retailer, and industry.*

### Herbicide Resistance and Weed Management Course

An online, interactive and self-paced course building skills to develop long-term, effective and economical weed management plans.

Launching January 2018.

[www.aep.iastate.edu/weeds](http://www.aep.iastate.edu/weeds)



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## Dicamba: Moving forward in 2018

### Objectives

- Participants will be able to describe processes that allow movement of dicamba from intended target sites.
- Participants will recognize how application parameters and environment influence off-target movement and non-target injury.
- Participants will be able to manage dicamba use in dicamba-resistant soybean to minimize the risk of non-target injury.

Dicamba-resistant (DR) soybean cultivars and the use of the new dicamba formulations were available for use in 2017. It became clear that the use of the dicamba-based weed management system resulted in unprecedented off-target complaints across the Midwest. Midwest farmer attitudes are such that a great number of issues that developed in 2017 went unreported given the desire to “get along” with neighbors; thus, the official numbers underestimate the extent of dicamba injury.

The off-target injury complaints involved particle drift, sprayer contamination and volatilization of the new dicamba formulations. Soybeans that are not DR are extremely sensitive to dicamba, as are many other plants in the rural landscape. As a result of the magnitude of the problem, the Environmental Protection Agency required the registrants to modify the labels of the new dicamba products in an effort to resolve the off-target movement risks. These changes include designating the dicamba products as Restricted Use Pesticides (RUP), requiring applicators to receive dicamba specific training, restricting applications to daylight hours, and reducing the wind speed allowed for application.

The implications of the label changes on the ability to apply dicamba within the label restrictions is illustrated in Figure 3. The limited hours available to spray will inevitably result in either delayed applications where weeds exceed label height restrictions or poor judgement in when to stop applications due to wind speeds. While these changes are important, they do not address an important factor in the off-target movement of dicamba – volatilization.

Off-target movement of dicamba is complex and involves a number of factors, some that can be addressed with better application techniques. Factors such as nozzle type, boom height, application speed, and wind speed and direction can be addressed by applicators. Other factors such as the inherent chemical characteristics of dicamba, the high sensitivity of susceptible soybean cultivars and other non-target plants, the effects of rain, temperature, relative humidity, and inversions, not just the day of application but for several days following application, cannot be addressed by applicators and increase the risks associated with the dicamba-based technology.

The need for different strategies and technologies to address the burgeoning problem of herbicide-resistant weeds must be considered in relation to the risks associated with the strategies and technologies. Preemergence applications of dicamba with DR soybean cultivars represent the least risky use strategy and is recommended. Early postemergence applications in May, when temperatures are typically cooler, have greater risk than at planting applications for off-target dicamba movement. The greatest risk from dicamba-based weed management is postemergence applications in June and later. We do not recommend using dicamba postemergence in dicamba-resistant soybean due to the greater risk of off-target movement.

### Resources

#### 2018 Herbicide Guide for Iowa Corn and Soybean Production

[store.extension.iastate.edu/product/12150](http://store.extension.iastate.edu/product/12150)

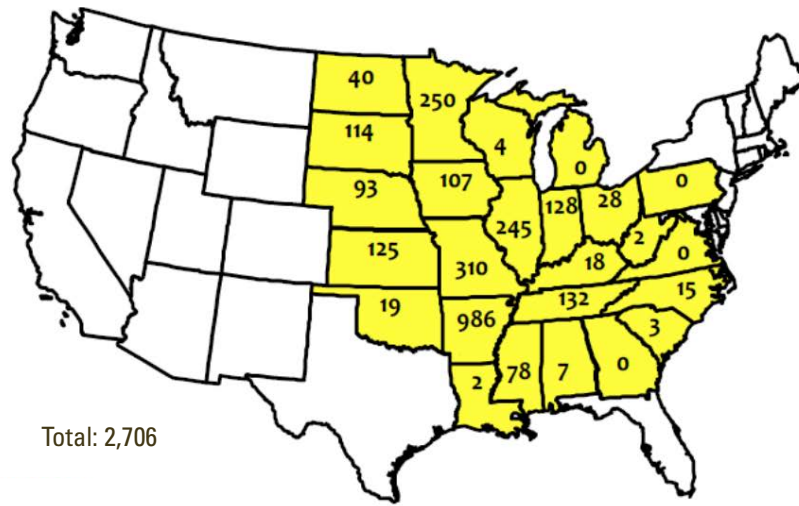
#### New Dicamba Labels Limit Application Timing

[crops.extension.iastate.edu/cropnews/2017/10/new-dicamba-labels-limit-application-timing](http://crops.extension.iastate.edu/cropnews/2017/10/new-dicamba-labels-limit-application-timing)

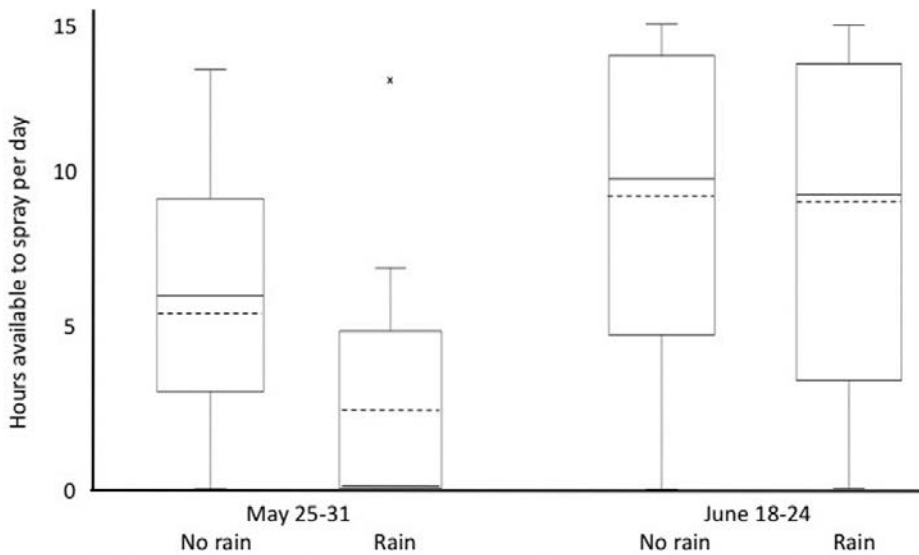
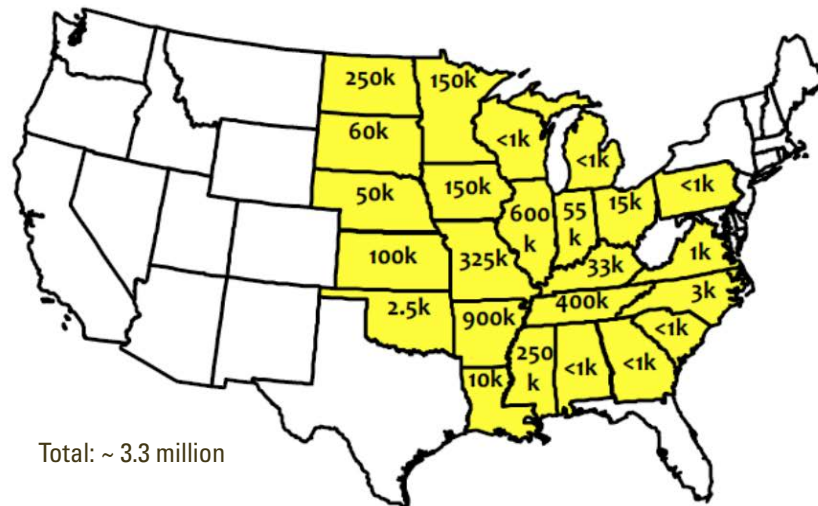
#### Factors Influencing Dicamba Volatility

[crops.extension.iastate.edu/blog/bob-hartzler/factors-influencing-dicamba-volatility](http://crops.extension.iastate.edu/blog/bob-hartzler/factors-influencing-dicamba-volatility)

**Figure 1.** Official dicamba-related injury investigations reported by state departments of agriculture as of October 15, 2017. *Source: Dr. Kevin Bradley, University of Missouri.*



**Figure 2.** Estimated dicamba-injured soybean acres in the U.S. as reported by state extension weed scientists as of October 15, 2017. *Source: Dr. Kevin Bradley, University of Missouri.*



**Figure 3.** Hours available to spray during daylight when the average wind speed is greater than 3 MPH and less than 10 MPH based on 4 years of data from the ISU Agronomy Research Farm, Boone County, Iowa. Each box represents the 2nd and 3rd quartiles, the horizontal solid and dashed lines with each box represents the median and average hours/day, respectively. The “whiskers” represent the maximum and minimum values and the “x” represents an outlier data point. *No rain* only considered wind speed while *Rain* accounts for wind speed and rainfall in determining available hours.



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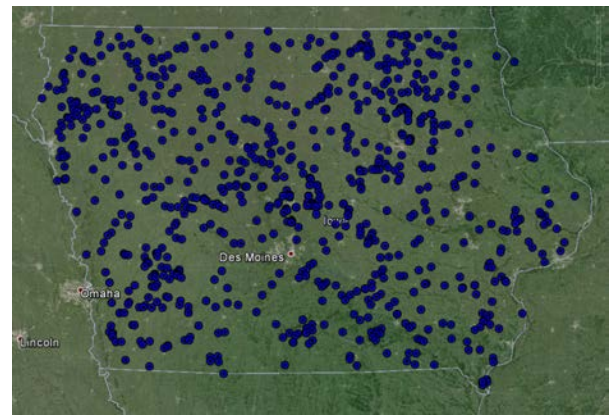
# The current state of herbicide resistance in Iowa

## Objectives

- Participants will understand the extent of herbicide resistance in waterhemp.
- Participants will learn that herbicide resistance is a complex problem with complex solutions.
- Participants will recognize that multiple herbicide resistance in Iowa waterhemp populations is the norm and not the exception.

Weeds with evolved resistance to herbicides are widely distributed in Iowa. Currently there are 10 weed species identified with evolved resistance to herbicides (Table 1). Waterhemp populations have been reported in Nebraska with evolved resistance to HG 4 herbicides and common sunflower populations have evolved resistance to HG 9. Iowa horseweed/marestail populations have evolved resistance to HG 2 and 5, but this has not been reported to the International Survey of Herbicide Resistant Weeds (<http://www.weedscience.com>). Similarly, giant ragweed populations in Iowa have evolved resistance to HG 27. Importantly, the evolution of herbicide resistance continues to increase in Iowa and herbicide resistant weed population densities in specific fields are increasing, thus becoming an economic concern.

In 2010, the Iowa Soybean Association requested that the Iowa State University weed science program survey soybean fields in Iowa to gain a better understanding of the herbicide resistance problem. Approximately 900 waterhemp populations were sampled in Iowa (Figure 1).



**Figure 1.** Sample collection locations in Iowa, 2011-2013.

The original idea was to arbitrarily sample soybean fields that had weeds visible above the canopy in August and September. Approximately 300 soybean fields were sampled in 2011 and 2012. This approach increased the likelihood that the escaped weeds were resistant to herbicides but no information about the herbicide use history was collected. In 2013, a procedure was developed that provided the prediction of herbicide resistance at the 95% confidence interval in any Iowa soybean field.

Herbicide treatments included an HG 2 herbicide (Pursuit), an HG 5 herbicide (atrazine), an HG 9 herbicide (Roundup), an HG14 herbicide (Cobra), and an HG 27 herbicide (Callisto). All herbicides were applied postemergence at label rates with adjuvants included as suggested in the herbicide labels.

The levels of herbicide resistance found were surprisingly high. However, given the years these herbicides have been used in Iowa, often in both corn and soybean, and the inevitability of evolved herbicide

resistance, perhaps it is not that surprising. It should be recognized that the waterhemp populations in most fields were relatively low in population density and often represented scattered patches and individual plants. Given the ability of waterhemp to produce high seed numbers, it is possible that the population density may increase quickly in these fields unless appropriate management tactics are adopted.

Resistance to ALS inhibitor herbicides (HG 2) in waterhemp is widely distributed and represents virtually 100% of all fields in Iowa with HG 2 resistance. Thus, HG 2 herbicides are not effective in managing waterhemp in Iowa. While waterhemp populations may not be homozygous for the resistance trait, the sensitive waterhemp in these populations is likely a minor component, given the historic use of HG 2 herbicides.

Date reported	Weed species ( <i>Latin binomial</i> )	Herbicide site of action reported in Iowa	Multiple herbicide resistances reported in Iowa
1985	Kochia ( <i>Kochia scoparia</i> )	5	No
1989	Common lambsquarters ( <i>Chenopodium album</i> )	5	No
1990	Pennsylvania smartweed ( <i>Polygonum pensylvanicum</i> )	5	No
1992	Giant foxtail ( <i>Setaria faberi</i> )	5	Yes (HG1 in 1994)
1993	Tall waterhemp (waterhemp) ( <i>Amaranthus tuberculatus</i> )	2	Yes (HG5 in 1996, HG 14, 9, and 27 in 2009)
1995	Common cocklebur ( <i>Xanthium strumarium</i> )	2	No
1997	Common sunflower ( <i>Helianthus annuus</i> )	2	No
1998	Shattercane ( <i>Sorghum bicolor</i> )	2	No
2000	Giant ragweed ( <i>Ambrosia trifida</i> )	2	Yes (HG 9 in 2009 and HG 27 in 2016)
2011	Horseweed/marestail ( <i>Conyza canadensis</i> )	9	No

**Table 1.** Weed species with evolved herbicide resistance in Iowa.



Atrazine was used as the representative HG 5 herbicide. Given the continued use of atrazine for many decades, it is not surprising that evolved resistance in waterhemp is so widely distributed in Iowa with 97% of the waterhemp populations sampled demonstrating HG 5 resistance.

The adoption of crop cultivars with genetically-engineered tolerance to glyphosate in the mid-1990s was arguably the most important change in agriculture since the introduction of the moldboard plow. Glyphosate has been used on most of the Iowa corn and soybean acres for more than a decade and the inevitable evolution of glyphosate resistance is wide-spread in waterhemp and is predicted to be in 98% of the fields in Iowa.

Given the increased importance of HG 14 herbicides to control glyphosate-resistant waterhemp, it is likely that while this survey shows that 17% of the waterhemp populations screened from 2013 samples indicated HG 14 resistance, this likely underestimates the occurrence of HG 14 resistance in waterhemp currently.

The last new herbicide mechanism of action commercially introduced was the HG 27 herbicides almost 30 years ago. These herbicides have been widely used in corn, and as a result evolved resistance to HG 27 herbicides is widely distributed in Iowa on 28% of fields based on the 2013 samples. It is suggested that these data underestimate the occurrence of HG 27 resistance given the increased use of these products since the survey ended. Further, the frequency of HG 27 resistance brings into question how effective the anticipated HG 27 resistance in soybean cultivars will be at supporting weed management.

A problem with herbicide resistance in waterhemp is there does not appear to be a fitness penalty associated with the resistance. As a result, the resistance trait is likely to be conserved even if the herbicide is not used and the new resistances will be added to previously evolved resistance. Given the dearth of new herbicide mechanisms of action, multiple resistances in waterhemp dramatically increased the difficulty of management. Also of

importance is that multiple herbicide resistances in Iowa waterhemp populations is the norm (Figure 2). Waterhemp populations with resistance to three herbicide groups increased over the course of this study, and in 2013 69% of the waterhemp populations demonstrated three-way resistance. This estimate is correct at the 95% confidence interval. Not surprising is the observation that the most common three-way resistance are for HG 2, HG 5, and HG 9, the most commonly used herbicide groups. Resistance to

four herbicide groups and five herbicide groups (all the herbicide groups used in the screen) did not change over the course of the study with four-way resistance more commonly detected than five-way resistance. Management of multiple herbicide resistant waterhemp is a significant challenge for farmers.

Regardless of pending changes in herbicides and crop traits, weed management diversification beyond herbicides must be considered in order to support the tools currently available to farmers. Iowa agriculture will not be able to resolve weed management issues by simply spraying herbicides. It is important to understand that most of the fields from which waterhemp populations were collected were transitioning from sensitive to resistant and the population density of waterhemp found was likely lower than the level that would be recognized by a farmer and cause a major concern. Nevertheless, the levels of herbicide resistance detected suggests that unless remediation is initiated, wide resistance to herbicides in Iowa waterhemp populations will likely increase. Despite farmers' desires to have available a new herbicide, it is impossible to spray the problem of herbicide resistance in waterhemp away. The only solution is the judicious use of herbicides and adoption of greater diversity of weed management tactics. Clearly, issues in weed management continue to be increasingly complex, and there are no simple and convenient answers despite what herbicide marketing might suggest.

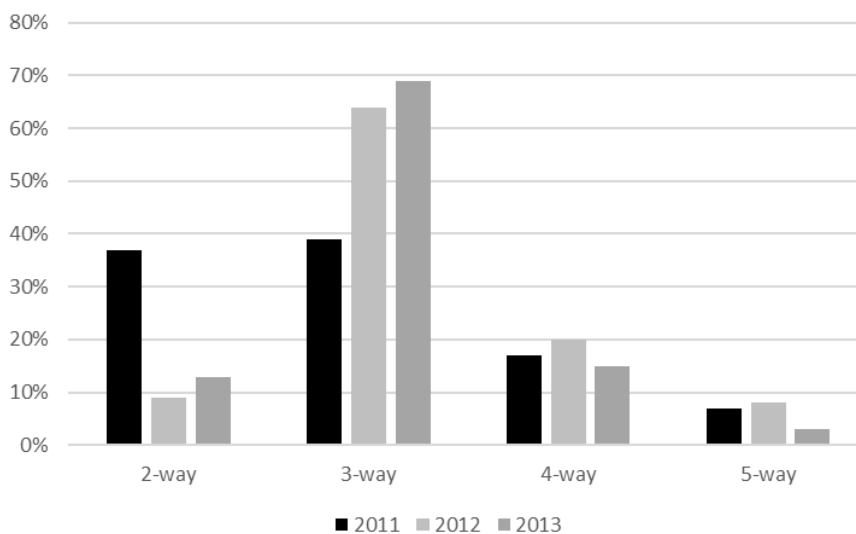
## Resources

### Low pesticide rates may hasten the evolution of resistance by increasing mutation frequencies

Gressel, J. 2011. *Pest Management Science* 67: 253-257

### International survey of herbicide resistant weeds

[www.weedscience.com](http://www.weedscience.com)



**Figure 2.** Evolved multiple resistance in waterhemp to in Iowa 2011-2013.



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## Strategies for diversifying weed management

### Objectives

- Participants will increase their understanding of how weed biology influences weed management and the need for more diverse management systems.
- Participants will be able to design herbicide programs that include multiple effective herbicide groups.
- Participants will be able to identify alternative weed management tactics that could be implemented on their farm.

The chemical era of weed management was initiated in the 1940s with the discovery of the phenoxy herbicides (2,4-D, etc.). By the mid-1970s more than 90% of US corn and soybean acres were treated with herbicides. Post-plant tillage (rotary hoeing, cultivating) remained an integral component of weed management in Iowa until the late 1980s when increasing farm size and the introduction of the Group 2 herbicides (ALS inhibitors) resulted in a rapid decrease in the use of these practices. Since the 1990s weed management in Iowa has relied largely on herbicides, providing simple and cost-effective weed control.

The result of heavy reliance on herbicides has been the rapid spread of herbicide-resistant weeds. While glyphosate resistance is frequently the focus of the resistance discussion, it is important to realize that weeds are rapidly evolving resistance to any herbicide that is widely used. In Iowa, waterhemp has evolved resistance to Group 2, 5, 9, 14, and 27 herbicides. Group 4 resistance has been identified in waterhemp in Nebraska and Illinois. The majority of Iowa's fields are infested with waterhemp biotypes possessing multiple herbicide resistance.

In the past industry was able to minimize the impact of herbicide resistance by introducing new chemistry, but those days are over. It has been more than 30 years since a new herbicide group was discovered. It is essential that weed management systems be diversified in order to preserve the effectiveness of the herbicides still effective on resistant-prone weeds such as waterhemp, marestail/horseweed, and giant ragweed.

The first step in diversifying weed management is taking into account how weed biology and ecology influences the effectiveness of control tactics. For example, the prolonged emergence pattern of waterhemp necessitates that control programs remain active later into the growing season than for most other weeds. The early emergence of giant ragweed provides opportunities to enhance management by delaying planting. Knowing what weeds are present in fields and how they respond to management tactics is essential for developing effective programs.

The second step involves developing herbicide programs that place selection pressure on weeds with multiple herbicide groups. To protect from selecting the next herbicide resistant weed biotype, individual herbicides must be used at rates and applied at times where they provide effective control by themselves, rather than relying on additive activity of the herbicides used in the program. While most farmers utilize programs with several herbicide groups, the herbicides are often used in ways that result in a single herbicide group providing the bulk of activity on problem weeds. Herbicide programs must be critically evaluated to determine how effectively individual active ingredients are being used.

Improved use of herbicides can delay further onset of herbicide resistant problems, but to sustain the current production system alternative control tactics must be adopted. Our current production system is based on herbicides minimizing labor requirements; therefore, any tactic that requires additional time can be difficult for many farms to adopt.

A simple approach to diversify weed management is to use field specific management. Weed problems vary from field to field; using the same herbicide program on all fields is an inefficient use of technology. Targeting labor-intensive tactics such as post-plant tillage for problem fields, or problem areas of fields, may make these strategies more compatible for a farm operation. Controlling problem weeds in field borders, terraces, drowned out areas of fields, etc. reduces seed contributions to the weed seed bank. For example, giant ragweed commonly is found in field borders, eventually leading to invasion of the crop field.

Another method to diversify weed management is the use of narrow row spacings. The time needed for the crop canopy to close the row decreases with reductions in row spacing. A competitive crop canopy is one of the most effective weed suppressing tools available, therefore reducing the selection pressure placed on weeds by herbicides. Cover crops are another tool that can reduce our dependence on herbicides. A cereal rye cover crop is very effective at suppressing winter annuals such as marestail and field pennycress. While the effectiveness of cover crops on summer annual weeds is limited somewhat by Iowa's short growing season, they can play a role in weed management. Delayed soybean planting can increase weed suppression by allowing the cover crop to accumulate more biomass before it is terminated.

Additional tactics likely will be introduced in the future to reduce our dependence on herbicides. Australia has led the way in development of tools to destroy weed seeds during harvest, and these tools are being adapted for Midwest cropping systems. Robotic tools that selectively remove weeds via herbicides or mechanical means are in various stages of development. Diversifying our cropping system to include crops with different life cycles (e.g. winter annuals, perennials) would be of great benefit for long-term weed management. Wider adoption of these alternative crops will require changes in infrastructure and economic incentives.

Weeds have the ability to adapt to any control tactic. The less diverse the management system, the more rapidly these adaptations occur. Over the past 50 years we have selected for a few weed species that are ideally adapted to herbicide-based systems. Herbicides will remain important tools in the future, but additional strategies are needed to preserve their efficacy. Alternative tactics are not as simple to incorporate into production systems as a new herbicide, but without diversification of weed management the effectiveness of these tools will continue to erode.

## Use IPM to manage field crop pests

### Objectives

- Understand how insecticide resistance can occur.
- Offer sustainable management recommendations for corn rootworm.
- Provide an update on pyrethroid resistance to soybean aphid.

### Insecticide resistance issue

With any pest, exposures to insecticides and Bt traits will eventually lead to resistance developing in the population. A combination of integrated pest management (IPM) and insect resistance management (IRM) tactics are needed to manage common field crop pests. Implementing IPM and IRM will prolong existing and emerging management tactics, while improving profit margins.

Before assuming insecticide or Bt resistance development in the field, rule out other possible factors, such as: misapplication of the product (incorrect rate, poor coverage, etc.), unfavorable weather conditions around the time of application (wind, rain, temperature), and pest recolonization. The overwintering and migratory behavior of field crop pests is not fully understood.

### Corn rootworm management recommendations

Western corn rootworm is an adaptable pest, and developed resistance to all available Bt traits in Iowa cornfields. Populations were highly variable in 2017, and some areas has significant root injury. Conditions in 2017 that increase the likelihood of corn rootworm issues in 2018 include: continuous corn production, late-planted or late-maturing hybrids, weedy fields and borders and more than a node of root injury. My recommendation for sustainable corn rootworm in Iowa is to:

- Implement crop rotation; planting soybean every 3-5 years can break up the rootworm life cycle.
- Rotate the use of Bt pyramids and soil-applied insecticides.
- Plant early and/or use early-maturing hybrids.
- Scout for larval corn rootworm injury to roots in July.

## Resources

### ISU Weeds Webpage

[crops.extension.iastate.edu/pests/weeds](https://crops.extension.iastate.edu/pests/weeds)

### Herbicide program development: Using multiple sites of action

[crops.extension.iastate.edu/blog/meaghan-anderson-bob-hartzler/herbicide-program-development-using-multiple-sites-action](https://crops.extension.iastate.edu/blog/meaghan-anderson-bob-hartzler/herbicide-program-development-using-multiple-sites-action)

## Soybean aphid management recommendations

Pyrethroid resistance has been confirmed for soybean aphid in the Midwest; however, the severity in Iowa is unknown. Population fluctuations between locations and years are typical soybean aphid dynamics for Iowa. The odds of making a profitable treatment decision are increased with regular scouting and applications made after exceeding the economic threshold. The economic threshold is validated annually at Iowa State University and is recommended regardless of fluctuating market values. My recommendation for sustainable soybean aphid management in Iowa is to:

- Plant early if the field is in an area with persistent soybean aphid populations.
- Scout for soybean aphid, especially during R1–R5, and use a foliar insecticide if aphids exceed the economic threshold of 250 per plant. Take note of natural enemies and other potential plant pests in addition to soybean aphid.
- Use a product labeled for soybean aphid, and use high volume and pressure so that droplets make contact with aphids on the undersides of leaves. Check aphid populations three days after application to assess product efficacy.
- Alternate the mode of action if soybean aphid populations need to be treated twice in a single growing season (e.g., organophosphates and pyrethroids).
- Understand that late-season accumulation of aphids, particularly after R5, may not impact yield like it does in early reproductive growth. A foliar insecticide applied after seed set may not be an economically profitable choice.

## Resources

### ISU Extension Crop Insects

[crops.extension.iastate.edu/pests/insects](https://crops.extension.iastate.edu/pests/insects)

### Soybean Entomology

[www.ent.iastate.edu/soybeanresearch/content/extension](http://www.ent.iastate.edu/soybeanresearch/content/extension)

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# Managing soybean cyst nematode with resistant varieties and seed treatments

## Key points

- Soybean cyst nematode (SCN) is Iowa's most-damaging soybean pathogen.
- Iowa's SCN populations are overcoming resistant soybean varieties.
- Active monitoring of SCN numbers in fields is advised.
- Consider managing SCN with nonhost corn, resistant soybeans, and seed treatments.

The soybean cyst nematode (SCN), *Heterodera glycines*, is a major yield-limiting factor of soybean in the United States and Canada. The nematode is found in every soybean-producing state in the United States except West Virginia. Also, it is in all 99 Iowa counties. Results of random surveys conducted in Iowa in the 1990s, repeated in the mid 2000s and again in 2017 indicate SCN is present in 60% to 70% of the fields in the state. The nematode has very high reproductive abilities and very effective long-term survival in the soil in the absence of host soybeans, making it a consistent threat to profitable soybean production.

## Managing SCN with resistant soybean varieties

Growing resistant soybean varieties was very effective and economical for managing SCN for several decades. The resistant varieties allowed relatively low (<10%) reproduction of the nematode and produced profitable yields in SCN-infested fields compared to susceptible varieties. Unfortunately, almost all SCN-resistant soybean varieties for Iowa in the past 25 years have contained the same resistance genes, from a single breeding line or source of resistance called PI 88788.

Growing soybean varieties with the same SCN resistance genes year after year is similar to using a single pesticide active ingredient on insects, fungi, or weeds year after year. Eventually, the pest population can build up resistance to the pesticide or resistance genes. And such is the case with SCN. The ability of SCN populations in Iowa farm fields to reproduce on varieties with PI 88788 resistance has been increasing for the last 15 years, and levels of 50% or more reproduction on PI 88788 now are not uncommon. Farmers should grow soybean varieties with different sources of resistance and also rotate among soybean varieties with the common PI 88788 source of resistance to delay the build-up of resistance-breaking populations of SCN.

## Managing SCN with seed treatments

Seed treatments are a relatively new management option for SCN. Currently there are seven choices (see Figure 1), with more products likely to come in future years. Each seed treatment has a different active ingredient and mode of action. Some have chemicals and others have biological organisms as active ingredients. Many, but not all, have direct effects on SCN. Some are very specific for SCN, such as Clariva, whereas some have activity against several species of plant-parasitic nematodes. Most of the nematode-protectant seed treatments are not sold as stand-alone products; they are offered bundled on top of seed insecticides and fungicides.








Using the nematode-protectant seed treatments may reduce SCN reproduction, may increase soybean yields, may have both effects, or may have no effect. Results when using these seed treatments undoubtedly will vary among the different products and likely also will vary among growing seasons and, perhaps, among soil environments and other yet-to-be-identified factors.

## Conclusion

Successful long-term management of SCN requires coordinated use of all available management tactics, which include growing nonhost crops, growing resistant soybean varieties, using nematode-protectant seed treatments, and active monitoring of SCN numbers through soil sampling.

## Resources

- ISU Soybean Cyst Nematode information [www.soybeancyst.info](http://www.soybeancyst.info)
- Soybean Research & Information Initiative [www.soybeanresearchinfo.com/diseases/scn.html](http://www.soybeanresearchinfo.com/diseases/scn.html)
- ISU SCN-resistant Soybean Variety Trials [www.isutrials.info](http://www.isutrials.info)
- SCN-resistant Soybean Varieties for Iowa [store.extension.iastate.edu/product/5154](http://store.extension.iastate.edu/product/5154)

Product name, company	Crop(s)	Targeted nematodes	Active ingredient	Mode of action
 Avicta <sup>Complete</sup> from Syngenta	cotton, corn, soybean	all ppns	abamectin	inhibits nerve transmission
 N-HIBIT from Plant Health Care, Inc.	all	all ppns	harpin protein	bolsters natural plant defenses
 VOTIVO from Bayer CropScience	cotton, corn, soybean	all ppns	<i>Bacillus firmus</i>	repels nematodes from roots
 Clariva <sup>pn</sup> from Syngenta	soybean	SCN	<i>Pasteuria nishizawae</i>	nematode parasite
 EVO from Bayer CropScience	soybean	SCN, RKN, reniform, lesion	fluopyram	SDHI enzyme inhibitor
 NEMASTRIKE from Monsanto	cotton, corn, soybean	SCN, RKN, reniform, lesion	tioxazafen	mitochondrial translation inhibitor
 AVEO from Valent	corn, soybean	SCN, reniform, lesion	<i>Bacillus amyloliquefaciens</i>	under investigation

**Figure 1.** Characteristics of currently available nematode-protectant seed treatments for SCN.

# Cover crops and crop diseases

## Key points

- The benefits of cover crops outweigh the risk of disease.
- Terminate rye at least 10 days before planting corn to reduce risk of seedling disease.
- Cover crops may mitigate some disease risks in corn and soybean.

There are numerous environmental benefits associated with cover crop use, e.g., reducing erosion, improving infiltration, mitigating nutrient loading in surface waters, and improving soil health. In Iowa, introducing winter cover crops into corn and soybean production is being encouraged due to the potential to improve water quality and sustain the productive capacity of agricultural land. The Iowa Nutrient Reduction Strategy (2013) includes example land-use scenarios in which all corn-soybean and continuous corn acres in the state are planted to cover crops. Despite the environmental benefits of cover crops, many farmers are reluctant to include cover crops on their farms because of numerous perceived risks including negative impacts on yield, and increased disease.

## Seedling disease

Many cover crops are hosts of the same pathogens that infect corn and soybean seedlings. We found that if corn is planted too soon after terminating a cereal rye cover crop, there is a risk of increased seedling disease that may result in reduced stands, poor plant vigor and lower corn yields (Table 1). It is likely that disease incidence is only partly responsible for the yield decrease, however, as other factors such as poor N availability after a rye cover crop may have played a part. Consequently we recommend terminating rye at least 10 days before planting corn.

No negative effects of rye on soybean seedling disease have been detected.

## Corn stalk rot

Some farmers have observed that corn standability at harvest is better in fields planted to cover crops the previous winter compared to fields left fallow over the winter. In a field trial in central Iowa in 2017, we detected significantly less stalk rot in plots in which a rye cover crop was present over the 2016-2017 winter compared to plots where no cereal rye was present over the same period. More research is needed to confirm the effect of a cover crop on stalk rot.

## White mold

In 2017, a farmer in northwest Iowa observed less white mold in soybeans where his winter rye cover crop had been taller compared to the area where the later planted rye was very much shorter. Research done at University of Wisconsin in 2001 reported less white mold and greater yields in plots where a small grain cover crop was present in early spring. Moreover, the number of apothecia (mushrooms growing from white mold sclerotia) observed in the plots varied across the growing season. More apothecia were observed in the cover crop plots in April and May compared to the soybean plots, where apothecia were observed in July. Cover crops may encourage an early flush of apothecia before soybean flowering that results in less infection and white mold development. Further research is needed.

## Sudden death syndrome

Some farmers have observed less SDS in fields where a cover crop was planted. Preliminary data from Iowa State University has been inconclusive but research is ongoing.

## Resources

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General disease information  
[www.cropprotectionnetwork.org](http://www.cropprotectionnetwork.org)

ISU Integrated Crop Management -  
Crop Diseases  
[crops.extension.iastate.edu/pests/diseases](http://crops.extension.iastate.edu/pests/diseases)

**Table 1.** Effect of time interval between rye termination and corn planting on seedling height, incidence of radicle root rot, and yield in field experiments in Iowa in 2015.

Treatment	Seedling height (inches)	Radicle root rot incidence (%)	Yield (bu/A)
No rye (control)	12.5 a <sup>1</sup>	8.3 b	224.5 a
Rye terminated 25 DBP <sup>2</sup>	10.7 c	25.0 b	209.7 b
Rye terminated 17 DBP	10.2 bc	25.0 b	208.2 b
Rye terminated 8 DBP	8.5 d	80.6 a	200.7 bc
Rye terminated 3 DBP	8.3 d	80.6 a	191.8 cd
Rye terminated 2 DAP <sup>3</sup>	9.5 c	83.3 a	182.9 d

<sup>1</sup> Numbers in a column with the same letter do not differ significantly (P<0.1).

<sup>2</sup>DBP = days before planting corn.

<sup>3</sup>DAP = days after planting corn



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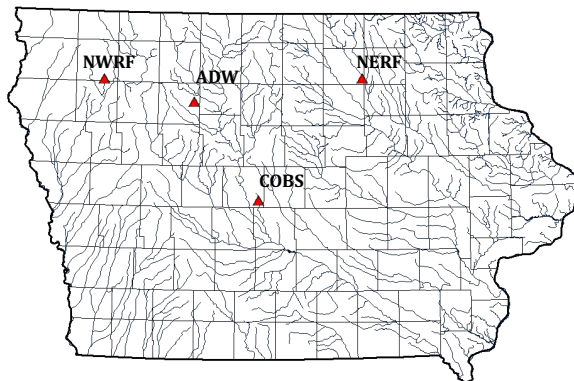
mhelmers@iastate.edu

# Impacts of 4R nutrient management on drainage water quality

## Key points

- ISU has been studying drainage water quality of N management for nearly 30 years.
- N rate has a bigger impact than source or time on nitrate loss in drainage.
- Reducing N loss starts with the 4Rs but we will likely need additional practices.

Currently, there is a concerted effort from industry, universities, and state and federal action agencies to promote the 4R nutrient management approach on-farm—considering the Right source, Right rate, Right time, and Right place— for managing nutrient additions from commercial fertilizer and organic materials ([www.nutrientstewardship.com](http://www.nutrientstewardship.com)). The drainage water quality information collected at various sites throughout Iowa have provided important information on the impacts of 4R Nitrogen Management on drainage water quality (Figure 1).



**Figure 1.** Location of Drainage Water Quality Research Facilities

## Main findings from these sites

### NERF

- Continuous corn systems required higher input of N fertilizers and resulted in significantly higher nitrate-N leaching losses compared to corn-soybean rotations fertilized with manure or urea ammonium nitrate (UAN).
- A cereal rye cover crop significantly reduced nitrate-N concentrations in drainage water compared to a similar treatment without a cover crop (10 mg/L with cover crop vs 14 mg/L without cover crop).
- Chisel plowed and no-till plots had similar overall nitrate-N concentrations and total N losses via subsurface drainage water.



### ADW

- When N-fertilizer is applied at economic N-rates, the average concentration of nitrate-N in tile drainage ranged from 12 to 16 mg/L (drinking water standard is 10 mg/L).
- For a corn–soybean rotation with no N-fertilizer applied there was still 15–20 lb-N/acre lost through tile drains at nitrate-N concentrations of 6–8 mg/L.
- In general, concentration of nitrate in the tile drainage was similar for the corn and soybean phases of the corn-soybean rotation.
- During the 13 years that timing of fertilizer application was studied, there was little difference in the concentration or loss of nitrate between spring- and fall-applied N fertilizers.
- Use of a cover crop has the potential to reduce nitrate-N concentration in drainage water.
- The use of poly-coated urea as a source of nitrogen fertilizer showed some potential to reduce nitrate concentrations in subsurface drainage.

### COBS

- Flow-weighted nitrate-N concentrations were 0.1, 0.6, 9.3, 10.4, 13.1, and 13.2 mg/L for prairie, fertilized prairie, continuous corn with cover crop, corn, soybeans, and continuous corn, respectively.
- Despite higher nitrogen application in the continuous corn with cover crop treatment (176 lb N/acre 7-year average), the nitrate-N loss was less than under the continuous corn with no cover crop (162 lb N/acre 7-year average).

## Resources

Agricultural Drainage Research and Demonstration Site – Gilmore City  
[store.extension.iastate.edu/product/15147](http://store.extension.iastate.edu/product/15147)

Comparison of Biofuel Systems Site  
[store.extension.iastate.edu/product/15148](http://store.extension.iastate.edu/product/15148)

Northeast Research and Demonstration Farm  
[store.extension.iastate.edu/product/15149](http://store.extension.iastate.edu/product/15149)

Northwest Research and Demonstration Farm  
[store.extension.iastate.edu/product/15150](http://store.extension.iastate.edu/product/15150)

# Nitrogen use: It's not your grandfather's corn

## Objectives

- Understand relation of nitrogen and increase in corn yield over time.
- Understand the change in corn grain and plant nitrogen from 1960 to 2000 era hybrids.
- Understand corn nitrogen uptake timing in 1960 compared to 2000 era hybrids.
- Understand corn grain nitrogen removal with harvest compared to nitrogen application rate.

Adequate plant available nitrogen (N) is a requirement for high yielding corn. Nitrogen fertilizer or manure is applied to supplement N supplied by the soil system. Fertilization rates are derived from on-farm research trials, and in Iowa suggested economic optimum N rates [Maximum Return To Nitrogen (MRTN) and most profitable N rate range] are provided through the online Corn Nitrogen Rate Calculator and the Iowa State University Extension and Outreach publication “Nitrogen Use in Iowa Corn Production”.

Corn yields have increased substantially in Iowa over time, from around 40 bu/acre through 1940 to now around 200 bu/acre (statewide averages). As yield goals were used for a long time to determine N applications (ex. yield goal bu/acre times a factor), many people still expect the current high corn yields to require concurrent high N fertilizer application rates. However, suggested MRTN rates provided by the Corn Nitrogen Rate Calculator are not based on yield goals, but instead recent research trials that measure yield increase to applied N. Not using yield level (goal) in N rate determination leads many people to believe that rate guidelines are too low to support the current high yields.

What is not widely accepted is that corn N fertilization requirements have been relatively constant for a long time. A two-year study near Ames Iowa that looked at N use by popular hybrids from ten-year periods (1960, 1970, 1980, 1990, and 2000 eras planted at the same time and same environment) showed that yields were highest, N response greater, and N use efficiency higher in the most recent era hybrids; however, grain and plant N concentrations were lower which tempered plant N demand in the most recent era hybrids. That is, grain and plant N content (amount) did not follow directly the higher yields across time. For example, in Table 1 where the 1960 and 2000 era hybrids are compared, the 2000 hybrids had 67% higher yield, but only 19% more total plant N and only 22% more grain N than the 1960 era hybrids. The per bushel grain N was 0.76 lb N/bu for the 1960 era hybrids, but only 0.58 lb N/bu for the 2000 era hybrids (a 24% lower N concentration). In several studies conducted across Iowa in recent years, the average grain N was 0.53 lb N/bu at

economic optimum N rates. This means, harvested grain N removal, even at high yields, is less than suggested MRTN application rates from the Corn Nitrogen Rate Calculator (especially for continuous corn) – likely opposite of what many would expect. Also, the internal plant N use efficiency (bu produced per lb total plant N) was 40% higher for the 2000 era hybrids than the 1960 era hybrids (which is a very good trait). Nitrogen use efficiency can vary with different years, environmental conditions and yield levels, and plant use efficiency helps explain why current yield levels do not match optimal N fertilization rates.

**Table 1.** Comparison of 1960 and 2000 era hybrids.

Plant Measurement	Era	
	1960	2000
Grain Yield (bu/acre)	134b	224a
Total N uptake at maturity (lb/acre)	159b	190a
Grain N (lb/acre)	113b	138a
Grain N Harvest Index	0.71a	0.73a
Grain Harvest Index (%)	49a	53a
Grain (bu/lb of total plant N)	0.84b	1.18a
Grain N Concentration (% DM basis)	1.61a	1.23b
Grain N (lb N/bu at 15.5%)	0.76a	0.58b

Letters indicate statistical difference in measurement between eras ( $P \leq 0.10$ ). K.P. Woli, M.J. Boyer, Roger W. Elmore, J.E. Sawyer, L.J. Abendroth, and D.W. Barker. 2016. Iowa State University.

Much progress has been made in corn yield improvement over time. It is helpful from an economic and environmental standpoint that higher N applications have not been needed to allow those yield improvements to be realized. However, on a regional basis as grain N removal compared to N application rate has remained similar over time (an example is the ratio of estimated grain N removal from statewide corn yields and fertilizer N applied to corn in Iowa), nitrate-N movement to water systems has also remained similar. Increasing N applications in reaction to high corn yields would only reduce profitability and worsen environmental issues such as nitrous oxide release to the atmosphere and nitrate-N in water systems.

## Resources

**Nitrogen Use in Iowa Corn Production**  
[store.extension.iastate.edu/product/14281](http://store.extension.iastate.edu/product/14281)

**Nutrient Considerations with Corn Stover Harvest**  
[store.extension.iastate.edu/product/14052](http://store.extension.iastate.edu/product/14052)

**Corn Nitrogen Rate Calculator**  
[cnrc.agron.iastate.edu](http://cnrc.agron.iastate.edu)

**ISU Extension Soil Fertility**  
[www.agronext.iastate.edu/soilfertility](http://www.agronext.iastate.edu/soilfertility)



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# Cover crops for Iowa 101

## Key points

- Using cover crops requires a complete evaluation of cropping system practices.
- Find 'easy entry points' where cover crops can provide direct and indirect benefits.
- Start with simple, start small, and learn as much as possible before going big.

Cover crop acres have grown tremendously over the past over the past decade: from fewer than 5,000 acres to over 600,000 acres. The fact remains that cover crops still only cover roughly 2.5% of the row crop acres in Iowa despite the many benefits that cover crops provide. The reasons for not planting cover crops often revolve around two things; 1) decreased yield of corn and soybean cash crops and/or 2) higher production costs with no direct return on investment.

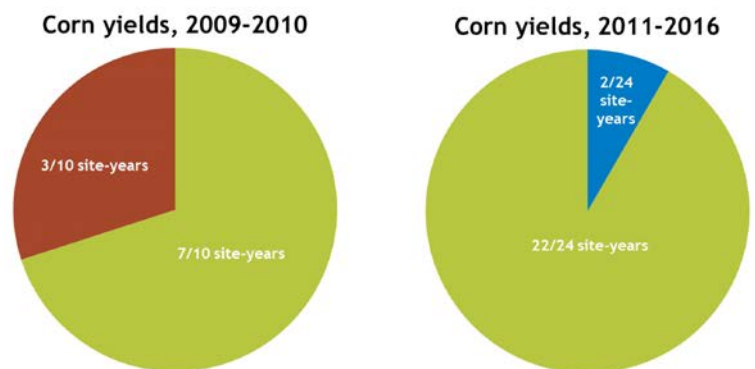
Research shows no yield loss to the subsequent cash crop when cover crops are well managed. There is even evidence where yields of soybean following cover crops are improved. Yes, it's true that cover crops do add to the cost of corn and soybean production. But can well managed cover crops implemented at easy entry points negate the return on investment argument? Gaining value by utilizing cover crops for cover crop seed production, grazing, or haylage quickly pays for the cost of implementation even if these uses minimally penalize corn and soybean yields.

## Steps for Successful Implementation of Cover Crops in Iowa

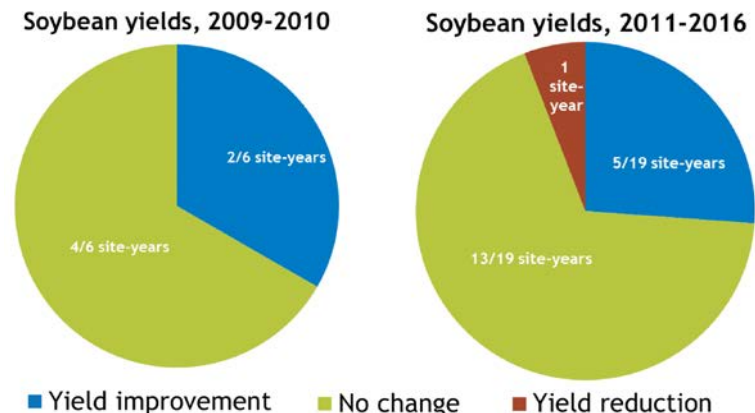
- Start small, start simple
- Complete change of cropping system
- Do your homework
- Look for easy entry points
- Target acres
- Terminate ahead of planting
- Adjust the row crop planter
- Scout both cover crops and cash crops

For successful implementation of cover crops, start simple and small with the ability to increase scale and complexity as knowledge and ability increase. Using cover crops requires a complete change in the cropping system. Put some time in ahead of seeding to plan how your herbicide, fertility, and tillage programs will need to change. Learn what this means on a small number of acres close to home that are easy to see and manage in the fall, spring, and summer. Target implementation on marginal areas that have a high risk of erosion and nitrogen leaching. Planting cover after corn silage, early maturing soybean, seed corn, small grains and on prevented planting acres or in drowned out areas of fields allow more time for planting and cover crop growth. Other easy entry points might be fields near livestock operations that might be conducive for grazing or forage harvest. Be diligent to ensure seeding and termination success. Have patience at planting to ensure the row crop planter is functioning properly. Scout both the cover crop and the cash crop to identify potential problems as well as identifying where improvements to be made in the future.

**Figure 1.** Trends with respect to cover crop effect on corn yields at 10 site-years from 2009 to 2010 and 24 site-years from 2011 to 2016 (source: Iowa Learning Farms).



**Figure 2.** Trends with respect to cover crop effect on soybean yields at 6 site-years from 2009 to 2010 and 19 site-years from 2011 to 2016 (source: Iowa Learning Farms).







**Figure 3.** Termination of cover crops is critical to the success of the subsequent cash crop. Termination by tillage (left image) can present challenges because of poor effectiveness but also creation of poor seedbed conditions while timing of herbicide applications (right image) after too much growth hinders coverage and termination success.

**Figure 4.** Properly adjusting row cleaners, row unit down pressure, placement depth, and closing wheel pressure will ensure stand established following a cover crop. These settings while important when planting into any conditions are more critical to ensure proper planting following cover crops.



## Resources

### Tips and Considerations for Getting Started with Cover Crops

[crops.extension.iastate.edu/cropnews/2015/08/tips-and-considerations-getting-started-cover-crops](http://crops.extension.iastate.edu/cropnews/2015/08/tips-and-considerations-getting-started-cover-crops)

### Cover Crops for Sustainable Crop Rotations

[www.sare.org/Learning-Center/Topic-Rooms/Cover-Crops](http://www.sare.org/Learning-Center/Topic-Rooms/Cover-Crops)

### Midwest Cover Crops Council

[mccc.msu.edu](http://mccc.msu.edu)

### Iowa Learning Farms

[www.iowalearningfarms.org](http://www.iowalearningfarms.org)



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# Iowa Nutrient Reduction Strategy: Statewide and local project progress

## Objectives

- Review the Iowa Nutrient Reduction Strategy and the identified nitrate and phosphorus reduction practice options.
- Understand the Logic Model approach to measuring progress of the Iowa Nutrient Reduction Strategy and progress made to date.
- Participants will review and discuss a local watershed project's goals and strategies and their contribution toward meeting the statewide goals of the Iowa Nutrient Reduction Strategy.

## Introduction

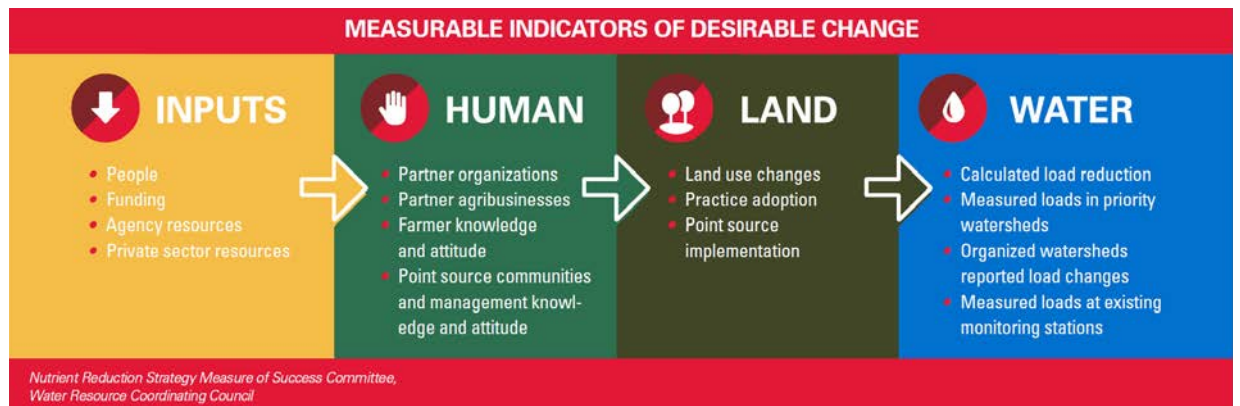
The Iowa Nutrient Reduction Strategy (INRS) is a science and technology-based framework to reduce nutrient loss to Iowa waters and the Gulf of Mexico. The strategy identifies methods and practices to reduce total loads of nitrogen and phosphorus from both cities and industrial point sources and agricultural nonpoint sources by a combined 45% (INRSSA, 2013). The approach was developed in response to the 2008 Gulf Hypoxia Action Plan that calls for Iowa and other states in the Mississippi River watershed to develop strategies to reduce nutrient loadings to the Gulf of Mexico and ultimately reduce the size of the gulf hypoxic zone. The INRS development was led by the Iowa Department of Agriculture and Land Stewardship and the College of Agriculture and Life Sciences at Iowa State University and included an assessment of recent research to identify practices that reduce nitrogen and phosphorus loss from the agricultural landscape. An assessment of nitrogen and phosphorus discharge from the state's largest wastewater treatment plants was conducted by the Iowa Department of Natural Resources. Through these

assessments, the point source reduction goals were set at 4% for nitrate-nitrogen and 16 % for phosphorus and non-point source goals are 41 % for nitrate-nitrogen and 29% for phosphorus (INRSSA, 2013).

## Statewide progress

A high rate of adoption of a combination of in-field, edge of field and land use change practices is needed to meet the nitrate and phosphorus reduction goal. The 2017 INRS Annual Report summarized implementation progress through the end of 2016 for the practices identified in the science assessment. Increases in funding, education, and technical assistance metrics have been measured and have led to increases in practice implementation. Approximately 623,000 acres of cover crops were established in 2016 with 305,000 acres implemented with state and federal cost-share programs and the remaining 318,000 estimated to be established by landowner, farmer and other private investment (INRS, 2017). Implementation of edge-of-field practices that reduce nitrate including nitrate removal wetlands and bioreactors, has also increased. According to available cost-share practice data, there are currently 85 nitrate removal wetlands installed in the state that are removing nitrate from 100,000 acres of tile drained crop land and 20 bioreactors treating approximately 1000 acres (INRS, 2017). Terraces and sediment control basins constructed since 2011, when data became readily available, are reducing sediment and phosphorus loss from approximately 250,000 acres (INRS, 2017). Land retirement through the Conservation Reserve Program has remained steady since 2001 with 1.4 million acres currently enrolled in the program in Iowa.

While the increases in practices that reduce nitrate and phosphorus loss are encouraging, acres and numbers of practices currently on the landscape fall far short of what's needed to reach the Iowa Nutrient Reduction Strategy nonpoint source goal. Approximately 12 million acres of cover crops, 7,600 wetlands, and 120,000 bioreactors will be needed to fully reach goals.



**Figure 1.** The Logic Model of the Iowa Nutrient Reduction Strategy, guided by measurable indicators of desirable change.

## Local practice implementation

Iowa has been addressing water quality impairments and soil conservation goals by working at the local watershed level for decades. In order to scale up the local watershed efforts and increase INRS practice implementation, the Iowa Water Quality Initiative (WQI) was created. This initiative awards funds to Soil and Water Conservation Districts and other agricultural and natural resource organizations to establish demonstration projects that showcase nitrate and phosphorus reduction practices. There are currently 16 WQI projects and 47 total active watershed projects in the state working to improve water quality. Four local watershed projects will be featured at the 2018 Crop Advantage Series.

The **Iowa Great Lakes Project** implemented by the Dickinson County Clean Water Alliance collaborates with stakeholders and partners to implement a wide range of urban low impact development and agricultural soil and nutrient management practices to protect and improve water quality in the Iowa Great Lakes region. The project is working to implement low impact development structures, protect shoreline with native shortgrass prairie, reconstruct wetlands and restore prairie to reduce sediment, nitrogen, and phosphorus loads entering the lakes.

The **West Branch of the Floyd River Water Quality Initiative Project** is engaging stakeholders through education and outreach across the agricultural community to showcase nutrient reduction practices. Public and private natural resource and agricultural

partners are collaborating to increase adoption of terraces, cover crops, no-till, grassed waterways, filter strips, nutrient management, and bioreactors.

The **Deep Creek Water Quality Initiative Project** in Plymouth County is collaborating with a variety of public and private partners to provide information and education on water quality concerns in the watershed. The project is focusing on the implementation of terraces, cover crops, no-till, grassed waterways, filter strips, nutrient management, nitrification inhibitor, and subsurface P (manure) placement.

The **Headwaters of the North Raccoon River WQI Project** in Buena Vista and Pocahontas Counties is working with local farmers, agricultural advisers and retailer partners to promote a suite of integrated nutrient management, land use change, and edge-of-field practices. The project is focused on the implementation of bioreactors, cover crops, sidedressed and spring applied nitrogen, nitrification inhibitor, no-till, strip till, and phosphorus placement.

## Resources

**Reducing Nutrient Loss: Science Shows What Works**

[store.extension.iastate.edu/product/13960](http://store.extension.iastate.edu/product/13960)

**ISU Extension Water Quality**

[www.extension.iastate.edu/waterquality](http://www.extension.iastate.edu/waterquality)

**Iowa Water Quality Initiative**

[cleanwateriowa.org](http://cleanwateriowa.org)

**Dickinson County Clean Water Alliance**

[cleanwateralliance.net](http://cleanwateralliance.net)

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[crops.extension.iastate.edu](http://crops.extension.iastate.edu)



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## Long-term tillage studies

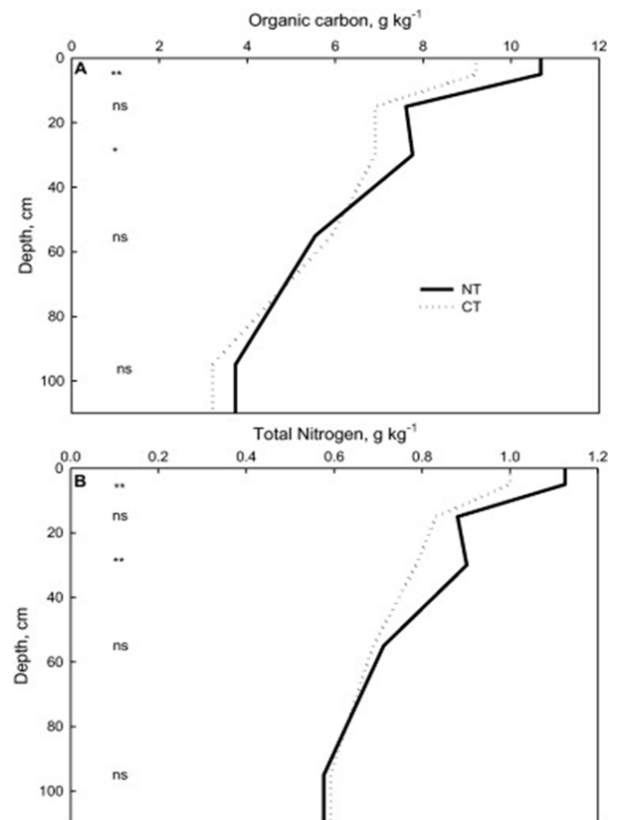
### Objectives

To learn about the impact of long-term tillage on Iowa's agricultural landscape. The specific objectives will be learn about:

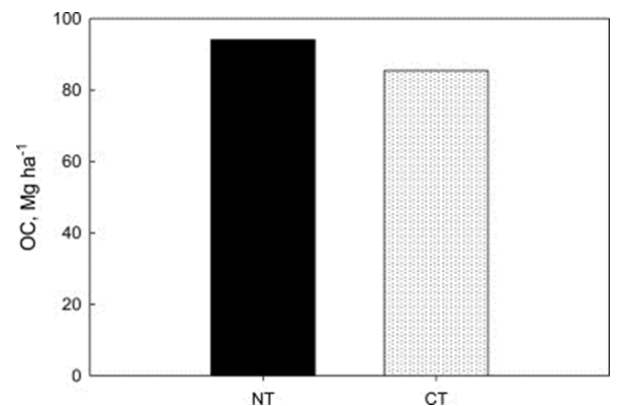
- The history of Iowa's landscape prior to and after European settlement.
- Soil tillage and Iowa's soil quality and health
- Soil Tillage Intensity Rating (STIR).
- Soil conservation and soil health.

Iowa's landscape was 85% (30 million acres) prairie prior to European settlement. 160 years after the settlement, less than 10% (3 million acres) of Iowa's prairies, woodlands, and wetland remained. By the beginning of the 20th Century, Iowa's entire prairie had been converted to farmlands. Human activities including deforestation, cultivation of grassland, drainage of the land and land use changes resulted in the drastic change in Iowa's landscape. Between 2009 and 2013 Iowa lost 192,000 acres of trees. However, in the same time period 49.5% (95,000 acres) of Iowa's landscape was also planted with trees (Tisinger, 2017). Trees act as buffers to prevent soil erosion, N and P losses to improve water quality (IDNR, 2006).

Soil erosion, which produces the sediments that reduce air and water quality, is accelerated with tillage, which leaves the soil bare and exposed to the erosive forces of wind and water. Without steps to prevent soil erosion, both wind and water become the most damaging factors that visibly deteriorate soil health across a landscape. Soil tillage intensity rating (STIR) is a numerical value in the range of 0 to 200 based on factors determined by the management decisions implemented for a particular field. STIR determines the extent and severity of soil disturbance by tillage operations. Lower STIR values indicate less overall disturbance of the soil layer. Therefore, specific components of STIR values include the operational speed of tillage equipment, depth of the tillage operation, and the percent of the soil surface disturbed. It is well documented that long-term tillage impacts soil health with losses in soil organic carbon, soil structure and soil water storage. Soil health is essential for plant and animal productivity, sustains soil biodiversity, supports human health and wildlife habitat and also enhances water and air quality. Therefore, the benefits of reduced or no-tillage include reduced soil compaction, enhanced soil permeability, increase in soil organic carbon and soil profile water storage. Less disturbed soils are healthier and enhance water and air quality, sustain plant and animal productivity, improve soil biodiversity, as well as human and wildlife habitat. Figures 1 and 2 show some of the effects of tillage on soil organic C and N.



**Figure 1.** Organic carbon (A) and total nitrogen (TN) for soils under no-till (NT) and conventional tillage (CT) in Oklahoma. ns, non-significant at 0.05. \*\*, \*\*\*, \*\*\*\*, and \*\*\*\* indicate significance at  $\alpha = 0.1, 0.005, 0.01,$  and 0.0001. Source: Silvano L. Abreu, Chad B. Godsey, Jeffrey T. Edwards and Jason G. Warren. 2011.



**Figure 2.** Organic carbon pool averaged across locations, significantly ( $p=0.07$ ) greater in no-till (NT) compared to conventional tillage (CT). Source: Silvano L. Abreu, Chad B. Godsey, Jeffrey T. Edwards and Jason G. Warren. 2011.

### Resources

ISU Soil Management/Environment  
[www.extension.iastate.edu/soilmgmt](http://www.extension.iastate.edu/soilmgmt)

NRCS Soil Tillage Intensity rating (STIR)  
<https://goo.gl/EbQ394>

# Climate resilience improves crop production, soil quality, and water quality

## Objectives

- Weather within a growing season is becoming more variable and affects production.
- Path toward climate resilience links soil and water quality and benefits crop production.
- Linkages among soil and water quality and efficient crop production are the foundation of Climate Smart agriculture.
- Weather-proofing the cropping systems for Iowa links genetics, environment, and management.

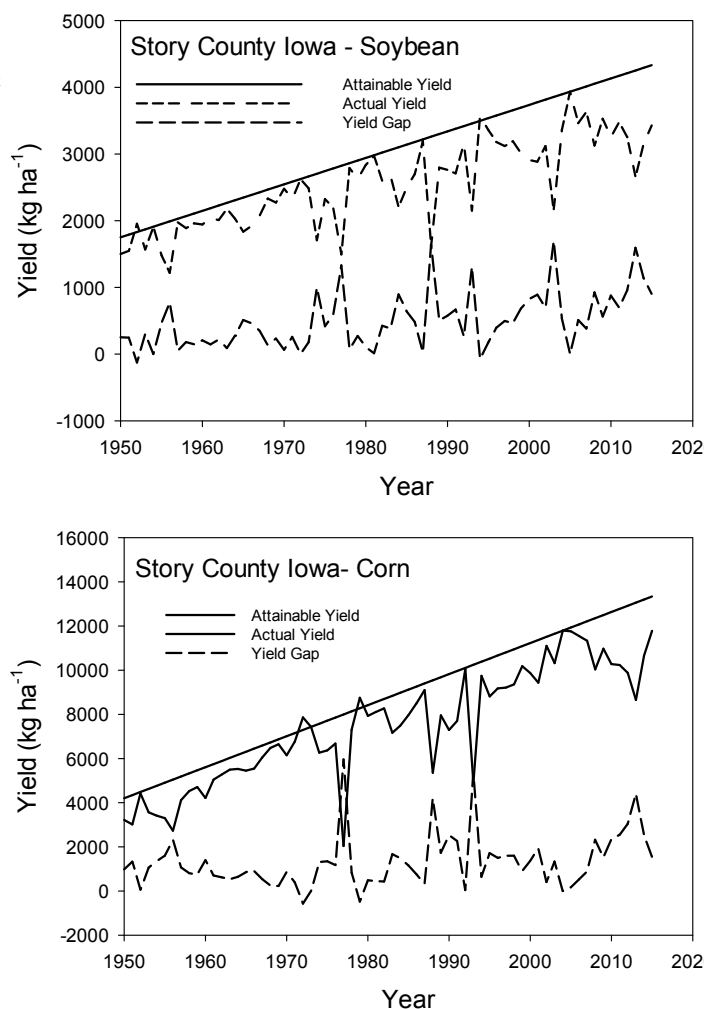
There is a continual discussion about what will happen in our climate in the future; however, there are trends in our climate that are indicative of the potential changes. Across the Midwest, these trends in climate reveal the following changes:

- There is an increasing amount of precipitation on an annual basis with a fewer number of years showing low annual totals
- There is a shift in seasonality of precipitation with more of the annual precipitation occurring in the spring (April-May-June) with reduced and more variable summer precipitation
- Rain events have become more intense with larger storm totals and are less frequent
- Temperatures have been increasing with more warming in the winter months
- Minimum temperatures are increasing more than the maximum temperatures especially during the summer months
- There is an increase in relative humidity during the summer

These changes in our climate and more importantly, the changes in the weather within a growing season have caused variations in expected yields of corn and soybean across Iowa. We have utilized a method of evaluating the weather parameters linked to yield variation at the county level. To do this, we have computed the yield gap as the difference between the highest county yield (attainable yield in Figure 1) and the observed yield for each year as shown in Figure 1 for Story County corn and soybean production since 1950.

For each year, the yield gap was related to different weather parameters and we found that July maximum temperatures, August minimum temperatures, and July-August total rainfall were the most significant factors explaining why we are not achieving attainable yields in both corn and soybean. July maximum temperatures are related to the effect on the efficiency of pollination, August minimums affect the efficiency of grain-fill and July-August rainfall supplies the water needed during the grain-filling period.

*Continued on page 30*



**Figure 1.** Yield gap difference between attainable county yield and observed yield, Story County, Iowa.



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*Climate resilience improves crop production, soil quality, and water quality –*

*Continued from page 29*

The goal is climate smart or climate resilient agriculture is to reduce the yield gap. The path toward achieving this goal can be attributed to the following.

- Increasing soil quality through the addition of organic matter and retaining crop residue on the surface improves water storage, increases the infiltration rate, and reduces the soil water evaporation from the surface. Soil water management throughout the growing season becomes even more critical given the trends in climate.
- Increasing the soil water supply offsets the impact of extreme July temperatures because a well-watered crop doesn't suffer water stress as frequently.
- Improving soil quality also increases the nutrient cycling in the soil and has the ability to supply nutrients during the grain-filling period and allows for a more efficient utilization of nutrients.
- There is a decrease in water quality problems with soil quality because we alter the water dynamics in the soil, this leads to reduced runoff and reduced leaching through the soil profile.

Yield variation exists across fields due to differences in soil quality in supplying water and nutrients. Understanding the patterns of yield variation provides a direction for overcoming the impacts of the increasing weather variation. Achieving climate resilience requires an integration of the soil and management practices to enhance and maintain the genetic potential.

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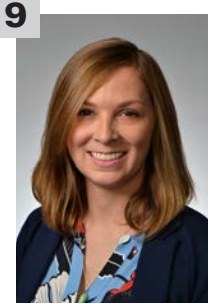
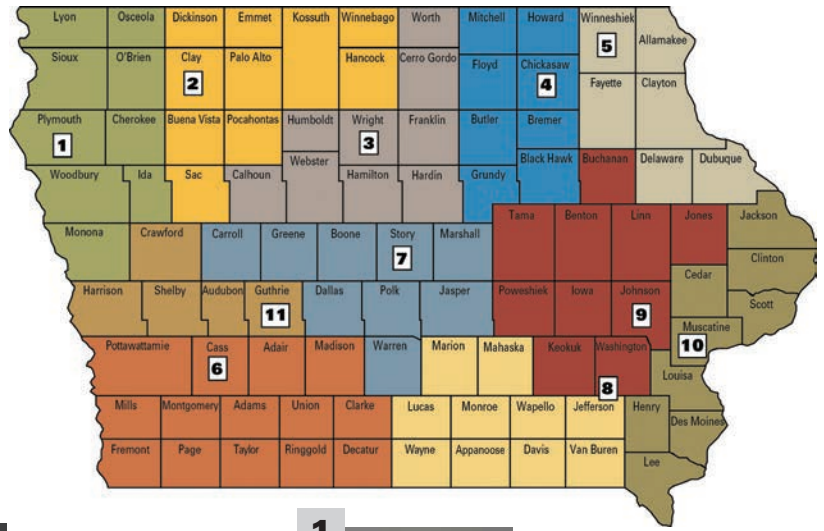
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Iowa State University Extension and Outreach Field Agronomists are located throughout Iowa to assist farmers with current crop production and protection information. They serve as a vital link in delivering current, relevant and research-based information to the citizens of Iowa.



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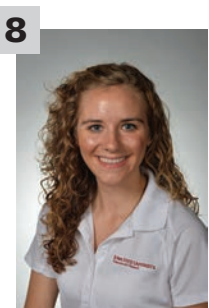
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